Adopting Continuous Assurance With a Front-End System for Ongoing Risk and Control Assessments – The Role of Internal Audit as Accumulator Across the Three Lines of Defence

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Table of Contents

List of Figures

List of Tables

Abstract

In this thesis, the adoption of Continuous Assurance in Swiss internal audit activities and how its acceptance can be increased have been evaluated. Continuous Assurance is an internal audit methodology combining continuous auditing with testing of the effectiveness of the first and second line of defences' continuous monitoring activities to achieve broader and more timely assurance. By employing technology and data analysis, auditors implement ongoing risk and control assessments to better understand (emerging) risks and control effectiveness. In a mixed-method approach, factors influencing Continuous Assurance acceptance were identified from interviews and the literature and tested in a survey among Swiss internal auditors. The results indicate that proper re-engineering of audit processes, focussing on visible benefits early-on, availability of the right skills, and an effective corporate IT will help auditors expect benefits from Continuous Assurance.

A front-end system for Continuous Assurance has been designed and implemented at a case study partner. In a design science research approach, the system design has been adapted over multiple iterations and its final impact has been evaluated using interviews and usage metrics. The front-end covers ongoing risk and control assessments, guiding auditors along the methodology to aggregate risks from visualized quantitative and qualitative inputs and to document work performed and conclusions drawn. Results confirm the importance of properly re-engineered audit processes and of a step-by-step implementation in which data-driven and qualitative analysis co-exist. Overall, an effective front-end system can increase acceptance among internal auditors: they observe efficiency gains and saw the roll-out as a commitment from management regarding the new methodology. Ideally, the Continuous Assurance methodology would be fully embedded within available audit management systems. The thesis presents user stories based on the initial design goals and subsequent iterations to enable this integration.

Zusammenfassung

In der vorliegenden Arbeit wurde die Akzeptanz von Continuous Assurance in der internen Revision in der Schweiz sowie Einflussfaktoren zu deren Steigerung untersucht. Continuous Assurance ist eine Methodik, die Continuous Auditing mit Tests zur Wirksamkeit des Continuous Monitorings in der ersten und zweiten Verteidigungslinie kombiniert, um breitere und zeitnähere Assurance zu erzielen. Durch den Einsatz von Technologie und Datenanalysen erhalten Auditors mit laufenden Risiko- und Kontrollbeurteilungen eine klarere Sicht auf (sich entwickelnde) Risiken und die Wirksamkeit der internen Kontrollen. Mit Interviews und einer Literaturrecherche wurden mögliche Einflussfaktoren erhoben und, einem Mixed-Methods-Ansatz folgend, in einer Umfrage unter Schweizer Auditors getestet. Ein sauberes Reengineering der Auditprozesse, ein Fokus auf früh sichtbaren Mehrwert, die richtigen Kompetenzen und eine wirksame IT-Abteilung tragen dazu bei, dass Auditors sich Vorteile von Continuous Assurance erwarten.

Mit einem Case-Study-Partner wurde ein Front-End-System für Continuous Assurance entworfen und implementiert. Design Science Research folgend wurde das Design iterativ angepasst und abschliessend mittels Interviews und Nutzungszahlen beurteilt. Das Front End begleitet den Auditor bei laufenden Risiko- und Kontrollbeurteilungen, der Aggregation quantitativer sowie qualitativer Risikofaktoren und der Erkenntnisdokumentation. Die Case Study bestätigt die Bedeutung des Prozess-Reengineerings und einer schrittweisen Implementierung, bei der visuelle, datengetriebene und qualitative Analysen koexistieren. Ein wirksames Front End kann die Akzeptanz der Auditors erhöhen: sie beobachten Effizienzgewinne und erleben die Einführung als Signal des Managements zur Bedeutung von Continuous Assurance. Idealerweise würde Continuous Assurance vollständig in bestehende Audit-Management-Systeme integriert, wobei in dieser Arbeit auf Basis der Designziele iterativ entwickelte User Stories als Vorlage dienen können.

Chapter 1

Introduction

This thesis aims to evaluate how adoption of continuous assurance (CA), understood as the combination of effective continuous auditing and continuous monitoring, can be improved in organisational practice, with a focus on internal audit.

New developments in regulation, technology and business have lead to the establishment of CA as a new methodology for assurance across all lines of defence (see section 1.3). However, even though academic discussion of CA has started over 20 years ago and various case studies of real-word implementation exist by now, adoption is still not as widespread as was once hoped (see section 1.4). Given the expected benefits of CA in addressing the challenges facing organisations and the ongoing transformation of the three lines of defence (see section 2.3), this seems unfortunate.

By identifying factors that influence adoption of CA and its sub-components and by designing and developing a front-end system that uses these factors to encourage adoption among internal auditors, this thesis aims to reduce the existing gap in CA between research and practice.

1.1 Focus on Internal Control

The large accounting scandals at the beginning of the century (Enron, Worldcom) lead lawmakers and regulators to increasingly focus on the *internal controls* of organisations (Moeller, 2008). In 2002, the United States enacted the Sarbanes-Oxley Act (SOX), which in Section 404 makes the management of public companies responsible for "establishing and maintaining an adequate internal control structure" (404(a)) and requires public companies' management to publish an internal controls assessment that needs to be attested to by the external auditor (404(b)).

Switzerland reacted to this change in its revision of the Code of Obligations (CO) in 2005, stating in art. 728a that the external auditor has to examine whether "there is an internal system of control" (para. 1) and that the auditor "takes account of the internal system of control when carrying out the audit" (para. 2). In the European Union (EU), the 8th Company Law Directive[1] published in 2006 defines in art. 41 that it is the audit committee's responsibility to "monitor the effectiveness of the company's internal control, internal audit where applicable, and risk management systems" (art. 41 para. 2(b)).

For the financial industry, the financial crisis of 2008 has brought an additional wave of regulatory attention on compliance and internal controls. The Dodd-Frank Act of 2010 in the United States has introduced various new restrictions on a bank's activities (such as the Volcker Rule, which restricts proprietary trading; SEC, 2013) that need to be monitored for compliance. In addition, control failures such as the unauthorized trading incident at UBS London discovered in 2011 have led to enforcement actions which required the affected banks to introduce "organisational measures aimed at strengthening [...] risk management and control capability" (FINMA, 2012). In Switzerland, the Swiss Financial Market Supervisory Authority (FINMA) has issued its circular 2008/24 "Supervision and internal control – banks" (FINMA, 2008) in 2008. It assigns responsibility for designing, maintaining and evaluating adequate internal control to the board of directors, defines the responsibility of its audit committee and establishes guidelines for a bank's internal audit activity. In 2017, this circular was replaced by circular 2017/1 "Corporate governance – banks" (FINMA, 2017), which increased the emphasis on independent second line of defence functions, in particular an independent compliance function.

[1] Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/to EEC (Text with EEA relevance).

This evolution of internal control in the regulatory domain has been complemented by supporting guidance on establishing and assessing internal control frameworks. The Committee of Sponsoring Organizations (COSO) was founded in 1985 to sponsor the National Commission on Fraudulent Financial Reporting (COSO, n.d.), which was set-up in response to the accounting frauds in that period. In 1992, it published its "Internal Control – Integrated Framework" (COSO, 1992). Following the developments above, in 2004 COSO issued its framework on Enterprise Risk Management (ERM; COSO, 2004a, 2004b), which did not replace but integrate the internal control framework by "providing a more robust and extensive focus on the broader subject of enterprise risk management" (p. v). Finally, in 2013 COSO updated its framework on internal control (COSO, 2013a). The updated framework accounts for increasing regulatory demands, business complexity and reliance on technology (Moeller, 2016, p. 34).

In the EU, the European Confederation of Institutes of Internal Auditing (ECIIA) teamed up with the Federation of European Risk Management Associations (FERMA) to issue their Guidance on the 8th EU Company Law Directive article 41 (Dennery et al., 2010; Dennery, Dequae, & Nelson, 2011). This guidance was instrumental in establishing the Three Lines of Defence (3LoD) model (see section 2.2) as the most widely accepted model to structure the responsibilities among management, an organisations' internal control functions and internal audit (Ruud & Kyburz, 2014).

These developments have lead to a shift in focus for internal audit departments: Where they were traditionally limited to auditing controls on financial statements using fixed audit plans, their role has evolved into a "multi-audit service provider, addressing operations, financial compliance, IT assurance, risk management, consultancy, and management support activities" (Guener, 2008, p. 23). As independent control functions outside of internal audit (the second line of defence) and holistic ERM have emerged and have taken over some tasks formerly performed by internal audit (Jacka, 2014), internal audit shifted to add value by evaluating the overall appropriateness and effectiveness of an organisation's risk management.

The Institute of Internal Auditors (IIA) has addressed this emergence of other assurance providers in a range of publications, such as its practice guides on "Reliance by Internal Audit on Other Assurance Providers" (Ames, Askelson, Hasan, Strealy, & Williams, 2011), "Coordinating Risk Management and Assurance" (MacLeod et al., 2012), and "Internal Audit and the Second Line of Defense" (Glynn, Hileman, Lerchner, & Sanglier, 2016), its position papers on "The Role Of Internal Auditing In Enterprise-wide Risk Management" (IIA, 2009b) and "The Three Lines of Defense In Effective Risk Management and Control" (IIA, 2013a), and its joint publication with COSO on "Leveraging COSO across the Three Lines of Defense" (Anderson & Eubanks, 2015). In 2012, a revision of the IIA's International Professional Practices Framework (IPPF) increased the risk-focus of internal auditors and newly mandates that the Chief Audit Executive (CAE) needs to review and adapt the audit plan whenever the organisation's risks change (Standard 2010, IIA, 2013b; Dahle, 2012). In 2017, the IIA restructured the IPPF, adding a mission of internal audit which highlights its evolved risk-oriented nature and broad scope: "To enhance and protect organisational value by providing risk-based and objective assurance, advice, and insight" (IIA, 2017b).

In 2019, the IIA started an initiative to "modernize and strengthen" the 3LoD model (John et al., 2019; Ruud & Schramm, 2019). This initiative aims to address that the model is perceived as too limited and too restrictive, focussing "exclusively on defensive actions rather than a more proactive approach to the identification, analysis, and preparedness for both opportunities and threats". It also aims to soften the rigid separation implied by the existing model, which "creates a tendency toward operational silos" and is seen as "not equipped to reflect the current realities of modern organizations". This modernization can be seen as both a consequence of more data-driven assurance, which leads to a shift in roles among the 3LoDs (Dai & Vasarhelyi, 2016), as well as a challenge for which "leveraging data and technology to facilitate insight capture, analysis and communication" can be a part of the solution (John et al., 2019, p. 11).

1.2 The Data Revolution and Assurance

In parallel to these developments in internal control, a technological shift is underway. Starting with the advent of comprehensive Enterprise Resource Planning (ERP) systems in the 1990s, more and more business information has moved from directly observable paper form to being stored as transactions and records in database management systems. For auditors, this means that applying established audit techniques becomes more and more difficult and that "auditors must change their approach to auditing" (Arens, Elder, & Beasley, 2014, p. 401; Rezaee, Sharbatoghlie, Elam, & McMickle, 2002). At the same time, some audit techniques are also becoming less relevant due to automated controls embedded in IT systems (Arens et al., p. 399).

In recent years, these changes have accelerated, making "auditing around the computer" more and more infeasible (Alles, 2015; Byrnes, Al-Awadhi, et al., 2012). The "now economy" requires the reduction of latency in business processes including auditing (Vasarhelyi, Alles, & Williams, 2010). Johnston and Zhang (2018) have shown that IT investment can reduce financial reporting and auditing time lags. And the emergence of Big Data is seen by many in the business world to affect almost all areas of enterprise[2], including audit practice[3].

Big Data is characterized by new means of leveraging data that combine some of the "four Vs" (Fasel & Meier, 2016):

- High *Volume* (requiring large storage and processing capacities)

[2]For example Bughin, Livingston, and Marwaha (2011), Lohr (2012), and McAfee and Brynjolfsson (2012).

[3]See Moffitt and Vasarhelyi (2013), Accounting Horizon's recent forum on this topic (Griffin & Wright, 2015), and the American Accounting Association (AAA)'s conference series on "Accounting is Big Data", `http://commons.aaahq.org/groups/cea5c9d7d1/summary`.

- High *Variety* (including unstructured data such as text, images or videos)
- High *Velocity* (a large amount of data needs to be processed quickly)
- High *Veracity* (data quality can not be assumed)

Today, the intelligent use of data ("the oil of the digital era", The Economist, 2017) is a priority across the professions, including auditing (Dai & Vasarhelyi, 2016). And the data that can be put to use today goes far beyond ERP data: Investors use satellite data to estimate store foot traffic or oil and gas storage levels (Alexander, 2014), information that might be just as useful to auditors.

1.3 Continuous Assurance for the Real-Time Economy

The combination of an increasing scope of internal audit, going beyond financial reporting and towards more timely assurance, the emergence of new assurance providers within the organisation, as well as the technological progress and growth in available data prompt a questioning of the established internal audit model. Already in 1999, Canadian Institute of Chartered Accountants (CICA) have proposed continuous auditing as an answer to the changing technological environment. They have focussed on external auditing and defined "continuous" auditing as "a methodology that enables independent auditors to provide written assurance on a subject matter using a series of auditors' reports issued simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter" (p. 5).

Since then, continuous auditing has mainly taken hold not in external but in internal auditing (Byrnes, Ames, Vasarhelyi, & Warren, 2012), where it has been extended to the concept of continuous *assurance* (CA)[4]. In 2015,

[4] Note that in external auditing, "continuous assurance" is understood as providing assurance on subject matters exceeding the regular financial statement audit (Alles, Kogan, & Vasarhelyi, 2002, p. 126).

the IIA provided their definition of continuous auditing (Ames et al., 2015b, p. 1):

> Continuous auditing comprises ongoing risk and control assessments, enabled by technology and facilitated by a new audit paradigm that is shifting from periodic evaluations of risks and controls based on a sample of transactions, to ongoing evaluations based on a larger proportion of transactions. Continuous auditing also includes the analysis of other data sources that can reveal outliers in business systems, such as security levels, logging, incidents, unstructured data, and changes to IT configurations, application controls, and segregation of duty controls.

To address the proliferation of other assurance providers in the organisation, Ames et al. (2015b) embed continuous auditing into the broader context of "continuous assurance" (CA): In areas where other units already perform effective continuous monitoring (CM), internal audit can limit itself to "audit testing of first and second lines of defense continuous monitoring" (p. 4). The combination of continuous auditing by internal audit and assurance on the effectiveness of other units' CM comprises CA.

The IIA's definition separates continuous auditing into two distinct subelements: ongoing risk assessments (ORAs) and ongoing control assessments (OCAs). Vasarhelyi, Alles, and Williams (2010, p. 41) similarly describe three "distinct but complementary components:

1. Continuous controls monitoring (CCM) which consists of a set of procedures used for monitoring the functionality of internal controls

2. Continuous data assurance (CDA) which verifies the integrity of data flowing through the information systems

3. Continuous Risk Monitoring and Assessment (CRMA) which is used to dynamically measure risk and provide input for audit planning."

By leveraging automation across the lines of defence and combining continuous auditing with testing of CM, CA can increase coverage and achieve a more timely reaction to emerging risks. It can thus be an effective response to the changing internal controls landscape and increased requirements outlined above (Debreceny, Gray, Ng, Lee, & Yau, 2005; Hardy & Laslett, 2015; Kiesow, Schomaker, & Thomas, 2016; Kuhn & Sutton, 2006). It also addresses the risk of duplication by the emergence of new assurance providers in the organisation and provides an answer to overlapping assurance activities and the weaknesses of the established three lines of defence (3LoD) model. By reducing communication costs and friction in exchanging information, efforts can become better aligned (Weins, 2012): by accumulating assurance across the 3LoDs in a data-driven and often automated way, culminating in overarching CA from the internal audit activity, CA can effectively and efficiently utilise the work performed by assurance providers outside of internal audit. This is supported by evidence that the use of data analytics (Barr-Pulliam, Brown-Liburd, & Sanderson, 2017) and of continuous auditing (Barr-Pulliam, 2018; Malaescu & Sutton, 2015) can improve the quality of the internal audit activity.

1.4 Continuous Assurance Adoption

While in the late 1990s and early 2000s academic discussion on CA and in particular continuous auditing was euphoric and focussed on upending the traditional audit model (e.g. in Elliott, 2002; Vasarhelyi, Alles, & Kogan, 2004), in practice a more "pragmatic" model seems to have developed at many companies, focussing on step-by-step changes and/or complementing existing audit and assurance work with central, periodic data analytics in specific areas or sub-domains (Byrnes, Ames, et al., 2012, p. 35).

By now, various successful "continuous assurance" and "continuous auditing" implementations exist[5] and also a lot of theoretical groundwork has

[5]See for example Alles, Brennan, Kogan, and Vasarhelyi (2006) and Medinets, Gross, and Brennan (2015) at Siemens; Alles, Kogan, and Vasarhelyi (2008) also at Siemens and

been laid. However, the understanding of what exactly comprises "continuous assurance" and of the roles and responsibilities of auditors versus operational management in this area still differs widely between different practitioners[6].

In addition to this uncertainty, Byrnes, Ames, et al. (2012), Kiesow, Schomaker, and Thomas (2017, p. 58), Vasarhelyi, Alles, Kuenkaikaew, and Littley (2012), and Whitehouse (2011) also all report that CA has not had the widespread adoption some have hoped for. For Garrido (2011), it appears that "Continuous Auditing has represented the future of our function for over twenty years though it is not clear when it will form part of the present" (p. 84).

1.5 Research Questions and Approach

Based on the understanding that CA is an effective response to changes in the assurance environment but that its adoption has so far not reached its potential, this thesis investigates how to bridge this gap. The overarching research question of the thesis is thus:

Q. How can adoption of Continuous Assurance (CA) in organisations be increased?

This thesis employs a combination of descriptive behavioural research into CA and design science research, following a multi-method approach (as suggested e.g. by Kuechler, Vaishnavi, & Kuechler, 2007).

at an unnamed health service provider; Appelbaum, Kozlowski, Vasarhelyi, and White (2016) at a U.S.-based non profit; Byrnes, Ames, et al. (2012, pp. 7-16) at Hewlett-Packard; Coderre (2006) at the Royal Canadian Mounted Police; de Aquino, Miyaki, and Sigolo (2013) at Itaú Unibanco; Garrido (2011) at BBVA; Goh (2017) at DBS Bank; Hardy and Laslett (2015) at Metcash; Kuznik and Küppers (2015) at Douglas Holding AG; Nelson (2004) at HCA Inc.; Rudyk (2015) at Zürcher Kantonalbank; Singh and Best (2015) at a "major international manufacturing organization"; Vasarhelyi and Halper (1991) and Hume, Daniels, and MacLellan (2000) at AT&T.

[6] See e.g. Hardy, 2014, p. 371, who describes continuous auditing as a "messy object".

In a first step, the factors influencing CA adoption were evaluated using empirical, behavioural research. Based on a systematic review of existing literature as well as expert interviews across the key stakeholder groups, potential drivers of CA adoption were identified. These potential drivers were subsequently tested in a survey format with Swiss internal audit practitioners for their impact on CA adoption, covering the following subquestion:

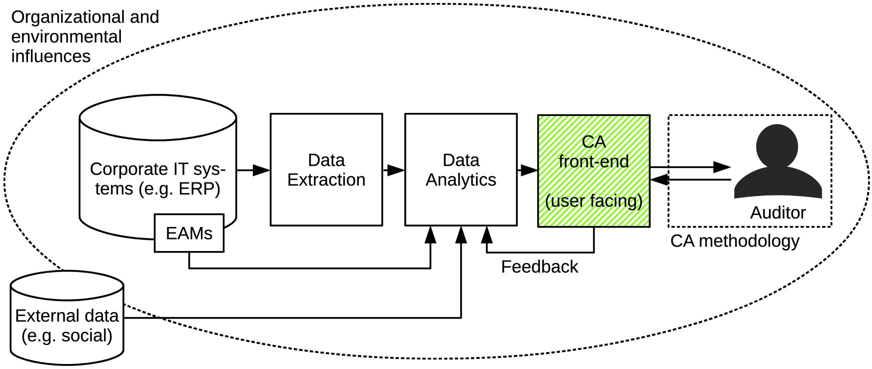
> **Q1.** Which factors have a significant impact on CA adoption in Swiss organisations, contingent on the organisational environment?

Focusing on Switzerland allows to avoid potential distortions due to differences in the role of interal audit and other assurance providers in organisations across legal and cultural boundaries. By focussing on internal audit, this thesis looks at the group that – due to currently being the primary assurance provider to the board of directors – will be at the heart of any shift to CA.

It can be assumed that CA adoption will be driven by organisational factors (e.g. the roles, responsibilities and resources of internal audit and other assurance providers in an organisation or their stakeholders' expectations) as well as the design and implementation of the CA methodology and technology used (see section 3.1.1), with the effect of these factors being contingent on their contextual environment (e.g. firm size, industry, regulatory environment, IT landscape, available data quality). The second part of this study focusses on a particular area of this overall structure (see Figure 1.1): A front-end system was designed and implemented that guides and supports users in their interaction with continuous auditing or continuous monitoring analytics and data for their ongoing risk and control asessments.

The focus on a CA front-end system is motivated by the assumption that the perception of CA and thus usage intentions and adoption (see section 3.1) will be most directly influenced by system parts which are closest to the individual user. In addition, areas such as environmental factors (see e.g.

Figure 1.1: The CA environment. Focus of research question Q2 on a CA front-end system highlighted as shaded area.



Byrnes, Ames, et al., 2012; CICA, 1999; Ramamoorti, Cangemi, & Sinnett, 2011; Whitehouse, 2012), CA methodology (e.g. Ames et al., 2015b; Vasarhelyi, Alles, & Williams, 2010), the overall system design (e.g. Alles, Kogan, & Vasarhelyi, 2004; Baksa & Turoff, 2011; Chan & Vasarhelyi, 2011; Kiesow, Zarvić, & Thomas, 2014) as well as analytics and data extraction technology (see e.g. Debreceny et al., 2005; Murthy & Groomer, 2004; Vasarhelyi, Alles, & Williams, 2010) are already well-covered in existing literature (see Figure 3.4 for an overview) without this having the desired effect on CA adoption. Areas such as data extraction and analytics also depend heavily on an organisation's existing IT and data environment, complicating the design of a generic artefact (Hardy, 2015, p. 4737). In contrast, this study hypothesizes that it is possible to develop a generic CA front-end system that can be configured and used in a wide range of environments and by different assurance providers (i.e. both in continuous auditing and monitoring settings).

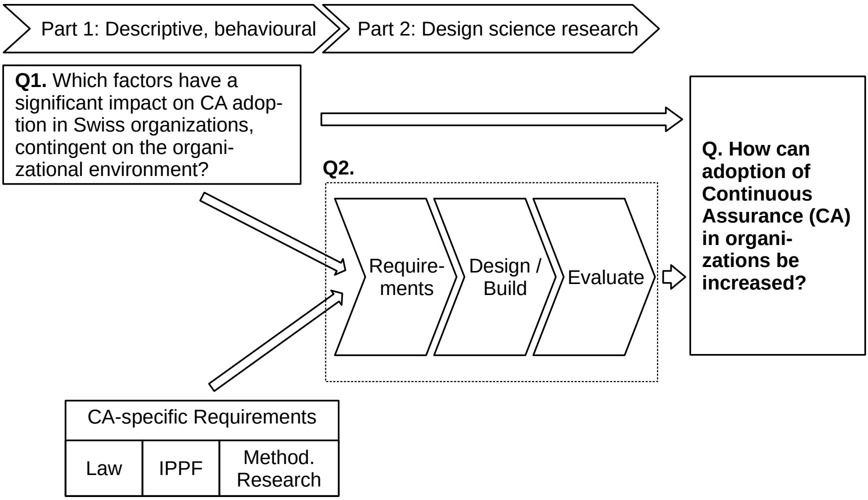
This part of the thesis uses a design science research (DSR) approach. DSR aims to answer questions by designing and evaluating innovative artefacts (Hevner & Chatterjee, 2010). DSR is a common research method in both information systems (Kuechler et al., 2007) and CA research (Alles, Kogan, & Vasarhelyi, 2013; Kiesow et al., 2016). McCarthy (2012) forcefully argues that DSR methods can improve the relevance of accounting research. While descriptive research seeks truth, DSR seeks usefulness (Winter & Aier, 2016): Developed artefacts are evaluated “with respect to their effectiveness and efficiency in the performance of the given task” (March & Storey, 2008, p. 726). This is highly relevant for the second subquestion, which focuses on effectively encouraging CA adoption through the use of information systems:

> **Q2.** How can a CA front-end system be designed to support CA adoption by organisations?

A DSR artefact needs to be grounded in kernel theories (Kuechler & Vaishnavi, 2008), which will inform the requirements that guide the design process. The requirements for our artefact will come from two distinct sources: Firstly, any effective CA front-end system needs to satisfy mandatory and recommended guidance on auditing and internal controls in general and CA in particular. These requirements are derived from sources such as relevant regulatory requirements on internal control and the IIA’s International Professional Practices Framework (IPPF; IIA, 2017a). Secondly, as our focus is on increasing CA adoption, our requirements are based on the findings to Q1 above: An adoption-focussed CA front-end system should incorporate factors that encourage and avoid factors that inhibit CA adoption, contingent on the environment of the target organisation and taking all relevant stakeholders into account.

Rigorous DSR relies on a thorough, “well-executed” evaluation of the designed artefact (Hevner, March, Park, & Ram, 2004, p. 85). Without evaluation, proposed artefacts remain purely prescriptive arguments without scientific truth (Iivari, 2007). Accordingly, the developed CA front-end system was put to use in a corporate internal audit department using a case study approach and its effect on CA adoption was evaluated. Following the iterative approach of DSR (Hevner et al., 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007), early insights allowed to refine the artefact while

Figure 1.2: Overall research approach of this thesis.



a final summative evaluation was conducted to determine whether the artefact achieves its goal of increasing CA adoption and what can be inferred from the intermediate design changes for theory development.

An overview of the overall research approach is shown in Figure 1.2. It emphasizes the two distinct sources of requirements (CA adoption factors versus requirements on the CA methodology) which form the kernel theories of the study.

Chapter 2

Continuous Assurance

Continuous assurance is a means to achieve timelier assurance over a broader range of topic areas by employing technologies such as data analytics throughout the lines of defence. It combines continuous auditing by internal audit with continuous monitoring in the first and second lines of defence. It is embedded in the overall governance for internal audit and subject to the same objectives and requirements faced by internal control and internal auditing overall.

This chapter will thus start by introducing the governance structures of internal control and internal auditing before establishing how CA fits into this environment.

2.1 Internal Control in Organisations

Internal control is defined by COSO (2013b) as "a process, effected by an entity's board of directors, management, and other personnel, designed to provide reasonable assurance regarding the achievement of objectives relating to operations, reporting, and compliance" (p. 3).

In the United States, sections 205 and 301 of the Sarbanes-Oxley Act of 2002 (SOX) have established that the board of directors via their audit committee has oversight responsibility for accounting and financial reporting of the organisation (Braiotta, Gazzaway, Colson, & Ramamoorti, 2010, p. 3). This is mirrored in Swiss law via CO art. 716a, which assigns as "non-transferable and inalienable duties" to the board:

> 3. the organisation of the accounting, financial control and financial planning systems as required for management of the company;
>
> [...]

5. overall supervision of the persons entrusted with managing the company, in particular with regard to compliance with the law, articles of association, operational regulations and directives;

For banks in Switzerland, the FINMA circular 2017/1 substantiates these requirements by clarifying that the board is responsible for “ensuring that there is both an appropriate risk and control environment within the institution and an effective [internal control system (ICS)]” (para. 14). The board’s audit committee is responsible for “monitoring and assessing the effectiveness of the internal control system, specifically risk control, the compliance function and internal audit (in so far as this responsibility is not discharged by the risk committee)” (para. 37). Note that this definition includes internal audit as part of the ICS.

For other firms, the industry organisation economiesuisse has developed the Swiss Code of Best Practice for Corporate Governance (economiesuisse, 2016; the “Swiss Code”), which serves as a self-regulatory corporate governance framework for Swiss companies. It also stipulates that the board is responsible for “ensuring a risk management and an internal control system which are adapted to the company”, with a broad understanding of risk management covering “financial, operational and reputational risks” (para. 20)[1]. This responsibility is being supported by the requirement to set-up an audit committee (para. 23), which “forms an independent opinion on the internal and external audit, the internal control system and the annual accounts”. The audit committee also “assesses the effectiveness of the internal control system including risk management and obtains an overview of the compliance of the organization” (para. 24).

While the board has an oversight role, management is responsible for operationalizing internal control across the organisation. For the United States, this is formalised in SOX Sec. 404(a)(1). Swiss law refers to internal

[1] All quotes from the Swiss Code are translations based on the German version.

control in CO art. 728a, which stipulates that the external auditor needs to verify whether "an internal control system exists". For banks, FINMA circular 2017/1 clarifies that the executive board is responsible for "developing and maintaining [...] an ICS and the necessary technological infrastructure" (para. 50).

For developing an ICS, multiple frameworks exist. The COSO Internal Control – Integrated Framework (which has been updated in 2013) is the most widely used framework in the United States and globally. Other models are the Criteria of Control Framework (CoCo) developed in Canada by the Canadian Institute of Chartered Accountants (CICA), the Framework for Internal Control in Banking Organisations by the Basle Committee on Banking Supervision and the "Turnbull Report" developed in Great Britain. COBIT is an IT governance and control framework developed by the Information Systems Audit and Control Association (ISACA). Briciu, Dănescu, Dănescu, and Prozan (2014) discuss and provide a comparative overview over these control models.

COSO establishes three categories of objectives for internal control (COSO, 2013b, p. 3):

- *Operations* Objectives: "These pertain to effectiveness and efficiency of the entity's operations, including operational and financial performance goals, and safeguarding assets against loss."
- *Reporting* Objectives: "These pertain to internal and external financial and non-financial reporting and may encompass reliability, timeliness, transparency, or other terms as set forth by regulators, recognized standard setters, or the entity's policies."
- *Compliance* Objectives: "These pertain to adherence to laws and regulations to which the entity is subject."

To address these objectives, COSO proposes five "components" of internal control (COSO, 2013b, pp. 4–5):

- The *Control Environment* "is the set of standards, processes, and structures that provide the basis for carrying out internal control across the organization". It includes the tone from the top starting with the board of directors, the corporate governance structure and the values of the organisation.

- The *Risk Assessment* includes establishing objectives and identifying risks to the achievement of these objectives. Risk assessment also includes identifying changes to the internal and external environment that risk rendering internal control ineffective.

- The *Control Activities* are "the actions established through policies and procedures that help ensure that management's directives to mitigate risks to the achievement of objectives are carried out".

- *Information and Communication* covers obtaining the information required for effective internal control and its dissemination inside and outside of the organisation via effective communication.

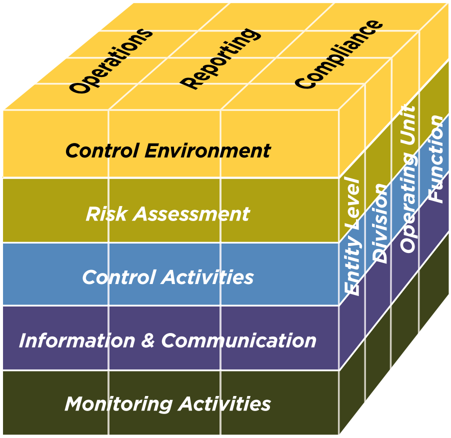
- *Monitoring Activities* are "ongoing evaluations, separate evaluations, or some combination of the two [...] to ascertain whether each of the five components of internal control, including controls to effect the principles within each component, is present and functioning".

The COSO framework aligns the three objectives, the five internal control components and the organisational functions of the entity in a cube (Figure 2.1). This highlights that all objectives need to be covered with all components and that internal control is not only the task of specific, dedicated control functions but of the organisation as a whole, across all its business units and functions.

2.2 The Three Lines of Defence and Internal Audit

As highlighted above, internal control is a responsibility across all areas of an entity. Nevertheless, not all areas will have the same role within internal

Figure 2.1: COSO objectives, internal control components, and organisational entities (from COSO, 2013b, p. 6).

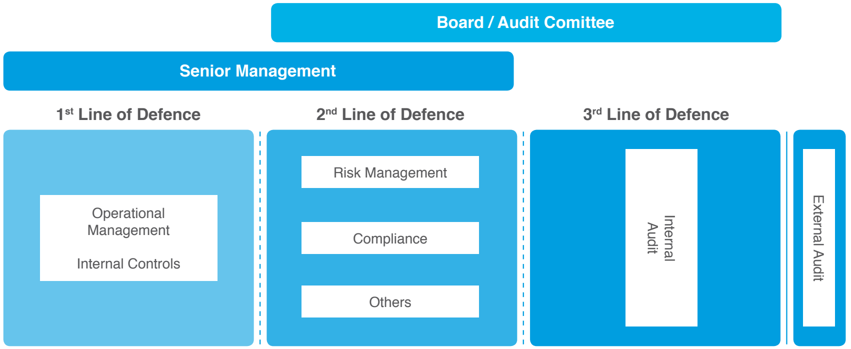


control. The 3LoD are "rapidly gaining universal recognition" (Dennery et al., 2010, p. 9) as a model to structure the roles and responsibilities of the stakeholders within an organisation who are responsible for the different aspects of internal control[2].

The *first line of defence* is the front line operating management, who own and manage risk and include controls in their day-to-day activities, while the *second line* oversee and monitor risk and control in support of management, usually as specialist functions such as risk, control, and compliance (Anderson & Eubanks, 2015). The *third line of defence* provides independent and objective assurance. While the first and second lines primarily report to senior management, the third line directly serves the organisation's governing body or its audit committee (see Figure 2.2). Note that for risks originating in second- or third-line functions' own operations (e.g. data leakage through internal audit staff), these functions will also be in a first LoD role (Kaiser,

[2]Huibers (2015) reports that 56% of internal auditors responding to their survey globally and 64% in Europe use the 3LoD model with internal audit being the third LoD (p. 11).

Figure 2.2: Three lines of defence, from Dennery et al. (2010, p. 9).



2015, p. 22).

Expansions to the 3LoDs have been proposed in the literature. Arndorfer and Minto (2015) suggest including external bodies such as external auditors and regulators as a fourth line of defence. Strasser (2011) splits the second line into two distinct lines: preventive, in-process risk management performed by control functions as the new second line and their overarching risk control as the new third line. Independent assurance becomes the fourth line in this model. For simplicity, this study continues to use the established 3LoD model. The IIA has recently opened a discussion on the future of the 3LoDs, which is being discussed in the context of the benefits of CA in section 2.3.

The 3LoD model postulates the need for a third line of defence as a provider of independent and objective assurance to the organisation's governance bodies which are tasked with overseeing internal controls (see section 2.1). These responsibilities are usually assigned to the internal audit activity.

Internal auditing is "an independent, objective assurance and consulting activity designed to add value and improve an organisation's operations. It helps an organisation accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control, and governance processes" (The Institute of Internal Auditors

[IIA], 2013). All companies listed at the New York Stock Exchange (NYSE) need to have an internal audit activity (NYSE Listed Company Manual Section 303A.07(c); NYSE, 2017). In Switzerland, the Swiss Code demands an internal audit activity that reports to the audit committee (economiesuisse, 2016, para. 20). For banks, FINMA circular 2017/1 requires that “every institution shall establish an internal audit function” (FINMA, 2017, para. 82), with exceptions only where this is deemed inappropriate (paras. 83–86).

To be able to fulfill its duties as the third line of defence, internal audit needs to be “independent, and internal auditors must be objective in performing their work” (IIA, 2017a, Standard 1100). Independence requires “direct and unrestricted access to senior management and the board”, for example through a dual-reporting relationship. Objectivity “is an unbiased mental attitude that allows internal auditors to perform engagements in such a manner that they believe in their work product and that no quality compromises are made. Objectivity requires that internal auditors do not subordinate their judgment on audit matters to others” (also see FINMA circular 2017/1 paras. 87, 90).

By providing independent assurance on the effectiveness of internal control, internal audit is a part of the monitoring activities component in the COSO framework. Monitoring can be performed within business processes, as part of the first line of defence, as management oversight over business processes (second line of defence) or separately in an independent manner, which will usually be the role of internal audit.

As internal control permeates all areas of an enterprise, it seems useful to structure it using general management models. The new St. Gallen Management Model builds on the original St. Gallen Management Model proposed by Ulrich and Krieg (1974). It provides a structure for grasping and talking about the management of firms as complex systems, with management being understood as “designing, controlling and further developing purpose-oriented socio-technical organisations” (Rüegg-Stürm, 2005, p. 11).

The process view within the model separates the processes within an entity into management processes, business processes and support processes. Management processes are further separated into three sub-categories (Rüegg-Stürm, 2005, pp. 55–58):

- *Normative orientation processes*, in which "the normative foundation of business activity is contemplated and clarified".
- *Strategic development processes*, which include "all activities that lead to the development of a workable strategy as well as this strategy's successful implementation".
- *Operative management processes*, which include leading people, financial controlling and quality management in day-to-day business, focussing on the "efficiency with which limited resources are utilised".

All management processes follow an ideal-typical sequence of "*orientation*, *planning*, *implementation* and *feedback*" (p. 58), the latter of which closes the "control cycle".

In this view, internal audit is understood to be a support process[3]. At first glance, this might seem at odds with the independence of internal audit. However, audit does not support operative management but the strategic development process: Audit is supporting the *feedback* loop in strategic development, providing high-level management and oversight bodies with an unbiased view on whether the defined strategy is being implemented efficiently and effectively.

To summarize, internal audit is a part of the monitoring activities component of COSO, the third line of defence in the 3LoD model and a support function for strategic development. By being independent and objective, it aims to provide the companies' governance bodies with the assurance they need to discharge their oversight responsibilities over internal control. However, internal control is a process that affects and is implemented by all areas

[3]Müller-Stewens and Brauer (2009, p. 497) see internal audit as part of the corporate center performing official governance duties, which are classified as supporting activites (p. 496).

of an organisation, with delineated responsibilities between first, second, and third line of defence.

2.3 The Need for Continuous Assurance

Traditionally, a companies' board receives assurance from internal audit, which use yearly and/or multi-year plans to – based on a systematic risk analysis across the "audit universe" of auditable projects, initiatives, business units, product or service lines, processes, programs, systems, and/or controls – determine which audit engagements will be conducted the following year (IIA, 2016a).

Within an individual audit engagement, auditors plan engagement procedures, the outcomes of which in combination will achieve the engagement objectives (IPPF Standard 2240; IIA, 2017a). Originally, procedures were manual and performed on a sample of the to be tested population. Common manual procedures are inquiry (e.g. interviews or surveys), observation and inspection. For a drawn sample, manual audit procedures include (IIA, 2016d, p. 3):

> Vouching – Internal auditors test the validity of documented or recorded information by following it backward to a tangible resource or a previously prepared record.
>
> Tracing – Internal auditors test the completeness of documented or recorded information by tracking information forward from a document, record, or tangible resource to a subsequently prepared document.
>
> Reperformance – Internal auditors test the accuracy of a control by reperforming the task, which may provide direct evidence of the control's operating effectiveness.
>
> Independent confirmation – Internal auditors solicit and obtain written verification of the accuracy of information from an

independent third party.

Statistical sampling allows samples to be chosen in a way that meaningful statistical results for the overall population can be obtained from the engagement procedures' results on the sampled items (see e.g. Guy, Carmichael, & Whittington, 2001).

Today, these manual procedures applied to sampled items remain common but are increasingly complemented with "computer-assisted audit techniques (CAATs)" (Moeller, pp. 304-328). CAATs apply computers to individual audit procedures, using data to perform analyses or aid in sample selection, but do not change the overall audit approach or planning[4].

While CAATs can improve audit efficiency by making individual audit procedures more efficient (through automation) or effective (by allowing a full population analysis), they operate within the existing way of doing things. That's why researchers and practitioners have begun to ask whether the recent advances in technology suggest that auditing should move beyond simple CAATs to a technology-based re-engineering of the audit process (Bumgarner & Vasarhelyi, 2015, p. 40; Byrnes, Criste, Stewart, & Vasarhelyi, 2014; Vasarhelyi et al., 2004).

The motivation for a new approach to auditing come from two directions: On the "supply" side, the emergence of integrated ERP systems and the digitization of many business processes has lead to large areas of corporate activity becoming accessible for data-driven, automated analysis. The emergence of Big Data has further fuelled this "data revolution" (see section 1.2). Automated analysis means less need for traditional audit methods and also less restrictions on traditional audit timing – an analytical module that has been developed once can be run frequently with little additional cost. As the amount of data grows, classic paper trails disappear (Woodroof & Searcy, 2001) and such automated analysis is the only way to deal with this

[4]Refer to Lambrechts, Lourens, Millar, and Sparks (2011), who state that "the overall objective and scope of an audit does not change. Data analysis must be seen as another tool that can be used to achieve the objective of the specific audit" (p. 3).

growing workload and complexity (Elbardan & Kholeif, 2017; Eulerich & Kalinichenko, 2014).

In addition, the proliferation of additional, second line of defence assurance providers such as risk management, risk control and compliance functions after the passage of SOX and especially after the financial crisis in the banking industry have increased the supply of control- and risk-related activity and data. If these functions already perform control testing in their area, it seems reasonable for internal audit to focus on evaluating the adequateness of their approach and if deemed sufficient to rely on these test results instead of duplicating work (IIA, 2016b).

This increase in assurance providers with potentially overlapping and blurred lines of responsibility is one reason that the IIA has announced its aim to modernise the 3LoD model (John et al., 2019; Ruud & Schramm, 2019), increasing the "demand" side of CA: the IIA proposes that internal audit should strengthen its role by becoming a coordinator of different assurance providers through "assurance mapping" and the use of "data and technology to facilitate insight capture, analysis, and communication". While the lines of defence become more blurred, the idea is that internal audit can "accumulate" and coordinate all the assurance work in the organisation and use that to act as a "guarantor" to the stakeholders that they will receive "the required level of assurance across all activities and capabilities". Whether this push by the IIA will be successful and how this expanded role for internal audit can be implemented remains an open question (Ruud & Schramm, 2019). However, given the complexity of today's organizations, it seems reasonable that such a broad mandate would require a better use of technology to become feasible. By leveraging technology to combine continuous auditing with effective CM in other assurance functions and the first LoD, CA could be a potential methodology to enable this shift.

In addition, firms are fearing disruption through various external influences, also leading to the demand for new answers from internal audit. The stakeholders expect internal audit to act as "trusted advisors" in proactively navigating this uncertainty, which requires moving towards more frequent risk analysis and using data to inform all parts of auditing (Kristall, Mack, Torcasi, & Basden, 2017). The real-time economy with instant communication and gratification means that the large time lags of traditional auditing seem more and more unreasonable (Eulerich & Kalinichenko, 2018; Vasarhelyi, Alles, & Williams, 2010). Static audit plans and sample testing are also not well-suited to deal with "black swan" events[5] such as systemic risk or fraud, leading to calls for a more frequent, more comprehensive, and more risk-based audit approach after each crisis (e.g. Alles et al., 2004, after Enron and Worldcom or Marks, 2009a, Weins, 2012, after the financial crisis). "Industry 4.0" leads to more complex supplier relationships, to business processes that increasingly rely on complex data and to "on demand" provisioning of services and resources that is highly dynamic and automated, which means that traditional audit methods will no longer be able to keep pace (Fantini, 2017). At the same time, auditing moves beyond the narrow focus on financial reporting with its quarterly or yearly cutoff dates to covering areas where assurance needs to be provided on a more continuous basis, such as regulatory compliance[6], corporate social responsibility (CSR)[7] and cloud service provision[8]. According to Peemöller (2018), 80% of chief audit executives (CAEs) expect substantial changes to the internal audit activity in their organisations.

CA aims to address these changes by combining data-driven auditing (continuous auditing) with testing of and reliance on data-driven monitoring (continuous monitoring) by assurance providers in the first and second line

[5] A term coined by Taleb (2010) for highly improbable high-impact events, which cannot be captured and are underestimated by classical statistical models.

[6] For example in banking, where regulatory supervision relies to a large extent on audit firms performing regulatory auditing tasks (FINMA, 2016).

[7] For example, continuous emissions monitoring (CEM) is a requirement to show compliance with the U.S. Acid Rain Program (40 C.F.R. §75, 1993).

[8] Lins, Thiebes, Schneider, and Sunyaev (2015) argue for this area that "continuous auditing of selected certification criteria is required to assure continuously reliable and secure cloud services and thereby increase the trust-worthiness of certifications" (p. 1).

of defence. The goal is to obtain more frequent and more comprehensive risk analysis and assurance (Ezzamouri & Hulstijn, 2018; also see sections 1.3 and 2.6). CA is not a technology but a methodology that changes audit planning and performance by focussing on more timely reactions to risks and control shortcomings (Ames et al., 2015b; Mainardi, 2011). Nevertheless, in most cases it will not be a radical replacement but a gradual enhancement of audit and internal control practice (Byrnes, Ames, et al., 2012, p. 35) and needs to operate within regulatory requirements and the mandatory guidance in the IIA (2017a)'s standards.

2.4 Continuous Assurance through Continuous Auditing and Monitoring

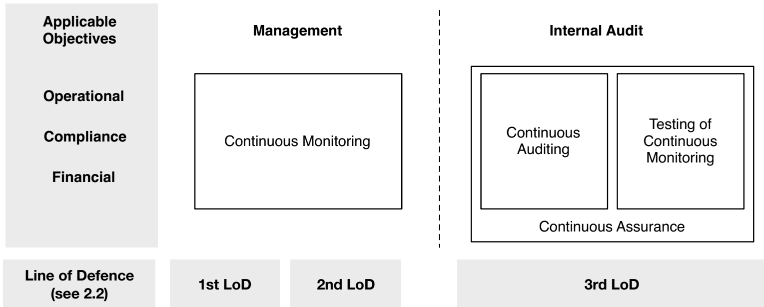
Continuous auditing is the combination of ORA and OCA by internal audit to achieve its objectives (see sections 1.3 and 2.6). It provides independent assurance by combining a timely assessment of risks with a regular testing of controls. This ensures that emerging risks continue to be covered by adequate controls and that the existing controls remain effective.

It is differentiated from CM, which is the monitoring of business processes and control performance by management, not the independent assurance function in the third line of defence.

CA combines "continuous auditing and testing of first and second lines of defense continuous monitoring" (Ames et al., 2015b, p. 3), as depicted in Figure 2.3.

CM belongs to the first and second LoD while continuous auditing is the role of internal audit and the third LoD (Cangemi, 2015, p. 11; Duscha, 2015). Both CM and continuous auditing can encompass systems that generate alerts when certain conditions are (not) met, but the two are differentiated by their ownership: CM is the process by which management ensures on an ongoing basis that internal controls are operating as intended. The focus lies on a timely remediation of control failures (IIA, 2013c). In contrast, continuous auditing is performed by auditors to independently evaluate the

Figure 2.3: Differentiating continuous assurance, auditing, and monitoring in the context of the three lines of defence.



overall effectiveness of risk management and internal control (Ames et al., 2015b). As with all audit procedures, if any deviations are identified auditors will strive to identify their root causes and to recommend measures to address these root causes (IIA, 2016d). Note that auditors conducting continuous auditing have – as part of the third LoD – no direct authority to require remediation (Ruud & Jenal, 2005). Often CM will be performed within a specific entity or function and be limited in scope. As internal audit covers the whole organisation, continuous auditing can also be much broader in scope.

While the 3LoD model emphasizes the segregation of duties within internal control, proponents also stress the importance of sharing information and coordinating activities between the different lines (Dennery et al., 2011; IIA, 2013a; IIA, 2016b; Ruud & Kyburz, 2014), culminating in the concept of "combined assurance" (Huibers, 2015; Ruud & Schramm, 2017). Examples include using the risk analysis of the prior lines for internal audit's risk-based audit plan (applying a "critical analysis"; Ruud & Sommer, 2006, p. 255). The IIA's recent exposure document on the future of the 3LoDs similarly proposes that internal audit takes on the role of an accumulator of 3LoD assurance work (John et al., 2019).

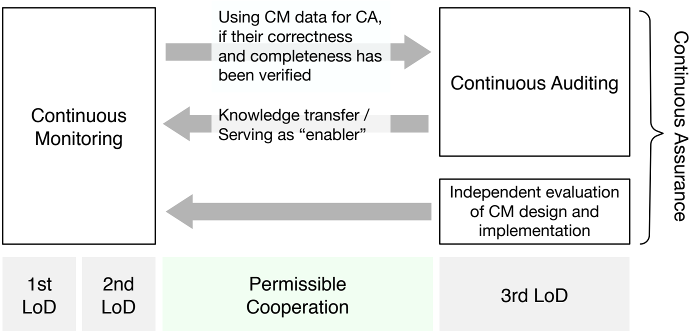
This is the idea behind CA (see Figure 2.4): there is no need to duplicate systems to cover similar areas. In practice, however, making systems developed by the third LoD available for use by the first or second LoD may risk compromising independence: auditors cannot objectively assess the effectiveness of CM if it relies on their own work. Thus, if continuous auditing is more advanced than CM the usual suggestion is for this knowledge (and where applicable the corresponding IT infrastructure) to eventually be transferred from the third to the first or second LoD (e.g. Ames et al., 2015b, p. 7; Cangemi, 2015, p.11; Ramamoorti et al., 2011, p. 8; Rudolf von Rohr, 2017). This is in line with guidance on how internal auditors may serve as enablers (but not operative owners) for ERM implementations (IIA, 2009b, p. 4). Auditors can then limit their work on evaluating the effectiveness and efficiency of the CM processes, testing the CM controls[9]. It is permissible for auditors to leverage existing CM systems in the first or second line for their own work, as long as they are reasonably confident that the CM systems are "appropriately designed, planned, supervised, documented, and reviewed" (Anderson & Eubanks, 2015, p. 12)[10]. This combination of its own continuous auditing where necessary plus reasonably confident reliance on first and second line CM is the idea of CA: CA accumulates existing assurance work within the organisation (with independent verification of its effectiveness) across the three lines of defence, with internal audit serving as overall aggregator. Bumgarner and Vasarhelyi (2015, pp. 14–15) discuss how continuous auditing and CM worked together at AT&T.

Note that this model summarized in Figure 2.4 should eventually lead to a shift in responsibilities: As control maturity grows at a corporation, more work will be performed as part of in-process controls and CM, shifting CA from continous auditing to testing of CM. In a firm that is thoroughly

[9]In line with the general audit approach of reducing substantive procedures if internal control is effective, see for example Canadian Institute of Chartered Accountants (CICA) (1984).

[10]Note that Cangemi (2015) differs, stating that "continuous auditing systems should be implemented independently from continuous monitoring" (p. 11).

Figure 2.4: Continuous assurance. Information sharing and coordination between continuous auditing and CM within the three lines of defence (inspired by Ames et al., 2015b, p. 7).



controlled by automated in-process controls and automated CM systems that analyze deviations on a timely basis, the role of internal auditing would shift to two to three areas of expertise: Firstly, internal audit would continue to develop an independent risk assessment with a focus on emerging risks, identifying areas where controls might not yet have adopted to a changing risk landscape. Secondly, internal audit would become primarily an IT audit activity which evaluates (ideally using automated, continuous auditing tools) that automated monitoring systems continue to function as implemented and have not been accidentally or deliberately corrupted. Thirdly (and optionally), audit activities might move away from control evaluations to an advisory role and more complex evaluations of strategic and business risks, which cannot easily be automated[11]. For Bumgarner and Vasarhelyi (2015) this is even a defining element of continuous auditing whose increasing automation will allow auditors to take “progressively higher judgement functions” (p. 48).

[11]See e.g. Kristall et al. (2017), who point to the need of internal audit to become more agile and active at providing guidance on corporate disruption. Laslett and Hardy (2015, p. 161) describe how responsibilities have shifted after a continuous auditing system was implemented and subsequently handed over to management as CM at Metcash.

During this process, internal audit would act as “driving innovator and not as a reactive force”, initiating a process for “dynamically adapting the internal control of the enterprise to the technical progress of the business processes” (translated from Duscha, 2015, p. 14). By leading the move to an integrated monitoring platform that can be used by different stakeholders for different needs, CA efforts would also help to reduce the current duplication of efforts within companies that have multiple “‘audit-like’ organizations” (Bumgarner & Vasarhelyi, 2015, p. 18). In the long-term, once full maturity is achieved, these new roles might lead to a reassessment of the delineation and scope of the 3LoDs as well as with external audit (Brown-Liburd & Vasarhelyi, 2015; Dai & Vasarhelyi, 2016).

This recognises that the first two roles sketched above also overlap with the external auditor’s responsibilities. How this reassessment might look like is currently an open question both in research (Issa, Sun, & Vasarhelyi, 2016, p. 6) and in practice (as John et al., 2019, is only initiating this discussion). Weins (2012) suggests that by using a shared IT platform with mostly automated control and risk assessment procedures, an “Integrated Continuous Auditing Approach” (Weins, Alm, & Wang, 2017), CA could improve communication and coordination between internal and external audit and lead to a combined audit approach.

2.5 A Management Model of Continuous Assurance

Referring to the new St. Galler Management Model, CA, as internal audit itself, is a support process in support of strategic development (see section 2.2). CM can either fall directly within operative management (if conducted by management) or will be a support process (if conducted by centralized units such as risk control) that supports management in discharging their operative management duties.

Note that this aligns with a different categorization presented by the New St. Gallen Management Model, between process control (fine-tuning, prioritizing within and ensuring the quality of processes) and process development (structuring and defining key success factors of processes): While CM deals with process control, i.e. ensuring ongoing quality and direction, CA deals with process development, by pointing out areas where operational reality differs from overarching strategy, norms or guidelines and further process development is thus necessary (and can be guided by internal audit's root-cause analysis). This corresponds to the above as process control is part of the operative management processes while process development is part of strategic development (Rüegg-Stürm, 2005, pp. 62–63).

Table 2.1 summarizes these differences between CM and CA in the context of the new St. Gallen Management Model.

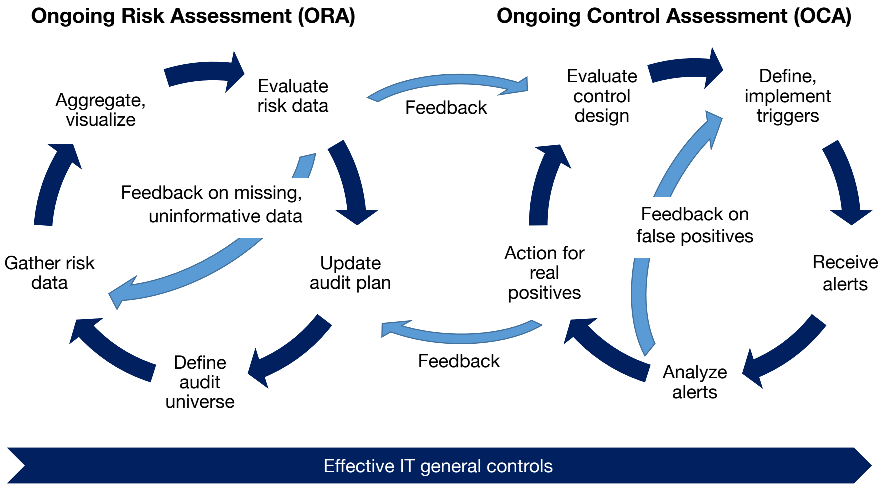
Table 2.1: CM and CA in the context of the new St. Gallen Management Model.

	Continuous Monitoring	Continuous Assurance
Process Category	Operative management	Strategy development
Sub-Process	Process control	Process development
Deliverables	KPIs measure process quality	Feedback on strategy implementation
Timing	Preventive or detective	Detective
Goal	Correct outliers, adjust process	Root-cause analysis
Responsibility	Management	Internal Audit

2.6 Continuous Assurance Methodology

CA is achieved by combining continuous auditing in the internal audit activity with effective CM by the first and second lines of defence (Ames et al., 2015b, p. 3). Audit testing provides reasonable assurance on the effectiveness of an organisation's CM. The two components feed into each other: Continuous auditing, in particular ORA, provides insight into risks against

Figure 2.5: How ORA and OCA interact in a prototypical continuous auditing process.



which the effectiveness of CM can be established. CM, once its reliability has been reasonably assured, can provide data (such as risk indicators) to be used by audit in its continuous auditing activities.

As CM increases in sophistication, reliability and coverage, effort for continuous auditing can be reduced, as CM documents control effectiveness (reducing the need for OCA) and provides risk data and insight (making ORA more efficient).

2.6.1 Continuous Auditing

While actual continuous auditing processes currently differ to a great extent between companies, a prototypical continuous auditing process can be developed based on the methodology in Ames et al. (2015b). It is depicted in Figure 2.5.

ORA is the continuous version of the “at least annual” update of the audit plan required by IIA Standard 2010.A1 (IIA, 2017a). ORA is a tool for audit planning – it is a means to spend audit resources on the most high-risk areas, recognizing that risks can shift quickly and planning must thus also be dynamic throughout the year. It begins with the definition of the audit universe in line with IIA (2016a). Based on the audit universe, appropriate data to support the risk assessment of the audit universe entities needs to be collected. Note that "data" is used in a very broad sense here. It does not only include database records such as transactions, account balances or risk measures but also "human-readable data" such as senior management meeting minutes (which at least for now are still mostly read and analyzed by humans). This "data" can and should also include risk indicators prepared by other units, such as value-at-risk (VaR) measures computed by the market risk function of a bank, in line with IIA (2016a) and IIA (2016b).

This data then needs to be aggregated and visualised. Again, "aggregated" is understood in a broad sense, including not only quantitative aggregation (such as summation or calculating means or deviations) but also qualitative aggregation, for example auditors summarizing key points from a set of meeting minutes. Auditors evaluate the data for the entire audit universe. If the data shows significant shifts in risk, the audit plan is updated accordingly. Also, insights from the risk data analysis are fed into planned and ongoing audits for their engagement planning, which includes input for the OCA. If the results show that the audit universe no longer reflects the corporate landscape, it is modified accordingly.

Examples for this ORA approach are given by Coderre (2006) at the Royal Canadian Mounted Police, Kuznik and Küppers (2015) at Douglas Holding AG, and Nigrini and Johnson (2008) at a franchise restaurant chain. In these examples, a set of aggregated quantitative measures are used to select the most high-risk branches or locations for risk-based, on-site audits. D. Moon (2014) discusses how key risk indicators and corresponding thresholds for ORA can be developed in a systematic fashion. Note, however, that such risk-based sampling means that – compared to fully random sampling – it is no longer possible to draw statistical inferences from the audit results as the sample is by design no longer representative for the overall population (Koreff, 2018).

OCA moves audit procedures out of one-off audits and into an ongoing process. As with all audit procedures, OCA relies on an assessment of objectives to be achieved and of risks that might affect achievement of objectives (IIA Standard 2201; IIA, 2017a). Based on the risk assessment, the effectiveness of control design can be evaluated (as in regular audits). If a control's design is ineffective, there is no point in testing whether it is working as designed. If control design is judged to be effective, triggers can be defined and implemented that utilize data to evaluate whether the control is working effectively on an ongoing basis[12]. In general, these triggers will lead to alerts that can then be analyzed. It is rare to find triggers where each alert corresponds to a control violation warranting action. Most triggers will lead to false positives, especially for newly set-up continuous auditing procedures ("alarms floods"; Alles et al., 2008, p. 205; Hardy, 2014, p. 368; Hardy, 2015, p. 4738; Singh & Best, 2015, p. 314). Thus, it is necessary for humans to analyze the alerts generated. If the analysis leads to real findings, the process follows regular audit processes: A root cause analysis is conducted (IIA, 2016d) and action plans need to be agreed by management and tracked by auditors for follow-up (IIA Standard 2500.A1; IIA, 2017a). In many cases, however, follow-up will effectively be conducted by continuing to run the audit procedure (Mainardi, 2011, p. 169): If the mitigating actions are implemented effectively, the number of alerts from the procedure should be sustainably reduced.

Depending on the results of the continuous auditing procedure, the initial judgement on the effectiveness of the control design might need to be challenged. Also, if controls are changed, control design needs to be re-assessed. In any case, triggers should be scrutinized from time to time whether they

[12]See e.g. Kiesow et al., 2017, pp. 67–68 for detailed process charts. They label their process "continuous auditing", but really focus on in-depth charts for parts of the OCA process.

still meet current objectives (IIA, 2013c, para. 15).

Note that OCA is just one approach of many to achieve assurance and can co-exist with regular audits, control self-assessments, testing of CM and other methods to evaluate the effectiveness of risk management, control, and governance processes. The audit plan will define which risk areas are best addressed using OCA and which using traditional methods. Examples of the OCA approach are given by Alles et al. (2006) at Siemens, Appelbaum et al. (2016) at a U.S.-based non-profit organisation, de Aquino et al. (2013) at Itaú Unibanco, or Nelson (2004) at HCA.

The differentiation between ORA and OCA is related to what Byrnes et al. (2014, p. 5) label "exploratory" data analytics (for ORA) versus "confirmatory" data analytics (for OCA). As they explain, exploratory analytics "starts with the data and the auditor asking questions such as, What do the data suggest is going on here? Do the data suggest something might have gone wrong? Where do the risks appear to be?". Confirmatory analytics on the other hand "starts with audit objectives and assertions" and "is used to provide the auditor with substantive or controls assurance".

ORA and OCA are depicted as cycles in Figure 2.5, highlighting their continuous, ongoing nature in comparison to "one-off" audits with a clearly delineated beginning and end. The arrows also show how these various steps feed into each other: In particular, there is feedback from ORA to OCA and vice-versa in that results from ORA's risk assessment should be taken into account when evaluating control effectiveness and that results from OCA regarding control effectiveness might call for a change in residual risk assessment and thus the overall audit plan (Byrnes, Brennan, Vasarhelyi, Moon, & Ghosh, 2015, p. 131). In addition to this, false positives in OCA and experience on which data aggregations and visualisations yield the most value should drive a refinement of data gathering and presentation and trigger definition (also see IIA, 2013c, para. 13).

Figure 2.5 also shows that technology-based continuous auditing processes rely on effective IT general controls as foundational element (CICA, 1999, pp. 13–15; Murthy & Groomer, 2004, p. 148). Effective IT general controls should provide reasonable assurance that properly set-up IT systems continue to function in the way they have been designed to (absent a documented change event) and that data streams are protected from manipulation (Arens et al., 2014, pp. 392–396; IIA, 2007). If IT general controls are lacking, IT-generated data cannot be trusted as systems or their inputs and outputs might have been modified at any time (intentionally or by accident).

2.6.2 Assurance over Continuous Monitoring

Practitioners define CM as "an automated, ongoing process that enables management to:

- Assess the effectiveness of controls and detect associated risk issues
- Improve business processes and activities while adhering to ethical and compliance standards
- Execute more timely quantitative and qualitative risk-related decisions
- Increase the cost-effectiveness of controls and monitoring through IT solutions" (Deloitte LLP, 2010, p. 3)

As CM is designed, implemented and performed by the first and second lines of defence, it lacks the independence that is a foundation of assurance provided by internal audit. This is why CM alone cannot provide continuous assurance. If, however, internal audit obtains reasonable assurance that CM can be relied upon to ensure ongoing control effectiveness over relevant risks, this will allow auditors to rely on CM in their overall assurance work (IIA, 2016b).

Obtaining assurance on CM effectiveness will not differ from obtaining assurance on the effectiveness of any other control or business process: Based on this overarching objective, internal audit will establish engagement objectives and scope, develop and document an engagement plan and work program and assign sufficient resources to the task (IIA Standards 2200-2240; IIA, 2017a). During the engagement, internal auditors "must identify, analyze, evaluate, and document sufficient information to achieve the engagement's objectives" (IIA Standards 2300; IIA, 2017a). Assurance on CM effectiveness can be obtained using traditional audit means as well as by employing continuous auditing.

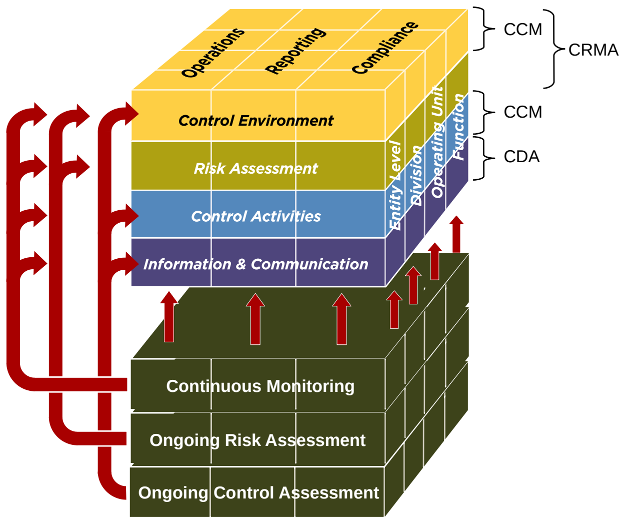
2.7 Continuous Assurance and the COSO Framework

Figure 2.6 shows how CM, ORA and OCA each address all control objectives but different components of the COSO internal control framework. As discussed, CA is part of the monitoring activities. COSO (2004a) suggest that "ongoing monitoring is performed on a real-time basis, reacts dynamically to changing conditions, and is ingrained in the entity. As a result, it is more effective than separate evaluations" (p. 75). Its reach captures all components of the framework: ORA can and should include measures that relate to the control environment (e.g. high employee turnover can point to cultural issues; Byrnes et al., 2015, p. 135) and by identifying emerging risks it challenges the organisation's risk assessment. OCA may also address parts of the control environment (e.g. it might flag employees that have repeatedly missed mandatory ethics training), but of course its focus lies on ensuring the ongoing effectiveness of the organisation's control activities.

CM covers all components of COSO: comprehensive CM supports management in evaluating the control environment, assessing risks to the business, monitoring the performance of control activities and supporting information and communication throughout the organisation.

Vasarhelyi, Alles, and Williams (2010) propose a three-part split of continuous auditing (see section 1.3). For simplicity, this thesis primarily follows the two-part approach put forward by Ames et al. (2015b). However, by separating out continuous data assurance (CDA) the three-part split makes it more obvious how CA and continuous auditing relate to the final COSO component, information and communication. By evaluating the quality of

Figure 2.6: CA and the COSO cube. CA is part of the monitoring activities component but monitors all areas of COSO. The right-hand side maps COSO to Vasarhelyi, Alles, and Williams (2010): CCM is continuous controls monitoring, CRMA is continuous risk monitoring and assessment and CDA is continuous data assurance.



data flowing through the internal control system, CA ensures the relevance of any communication relying on that data. In our model, CDA is primarily part of CM and OCA, as data quality should be ensured through adequate controls within the business. However, ORA might also include risk indicators that focus on data quality (e.g. number of likely duplicate vendors in the system, which is a risk indicator for the likelihood of duplicate payments). Note that even if CA does not specifically evaluate data quality, it will quickly surface many data quality issues as it requires auditors to work intimately with the organisation's data (Hardy, 2014).

By allowing tests to be run and indicators to be computed on the overall population, Figure 2.6 indicates that CA is well-suited to cover the entire organisation across business units and functions. However, implementation-wise most companies will start focussing on high-risk areas and be limited by the availability of data (Tabuena, 2011). Also, not all audit and monitoring activities will be applicable to all functions.

2.8 Continuous Auditing and Monitoring Technology

CA is based on the abundance of data produced by corporate IT systems, including but not limited to the company-wide ERP systems. For using this data, two approaches are feasible: either data can be extracted (on a regular schedule or as a "live feed") from these systems and analyzed in a separate data analytics environment, or data can be analyzed and processed directly inside the relevant systems[13]. The latter is known as embedded audit modules (EAMs) as it requires auditing code to be embedded into the production systems (Murthy & Groomer, 2004). While the focus in most implementations is on analyzing internal data, continuous auditing or monitoring do not need to be limited to this – analytics can also leverage external data feeds (e.g. to compare figures used with external market data

[13]See Vasarhelyi, Alles, and Williams (2010, pp. 44–45) for a discussion, including advantages and disadvantages of each option, Kiesow et al. (2017) for different process models for each approach and Lins et al. (2015) for a summary in the context of continuous auditing of cloud service providers.

or to monitor social media sentiment, see Marks, 2013, p. 32, for examples).

In either case, the resulting analyses need to be presented to the recipient and feedback on the results needs to be captured (i.e. which results were false positives and for which results action has been taken). This front-end can be as simple as a Microsoft Excel spreadsheet or it can utilize dedicated dashboard and visualisation tools. Kocken and Hulstijn (2017) propose a web-based portal that will alert auditors about exceptions and provide a controls dashboard which visually depicts control effectiveness, integrating audit data with 2LoD data to attain CA as the combination of continuous auditing and testing of the 2LoD's continuous monitoring. Singh and Best (2016) developed a prototype for a "Fraud Analytics Dashboard". Kiesow et al. (2017) similarly suggest providing an "Audit Dashboard". Feedback on the results needs to be captured and stored as supporting evidence[14]. The advantage of capturing feedback within the CA environments is that it enables a feedback loop – deploying manual adjustments or automated machine learning techniques, the feedback can be fed back to adjust the data analytics, potentially increasing accuracy and decreasing false positives.

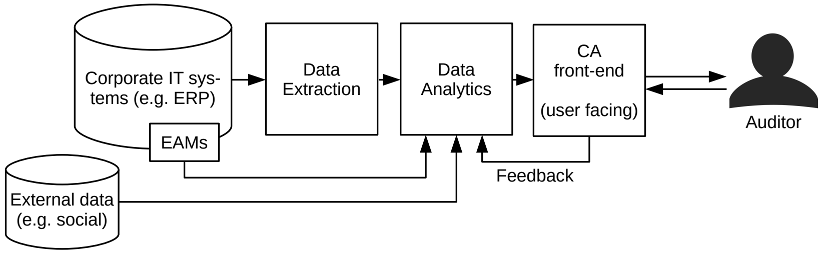
A high-level, generalized view of the resulting technical stack can be seen in Figure 2.7. More detailed architectures have been suggested in the literature, but they usually generalize well to this high-level view[15]. This report will use the terms from Figure 2.7 going forward.

Note that this high-level view does not specify where the relevant data will be warehoused. In most cases, this will depend on the existing IT landscape of the organisation: if there is already a comprehensive, properly controlled data warehouse available, it seems redundant to create a separate

[14] For continuous auditing, this is required by IIA Standard 2330 "Documenting Information" (IIA, 2017a). For CM, this is necessary to enable assurance over CM effectiveness.

[15] See Baksa and Turoff (2011, pp. 239-240), who reference various suggestions for continuous auditing architectures. The shown high-level view agrees with their observation that in "its simplest form, the continuous auditing system architecture requires only a digitised data source, well-defined data validation engine, and an alarm and/or reporting mechanism to alert the appropriate parties when these rules are violated."

Figure 2.7: High-level, generalized view of CA technical architecture.



"CA warehouse" and source data storage will thus occur within corporate IT systems. In other situations (such as in Alles et al., 2006, p. 158) it can be beneficial to implement a dedicated assurance data warehouse (Rezaee et al., 2002), which will reside between the data extraction and the data analytics layer. Depending on the business set-up, all technical layers may reside in the same organisation or may be spread out across multiple organisations and/or cloud layers (Kiesow & Thomas, 2017).

Also note the broad definition of "transaction" used: in this context, every process that generates a data point can be considered a transaction, which goes far beyond a narrow focus on accounting transactions. In particular, this definition includes data as diverse as website visits, readings from industrial sensors, and even unstructured data such as emails sent or received.

2.8.1 Basic analytics

Continuous auditing or monitoring does not require highly advanced analytical approaches to yield valuable results. Many tests (such as those recommended in Lambrechts et al., 2011, or specifically for fraud analysis in IIA, 2009a) can be implemented with what could be called "basic" analytics:

- *Filtering* means obtaining entries from a dataset that satisfy specific criteria, such that a specific data field is equal or similar to some predetermined value or to some other field or that the field value is between or outside certain pre-defined limits.

- *Merging* refers to combining multiple data sets using a specific key or rule (e.g. merging the vendor invoices with the supplier master data using the unique vendor key that is present on both data sets).

- *Aggregating* refers to grouping data entries by some common criteria and then applying summary statistics (such as summing or counting the entries, calculating the mean or median) to one or multiple data fields (e.g. summing the total value of all received vendor invoices per supplier).

The combination of these relatively basic operations that can be implemented in almost all data processing and analysis environments already allows covering such common rules as identifying duplicate payments, suppliers without valid address data or with addresses equal to employee addresses, accounts with conflicting access rights, or analyzing data using the Newcomb-Benford Law (da Silva, de Melo Travassos, & de Freitas Costa, 2017).

2.8.2 Advanced analytics

The advent of Big Data has given rise to (renewed) interest in machine learning techniques, in which the computer "learns" from large data sets and either acts on the learned information or presents it in novel ways to the user. The Big 4 accounting firms are currently investing heavily in this area (Issa et al., 2016, p. 3). Machine learning covers everything from Amazon's suggestions on what to purchase next (U.S. Patent No. 6,266,649, 2001) to Google's self-driving cars (Urmson, 2015, p. 5). For CA purposes, machine learning can be separated into two distinct categories (Langley, 1998, pp. 8–9):

- *Supervised learning* refers to techniques where the computer is given a sample of data elements with some kind of additional information and the computer learns to generalize this sample to a larger population, being able to deduce this additional information on new but similar data. In an oversimplified example, this can be used for autonomous driving: the computer is fed with a large number of driving situations and what a human driver did in each one of them and will learn from this how to behave in different but similar new situations (e.g. in Pomerleau, 1995).

- *Unsupervised learning* refers to situations where the computer is just given a large data set without additional information and is asked to make sense of it. This includes clustering techniques, in which the computer highlights which data elements are the most similar to each other, outlier analysis, and process mining, further discussed below.

In the assurance context, supervised learning is applicable to situations where a large number of both positive and negative examples for transactions are available. Supervised learning is, for example, successfully being used to detect credit card fraud (for a comparative study see Bhattacharyya, Jha, Tharakunnel, & Westland, 2011), a relatively frequently occurring type of fraud. It is thus conceivable to use supervised learning to automate assurance tasks which are based on electronic data, have to be performed repetitively and which produce many "hits"[16].

However, many of the tasks where CA might be most valuable involve using analytics to help to find the "needle in the haystack"[17] or to identify risks and issues that might not even be on the radar yet. In such cases, unsupervised learning can be employed (Y. Kim & Kogan, 2014). Two unsupervised learning techniques which seem especially applicable to assurance

[16]See also Kokina and Davenport (2017) for a discussion on which assurance tasks are most suitable for automation.

[17]Perols, Bowen, Zimmermann, and Samba (2017, p. 221) note that detecting financial statement fraud "involves challenges related to (1) the rarity of fraud observations, (2) the relative abundance of explanatory variables identified in the prior literature, and (3) the broad underlying definition of fraud".

work are outlier analysis (or anomaly detection) and process mining.

Outlier analysis uses statistical criteria to determine data elements which are substantially "different" from the overall data set. By taking into account all the available information of an individual element and all the others in the pool, this goes beyond simply filtering for transactions over a specific dollar amount. As the algorithms cannot know "why" an element does not fit in, it is up to the analyst to decide on whether identified outliers indicate actual issues.

Process mining is a very specific set of algorithms that can be applied to log files which contain time-stamped process steps through which individual transactions are passing. Based on these log files, process mining algorithms deduce how processes in an organisation are looking like and can identify bottlenecks and transactions which did not follow the usual processes (van der Aalst, 2011). This has obvious applications for auditors, as it both allows to see how processes in the business are actually executed and to look for deviations from these processes (Jans, Alles, & Vasarhelyi, 2013). Process mining does require high-quality logging data, though, which might not be available if processes are passing through many different systems or include steps which are not recorded in IT systems at all.

In addition to these more general machine learning ideas, there are many more specific analysis tools that can be leveraged for assurance work (and that sometimes build on these machine learning foundations). For parsing and analyzing unstructured, scanned documents, optical character recognition (OCR) can be used. Working within the boundaries set by privacy regulations and best practices, text mining can be used to evaluate emails (Torpey & Walden, 2009) or social media messages for sentiment or warning signs. Multiple analytics mechanisms can be combined to implement scoring techniques that score data sets on multiple different criteria (see Hugh, 2015, for an example at JP Morgan). How to optimize algorithms for situations where others specifically try to thwart machine learning success, as can be the case in fraud detection, is the focus of ongoing research into "adversarial machine learning” (Huang, Joseph, Nelson, Rubinstein, & Tygar, 2011). Krieger and Drews (2018) have developed a taxonomy for Big Data and analytics in auditing, and Amani and Fadlalla (2017) provide a literature review of advanced analytics in accounting.

2.8.3 Data Protection and Continuous Assurance

Various data scandals and the adoption of the General Data Protection Regulation (GDPR) in the European Union have meant that data protection has increased in importance and attention in the past years. In this environment, CA can help by serving as an enabler of better data protection assurance (Hertzberg, 2018; Lins, Schneider, & Sunyaev, 2016). At the same time, however, CA is also affected by the GDPR, as it derives many of its methodological benefits through the increased use of data.

The use of CA will thus normally be discussed with the organization‘s data protection officer and specialised guidance on data protection compliance might need to be consulted. In many cases, it can be possible to avoid using personal data in which persons can be directly or indirectly identified — for example, risk assessments will often work with sufficiently aggregated data and control assessments can often focus on business transactions without personal data. In other cases, the use of personal data for CA can be the intended use and covered by the data subject‘s consent or by legal requirements, e.g. in regulated industries where certain assurance activities are prescribed by laws or regulation. Note that such considerations on data protection should not only include the input data used by CA but also the output data generated by CA — the documentation of work performed and conclusions drawn, which might contain new personal data. For CA output data, data protection guidelines that already exist for the regular audit working papers can be leveraged, as CA falls under the same IIA guidance on documenting work performed.

In some countries, other or additional local requirements might apply. For example, Germany knows strict rules limiting employee surveillance

(Sowa, 2016). Regardless of legal permissibility, it should also be noted that employees getting the impression that they are under constant surveillance has other negative effects, too: Warren, Moffitt, and Byrnes (2015) reference Martin and Freeman (2003) to highlight that increased employee monitoring “involves backlash attributable to economic, legal, and ethical issues“ and that “excessive tracking could suppress employee creativity and/or motivation“. Holt, Lang, and Sutton (2017) find experimental evidence that a high monitoring environment leads to a perception of a worse ethical environment among employees, which can undermine the tone from the top.

Setting up CA in a privacy-conscious manner is possible; however, fears around privacy might be one reason that limits CA adoption and thus those fears need to be taken into account when designing successful CA programs. Evaluating this and other factors influencing (and maybe limiting) CA adoption is the main goal of the research design of this study, which will be elaborated in the following chapter.

Chapter 3

Research Design

Given the advantages of CA (see section 2.3), its comparable lack of widespread adoption (see section 1.4) seems to be both unfortunate and an interesting topic of inquiry. This work investigates this gap between research on CA and its actual adoption in organisations and how it can be closed, using a two-phase, mixed-mode design, combining empirical, behavioural research with a design science research case study to develop a working artefact affecting CA adoption.

3.1 Research Questions

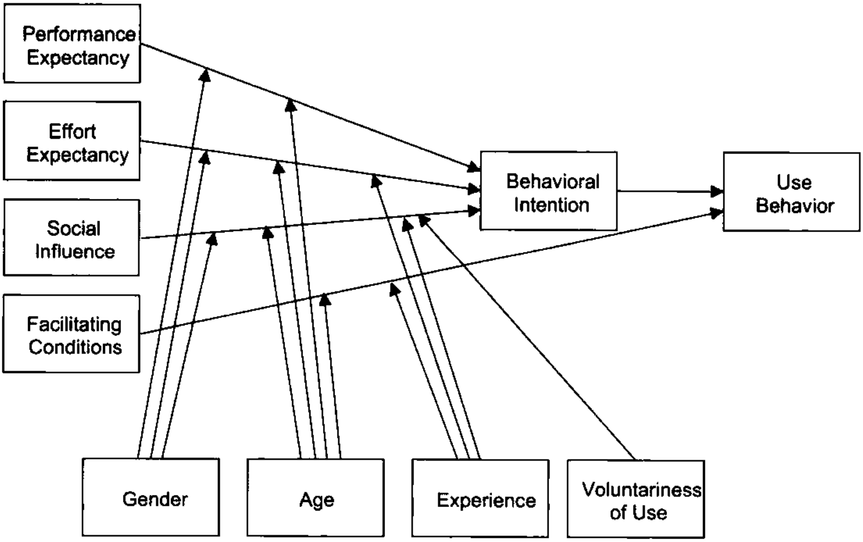
This research work started with the following overarching research question:

Q. How can adoption of Continuous Assurance (CA) in organisations be increased?

As we have seen, CA has not yet seen the adoption rates once expected. To better understand the reasons for this lagging adoption and to develop an effective front-end system for ORA and OCA that can help increase intention to use, it can be helpful to look to existing information systems (IS) research on technology adoption for guidance.

The (revised) DeLone and McLean IS Success Model suggests that IS quality consists of information quality, system quality, and service quality, which in turn drive intention to use, user satisfaction, and net benefits of the system as measures of its success (DeLone & McLean, 2003; Urbach & Müller, 2012). The Technology Acceptance Model (TAM) posits that a user's behavioural intention to use an IS is a function of the perceived usefulness and the perceived ease of use of the system (Bradley, 2012; Davis, Bagozzi, & Warshaw, 1989). For an IS to be accepted, its users must expect

Figure 3.1: Unified Theory of Acceptance and Use of Technology (reproduced from Venkatesh et al., 2003, p. 447).



to be able to better perform their work using the system (usefulness) and the perceived benefits must outweigh the effort of using the system (ease of use).

Venkatesh, Morris, Davis, and Davis (2003) summarize and test a variety of different technology adoption models and thus provide a thorough overview over the landscape. Based on this overview and their experimental findings, they combine the various disparate models into a unified theory, the Unified Theory of Acceptance and Use of Technology (UTAUT). Their tests indicate that this unified model is able to explain a larger amount of variance than any of the original models tested. In UTAUT, user acceptance of technology is driven by *Performance Expectancy*, *Effort Expectancy* and *Social Influence* (see Figure 3.1).

Performance Expectancy is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance” (Venkatesh et al., 2003, p. 447) and corresponds to the perceived usefulness in TAM. *Effort Expectancy* captures the ease of use attributed to a system, and thus corresponds to the perceived ease of use in TAM. *Social Influence* “is defined as the degree to which an individual perceives that important others believe he or she should use the new system” (p. 451). Venkatesh et al. (2003) point out that in past studies this effect is highly linked to whether system use is perceived to be mandatory.

In addition to these drivers of intention to use, they also model *Facilitating Conditions* but posit that these will be captured within Effort Expectancy and will thus not be a significant predictor for user acceptance, however they will affect actual usage (which in UTAUT is driven by intention to use and Facilitating Conditions). Facilitating Conditions refer to support structures such as training, helplines or compatibility with existing processes and systems.

Venkatesh et al. (2003) suggest that Effort Expectancy will be more relevant during the initial adoption of a new technology and will loose relevance once the technology is already in active use. As Gonzalez, Sharma, and Galletta (2012) find Effort Expectancy to be the main predictor of continuous auditing adoption, this further confirms that notwithstanding the long period of research in this area CA is still in an early stage of real-world adoption.

In UTAUT, these drivers are moderated by gender, age, voluntariness of use and experience. As the current study looks at CA adoption in professional organisations, it will in general not to be able to influence these drivers. In their bibliometric analysis, Williams, Rana, and Dwivedi (2012) also find that while many studies have started to rely on UTAUT, quite a few do so without the proposed moderators. Accounting researchers in particular seem to be reluctant to use these moderators, as both Curtis and Payne (2008) and Gonzalez et al. (2012) did not adopt them for their UTAUT-based studies and Langhein and Thomas (2018) do not plan to do so. Curtis and Payne (2008) analyze how implementation of a new software solution by external auditors is affected by short-term budget pressures (an issue applicable to CA adoption as well) while Gonzalez et al. (2012) explicitly apply UTAUT to continuous auditing intention to use. Langhein and Thomas (2018) plan to apply UTAUT to audit cloud adoption by German audit firms.

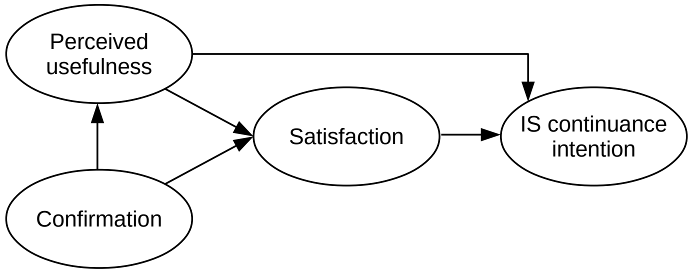
Note that UTAUT, as the theories it is based on, focuses on end user adoption of an existing information system. This study, however, wants to investigate how a new system has to be designed in order to maximize adoption within organisations. In today's digitalized world, user-centric research needs to account for the complex interactions between strategies, processes, structures, data and IT systems within organisations (Brenner et al., 2014). Nevertheless, results from Curtis and Payne (2008) are encouraging, in that they successfully applied UTAUT to the question of installing a new software solution within an organisation and not to the acceptance of existing software. For the current study, results building on UTAUT can yield user-centric requirements for an adoption-focused system, but those need to be complemented with additional theory on system design and with requirements originating in the nature of CA and its use in organisations. To cover adoption within organisations, approaches such as Stakeholder Theory or the Technology-Organisation-Environment (TOE) framework can be used. Stakeholder theory was originally a model of the firm, with stakeholders being "those groups without whose support the organization would cease to exist". Stakeholders of the firm are shareholders, customers, employees, suppliers, competitors, government and overall civil society, of which the first four are "key" stakeholders (Freeman, 1984). Since then, this theory has been adopted to various use-cases, including in information systems (Mishra & Dwivedi, 2012), where it has often been applied to influencers on IT decisions, e.g. as "a group of people sharing a pool of values that define what the desirable features of an information system are and how they should be obtained" (Ahn & Skudlark, 1997). In UTAUT, the influence of stakeholders is partially captured through the Social Influence construct, which accounts for the effect of the opinions of others on a user's technology adoption decisions. The TOE framework describes technology acceptance in organisations as being influenced by their technological (availability and characteristics), organisational (size, structure, governance) and environmental (industry, competition, regulation) context (DePietro, Wiarda, & Fleischer, 1990). They present "both constraints and opportunities for technological innovation" (Baker, 2012; Tornatzky et al., 1990).

While models such as TAM and UTAUT focus on the initial adoption of new technology, Bhattacherjee (2001) and others have pointed out that after this initial adoption phase it is as important to identify why users are continuing to use a given information system instead of abandoning it. Bhattacherjee (2001) proposes a theory of information systems "continuance" based on expectation confirmation: in this model, the continuing use of an information system is driven by the *Perceived Usefulness* of the system and the user's *Satisfaction* with it (see Figure 3.2). These are in turn influenced by whether the user's experience with the system matches the user's prior expectations (*Confirmation*). Confirmation drives both perceived usefulness (i.e. a user will experience a system as more useful if it matches or exceeds original expectations) and satisfaction with the system, which is also based on perceived usefulness. Contrary to TAM and UTAUT, this model does not account for perceived ease-of-use as Bhattacherjee (2001) argues that while perceived ease-of-use would also fit into the expectation confirmation constructs, only perceived usefulness is "demonstrated to consistently influence user intention across temporal stages of IS use" (p. 355).

Technology acceptance models provide general answers to what drives adoption, but they do not directly translate into specific measures to increase technology adoption in a given context (Venkatesh & Bala, 2008). They also focus on the end user, not the different organisational stakeholders impacting decision making, and on the adoption of existing systems instead of on designing new ones.

In the CA context, Gonzalez et al. (2012) have applied the UTAUT

Figure 3.2: Information systems continuance (reproduced from Bhattacherjee, 2001, p. 356).



model to continuous auditing adoption (see section 3.1.1). Byrnes, Ames, et al. (2012), Hardy (2014), Ramamoorti et al. (2011), and Vasarhelyi et al. (2012) use a multi-case approach to identify criteria for successful continuous auditing implementations. In addition to these quantitative or multi-case studies, various single-case studies have been published over the years detailing how CA is implemented in individual organisations (see Table 3.1).

Table 3.1: Case studies detailing how CA is implemented in individual organisations. Success factors are given as positive (+) and negative (−) influences.

Description	Success Factors
Alles et al. (2006) describe the approach for and lessons learned from continuous controls monitoring at Siemens.	(+) Re-engineering of audit processes (−) Alarm floods
Alles et al. (2008) provide lessons from two case studies, one at Siemens and one at an unnamed health service provider, with CA combining continuous controls monitoring and continuous data assurance.	(+) Change management planning (+) Involvement of stakeholders (+) Re-engineering of audit processes (+) Integrated ERP systems (−) Impact on auditor independence (+/−) Overlap with management control

Table 3.1: Case studies detailing how CA is implemented in individual organisations. Success factors are given as positive (+) and negative (−) influences.

Description	Success Factors
Appelbaum et al. (2016) present a case study of continuous auditing of the HR function in a medium-sized non-profit organisation.	(+) Early success stories (+) Strong motivation of internal audit for CA (−) Non-standardised data formats (−) Lack of IT funding (−) Little-known and outdated enterprise IT
Coderre (2006) describes continuous auditing of the accounts payable (AP) function at the Royal Canadian Mounted Police. It is used to compare the decentralized AP offices, to target on-site audits to high risk areas and to automatically evaluate control effectiveness and fraud, waste or abuse indicators. He finds a positive impact on overall audit effectiveness.	(+) Management support (+) Knowledge of business processes and systems (+) Technical skills of the audit team (+) Adoption by all audit staff members
de Aquino et al. (2013) describe how a South American bank reduced its effort spend on on-site audits of all its individual branches by a factor of four using a continuous auditing system. The system monitors all branches on a daily basis by comparing various indicators to their dynamically calculated permissible range. It generates alerts for any violations which then have to be followed-up by branch managers.	(+) Lack of resources for full manual audits (+) Dedicated group within audit department (−) Difficult to separate continuous auditing and CM (−) Impact on auditor independence

Table 3.1: Case studies detailing how CA is implemented in individual organisations. Success factors are given as positive (+) and negative (−) influences.

Description	Success Factors
Garrido (2011) presents how BBVA, a global bank, employs continuous auditing. A Risk Assessment module scores branches monthly for different risk factors while a Daily Alert module generates alerts if controls are breached for immediate follow-up by a dedicated audit team with branch staff.	(+) Economies of scale (+) Constant feedback and indicator adjustment (+) Clear alert resolution procedures (+) Inclusion of unstructured data (e.g. meeting minutes) (−) Lack of IT integration (−) Too singular focus on technology (−) Too transactional view
Goh (2017) presents the data-driven, “predictive” audit model at DBS Bank in Singapore. They analyse data to identify anomalies in trading patterns and for fraud analysis and use KRIs to measure the “risk profile of [their] individual branches”.	(+) Abundant data due to ERP and data warehouse (+) Collaboration with researchers
Hardy and Laslett (2015) discuss continuous auditing at Metcash, an Australian wholesaler. They present evidence that Metcash can be rated between “emerging” and “maturing” continuous auditing on Vasarhelyi et al. (2012)’s audit maturity model. Metcash uses 106 alert procedures to “audit-by-exception”. Auditing has progressed into CM by business management which is evaluated independently by internal audit.	(+) Business need for more timely risk and control assurance (+) Cooperation with business, audit to CM handover (+) Senior management support (−) Need for combination of IT and business skills (−) Need to adjust analytics to reduce false alerts (−) Non-standardised data formats (−) Impact on auditor independence

Table 3.1: Case studies detailing how CA is implemented in individual organisations. Success factors are given as positive (+) and negative (−) influences.

Description	Success Factors
Kuznik and Küppers (2015) describe their "StoreAuditSystem" at Douglas Holding AG, a European cosmetics retailer. They rank individual stores using a variety of risk metrics to identify high-risk stores for on-site audits.	(+) Lack of resources for full manual audits (+) Benefits visible for audit and business
Medinets et al. (2015) present continuous controls monitoring (CCM) at Siemens Financial Services. At Siemens, CCM is located outside of internal auditing in a separate independent control function. Their system covers about 250 analytics for "data input checks, validity checks, and compliance with regulations and internal policies" (p. 150) and has lead to a visible reduction in non-compliance since its inception.	(+) Right balance between complexity and flexibility (+) Management buy-in and expertise
Nelson (2004) describes continuous auditing at HCA Inc., a health-care provider. Their system is developed by internal audit, but exceptions are sent to business staff (either directly for clear violations or indirectly by the auditors if alerts need to be validated first) for comment. Audit follows-up if comments are missing or unsatisfactory.	(+) Ability for business managers to "self-audit"

Table 3.1: Case studies detailing how CA is implemented in individual organisations. Success factors are given as positive (+) and negative (−) influences.

Description	Success Factors
Nigrini and Johnson (2008) detail a risk scoring system at a franchise restaurant chain with about 5'000 franchisee. They use risk indicators to identify franchisee with a high risk of underreporting their sales numbers (which form the basis for franchise fees) for on-site compliance audits.	(+) Lack of resources for full manual audits (+) Expertise of project team
Singh et al. (2014) present three case studies on continuous auditing and monitoring in ERP environments. One covers automatically monitoring SAP settings and access rights. In the second one SAS code is used to identify fraud by applying a ruleset to vendor master, invoice, and payment data. The third case is a generic continuous monitoring system developed by Oracle that monitors deviations in payroll, procurement, and finance processes.	(+) Integrated ERP systems (+) Fully automated (+) Real-time data access
Singh and Best (2015) describe a visualisation dashboard that they have implemented to identify segregation of duty violations and other fraud-relevant anomalies in accounts payable for an unnamed SAP installation.	(+) Data visualisation

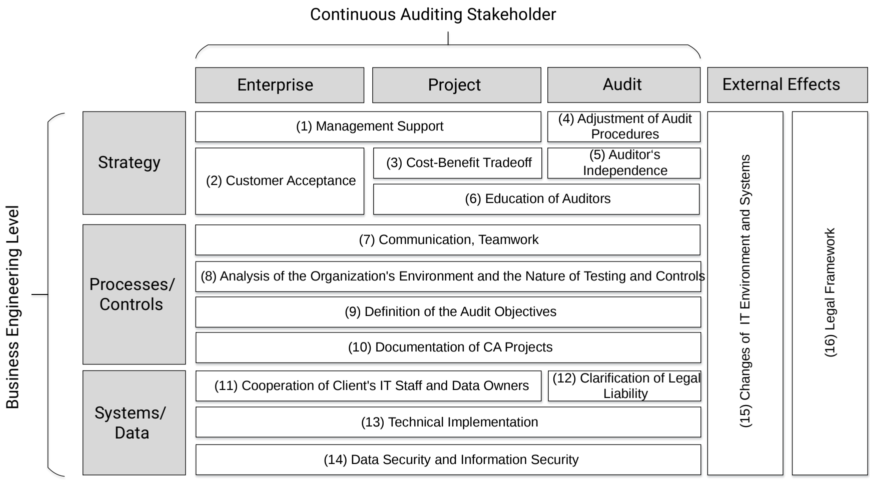
Table 3.1: Case studies detailing how CA is implemented in individual organisations. Success factors are given as positive (+) and negative (−) influences.

Description	Success Factors
Vasarhelyi and Halper (1991) describe one of the first continuous auditing inplementations, focussed on billing at AT&T. The system comprises an audit platform with drill-down features to alert-generating heuristics and analytics.	(+) Integrated audit platform (−) High start-up costs (−) Lack of experience with emerging evidence

Sun, Alles, and Vasarhelyi (2015) have looked at inter-country differences to identify a lack of competition (need), government interference, a lack of independence, of support from management, of legal and professional guidance, and of sophisticated technology as key factors hindering CA adoption in China when compared to the United States. Kiesow et al. (2016) have performed a systematic literature review to identify challenges to continuous auditing adoption. They found that continuous auditing adoption (with a focus on external audit) is hindered by challenges relating to technical implementation, external auditors' independence, adjustment of audit procedures, auditors' education, documentation of projects, and data security and privacy (p. 8). Kiesow, Zarvić, and Thomas (2015) developed a continuous auditing implementation framework, identifying from the literature 16 critical success factors, depicted in Figure 3.3.

While many case studies provide singular evidence on specific factors that supported or hindered CA adoption in each case, there is still "limited understanding of how to adopt CA and CM effectively and how to leverage it" (Ezzamouri & Hulstijn, 2018). Only few overarching studies have been conducted and they are mostly older and based in the United States or Australia. The expectation is that an updated analysis based on auditing

Figure 3.3: Continuous auditing implementation framework designed by Kiesow et al. (2015).



practice in Switzerland will add to the knowledge base by bringing a current, European perspective to the discussion. By deriving potential adoption-influencing factors to be tested from the studies discussed above, it recognises and builds on existing work.

3.1.1 Factors Influencing CA Adoption

To be able to increase CA adoption, it is necessary to understand the factors that influence (i.e. tend to increase or decrease) CA adoption and how they are contingent on the environmental context of the organisation (e.g. size, industry, and regulation). This leads to the following initial subquestion:

> **Q1.** Which factors have a significant impact on CA adoption in Swiss organisations, contingent on the organisational environment?

Gonzalez et al. (2012) use UTAUT to identify Effort Expectancy, Social Influence and annual sales as moderator for Performance Expectancy as significant drivers of continuous auditing adoption. Interestingly, in their overall results they do not find Performance Expectancy, a key driver in UTAUT, to be significant. However, in their regional breakdown, Performance Expectancy is highly significant in the “other” region, which includes Europe. For the purposes of this study, Performance Expectancy should thus be included as potential driver of continuous auditing adoption. These drivers can be seen as umbrella terms for the success factors detailed in various theoretical and survey-based studies or derived from case studies. This view is shown in Table 3.2, which shows a wide range of potential sucess factors from the studies above mapped to the identified adoption drivers from UTAUT without making any assertion of completeness. Not all success factors will be equally relevant for all organisations, instead any analysis needs to account for the differences in their environment.

Table 3.2: Success factors identified from the literature, mapped to the relevant UTAUT antecedents (as identified by Gonzalez et al., 2012, for continuous auditing) and the areas of Figure 3.4.

UTAUT	Success Factor	Sources	Area
Effort Expectancy	Right balance between complexity and flexibility	Medinets et al. (2015)	Analytics
Effort Expectancy	Avoidance of alarm floods	Alles et al. (2006)	Analytics / Front-end
Effort Expectancy	Constant feedback and indicator adjustment	Garrido (2011); Hardy and Laslett (2015)	Analytics / Front-end
Effort Expectancy	Build on existing enterprise tools and platforms	Hardy (2015); Marks (2009b)	Environment
Effort Expectancy	Dedicated group within department	de Aquino et al. (2013)	Methodology
Effort Expectancy	Standardised data formats	Appelbaum et al. (2016); Hardy and Laslett (2015)	Data Extraction
Effort Expectancy	Availability of skills	CICA (1999); Hardy and Laslett (2015); Kiesow et al. (2016); Nigrini and Johnson (2008); Vasarhelyi and Halper (1991)	Environment
Effort Expectancy	Integrated IT systems	Alles et al. (2008); CICA (1999); Garrido (2011)	Environment
Effort Expectancy	Up-to-date corporate IT	Appelbaum et al. (2016)	Environment

Table 3.2: Success factors identified from the literature, mapped to the relevant UTAUT antecedents (as identified by Gonzalez et al., 2012, for continuous auditing) and the areas of Figure 3.4.

UTAUT	Success Factor	Sources	Area
Effort Expectancy	Knowledge of business processes and systems	Coderre (2006)	Environment
Effort Expectancy	Managing high start-up costs	Vasarhelyi and Halper (1991)	Environment
Effort Expectancy	Clear alert resolution procedures	Baksa and Turoff (2011); Garrido (2011)	Front-end
Effort Expectancy	Inclusion of unstructured data	Garrido (2011)	Front-end
Effort Expectancy	Integrated audit platform	Vasarhelyi and Halper (1991)	Front-end
Performance Expectancy	Re-engineering of audit processes	Alles et al. (2006, 2008); Kiesow et al. (2016)	Methodology
Performance Expectancy	Clear positioning within 3LoDs	Alles et al. (2006); de Aquino et al. (2013); Hardy and Laslett (2015); Kiesow et al. (2016)	Methodology
Performance Expectancy	Economies of scale	Garrido (2011)	Methodology
Performance Expectancy	Going beyond transactional view	Garrido (2011)	Methodology

Table 3.2: Success factors identified from the literature, mapped to the relevant UTAUT antecedents (as identified by Gonzalez et al., 2012, for continuous auditing) and the areas of Figure 3.4.

UTAUT	Success Factor	Sources	Area
Performance Expectancy	Do not focus solely on technology	Garrido (2011); Mainardi (2011)	Methodology
Performance Expectancy	Benefits visible for audit and business	Kuznik and Küppers (2015)	Methodology
Performance Expectancy	Critical size	Whitehouse (2012)	Environment
Performance Expectancy	Data visualisation	Singh and Best (2015)	Front-end
Performance Expectancy	Lack of resources for manual procedures	de Aquino et al. (2013); Kuznik and Küppers (2015); Nigrini and Johnson (2008)	Environment
Performance Expectancy	Need for more timely risk and control assurance	Hardy and Laslett (2015)	Environment
Social Influence	Senior management support	Coderre (2006); Hardy and Laslett (2015); Kiesow et al. (2015); Medinets et al. (2015); Ramamoorti et al. (2011)	Environment

Table 3.2: Success factors identified from the literature, mapped to the relevant UTAUT antecedents (as identified by Gonzalez et al., 2012, for continuous auditing) and the areas of Figure 3.4.

UTAUT	Success Factor	Sources	Area
Social Influence	Board level support	Byrnes, Ames, et al. (2012)	Environment
Social Influence	External auditor encouragement	Byrnes, Ames, et al. (2012)	Environment
Social Influence	Change management	Alles et al. (2008)	Environment
Social Influence	Managing data security and privacy	Kiesow et al. (2016)	Environment

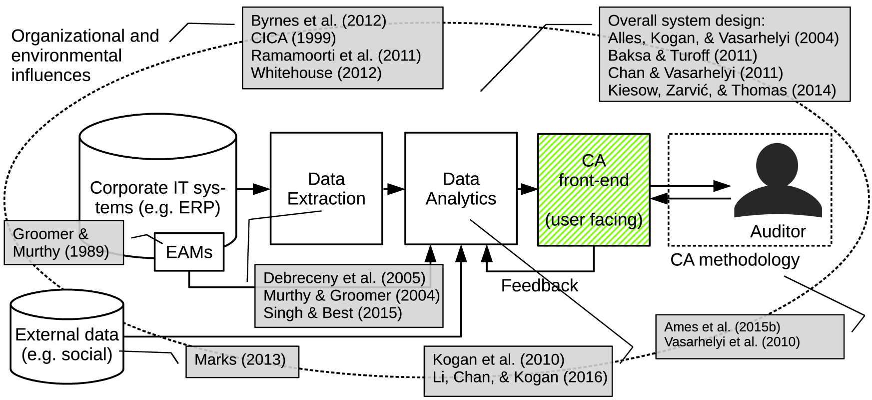
3.1.2 Front-End System Design for ORA and OCA

Table 3.2 suggests that to influence CA adoption, areas of interest are the environment for CA (e.g. management support, skills available etc.), the CA methodology (e.g. how well the methodology supports assurance providers in performing their work) and the technology (the EAM / data extraction, analytics and front-end layers) supporting CA. As the environment depends on the individual organisation, it seems difficult to provide a generic artefact in support of CA in this area. The methodology is already well-supported by a deep body of literature (e.g. Ames et al., 2015b; Bumgarner & Vasarhelyi, 2015; CICA, 1999; Mainardi, 2011; Vasarhelyi, Alles, & Williams, 2010). For technology supporting CA, a lot of discussion has focussed on how to retrieve data from enterprise systems (e.g. whether to use EAMs, Groomer & Murthy, 1989, or a monitoring and control layer, Vasarhelyi et al., 2004, p. 11; or how to extract data from ERP systems, e.g. in Debreceny et al., 2005, Singh & Best, 2015), and on how to analyze this data (e.g. using continuity equations, Kogan, Alles, Vasarhelyi, & Wu, 2010, auditor-defined thresholds, de Aquino et al., 2013, or machine-learned rules, Li, Chan, & Kogan, 2016). Figure 3.4 shows existing literature in the context of CA and the research focus of this thesis.

Far less research has been conducted on how best to present the analytical results to the auditors or control functions and how to gather their work performed on the obtained data sets. This seems curious in this context given that documentation of work performed is an important topic in auditing (IIA Standard 2330, IIA, 2017a) and also given that this part of the system will be the most visible to the individual user, thus being the public "face" of CA. Sutton, Holt, and Arnold (2016) note that in particular when advanced analytics and artifical intelligence techniques are being used, "novices may actually make worse decisions when using a system that is more knowledgeable than the user" and call for "much more research on the usability, and use, of artifical intelligence in accounting domains".

Kiesow et al. (2014) present an integrated audit approach focussing on

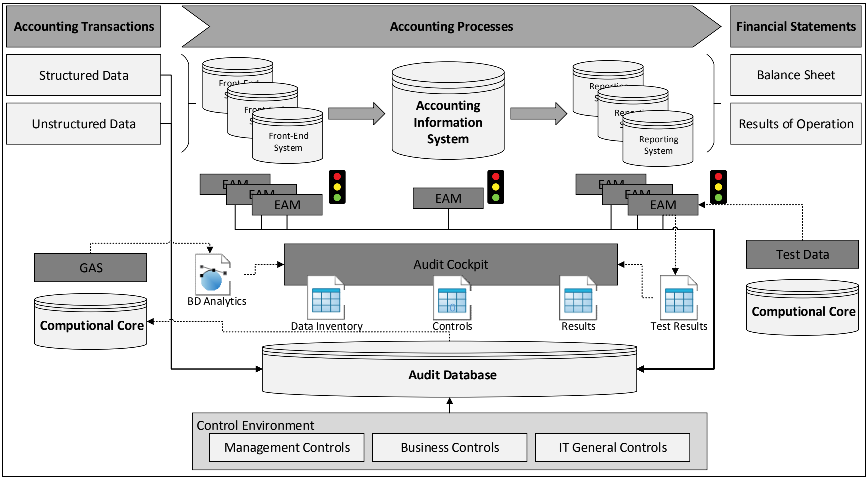
Figure 3.4: Select literature in the CA context. Light green = focus of the second part of this thesis.



an "Audit Cockpit" (see Figure 3.5). This cockpit would visualise the link between the data, controls and control results, but they do not provide further details on how it would look or function. In the context of cybersecurity assurance, No and Vasarhelyi (2017) propose a dashboard "of cybersecurity risk or of data and control risk" as a more useful alternative to a yes/no binary audit opinion (p. 3). Kocken and Hulstijn (2017) note that while continuous auditing is well established, the link between continuous auditing and continuous monitoring that is required to achieve CA has received far less research attention. They propose a system architecture with a web-based front-end that combines audit data with 2LoD monitoring data to really achieve CA.

Baksa and Turoff (2011) stress that a continuous auditing system needs to "integrate continuous auditing's detection and alerting functions with the tracking of decisions and decision options for situations that can be more effectively handled by human judgement". Any front-end would thus not only have to present computer-generated reports to the user but also to gather user feedback on the seriousness of the reported alerts, guiding the user in this decision-making process. However, they also do not provide a blueprint

Figure 3.5: “Integrated Audit Approach” (reproduced from Kiesow et al., 2014, p. 909). The “Audit Cockpit” corresponds to the CA front-end system.

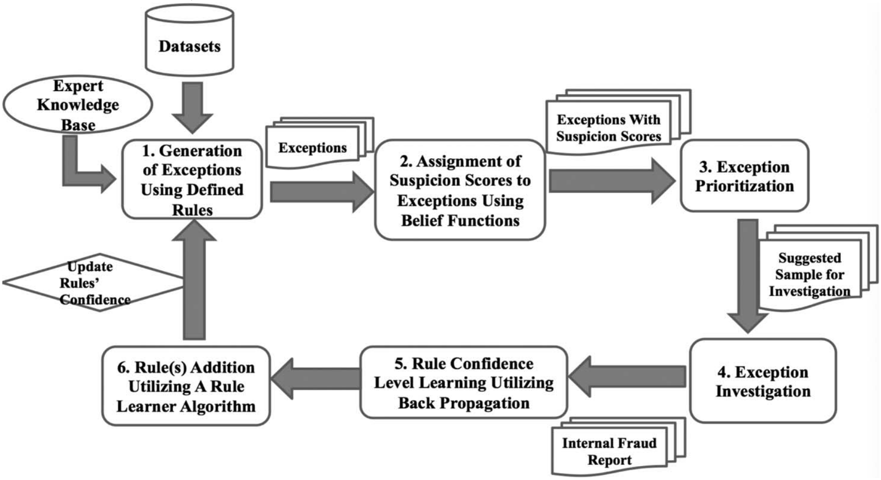


for such a system, but refer to research on emergency preparedness systems such as in Geldermann et al. (2009) or Turoff et al. (2004) as potential inspiration for front-end systems.

Perols and Murthy (2012) highlight the need for any front-end systems to make generated alerts more manageable and suggest to use additional analytical modules to perform “intelligent summarization” for the end user (“continuous assurance fusion”). Issa and Kogan (2014) similarly suggest that it is “crucial to provide a certain level of exceptions processing before presenting them to the human users” (p. 215). Li et al. (2016) have implemented such a fusion approach in an exception prioritization framework (see Figure 3.6), where analytics data is pre-filtered with machine learning techniques before being presented to the user.

While these are individual aspects of how an intelligent front-end system can make CA more usable, these studies do not look at the overall stakeholder experience of such systems and how their design can influence CA adoption. This study aims to address this research question:

Figure 3.6: "Exception Prioritization Framework" (reproduced from Li et al., 2016, p. 137).



Q2. How can a CA front-end system be designed to support CA adoption by organisations?

Individual CA solutions including front-ends have been presented in the literature (also see Table 3.1). Particularly detailed explanations of technical implementation and resulting screenshots are provided by Alles et al. (2006) for Siemens, by Byrnes, Ames, et al. (2012) for HP, and by Singh and Best (2015) at an unnamed SAP user. These reports do not, however, draw a line from their implementation to the larger theory or provide generalizable design guidance.

Commercial vendors provide a variety of tools that address certain areas of CA. For data analytics, both powerful general-purpose tools such as R[1], SAS[2] as well as data analytics tools tailored for audit and internal control

[1] https://www.r-project.org/

[2] http://www.sas.com/en_ca/home.html

work such as ACL[3] and IDEA[4] support the development of data analytics procedures which obtain, transform, analyze and report on data. For data quality monitoring, Expectus ExMon[5] is being used in CA contexts (Rikhardsson & Dull, 2016). CaseWare Monitor[6] focuses on CM, including front-end design, but does not implement ORAs. For data visualisation, tools such as Tableau[7] or even Microsoft Excel can be used to develop dashboards that visually represent data analytics output.

Audit management tools such as Audimex[8], Pentana[9], or TeamMate[10] support the planning, fieldwork, and reporting of audit work by recording risk analysis, audit planning, and electronic workpapers in a systematic fashion, closely adhering to and guiding their users in adherence to the relevant IIA standards. However, none of these tools are built for continuous auditing, comprised of ORA and OCA components, as laid out in Ames et al. (2015b). In external auditing, Kiesow et al. (2015, p. 2) similarly find that "market-ready [continuous auditing] solutions for external auditors are still lacking".

3.2 Research Methodology

To address these questions of interest, a two-phase design was implemented for this study: In the first phase, an empirical, behavioural research approach was used to gain a better understanding of factors influencing CA adoption (research question Q1). In the second phase, a design science research approach was used to design a CA front-end system that aims to increase CA adoption by considering the results from the first phase (research question Q2).

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[3] `http://www.acl.com/`
[4] `http://www.casewareanalytics.com/products/idea-data-analysis`
[5] `http://www.exmon.com`
[6] `https://www.audimation.com/Product-Detail/CaseWare-Monitor`
[7] `http://www.tableau.com/`
[8] `http://www.audimex.com/en/`
[9] `https://www.ideagen.com/products/pentana/`
[10] `https://www.teammatesolutions.com/`

3.2.1 Factors Influencing CA Adoption

Internal audit operates in an environment with multiple different stakeholders (see Figure 3.7)[11]. Including the discussion on the 3LoDs from section 2.2, the stakeholders internal to the company can be further separated into the first and second LoD functions. The key stakeholders will all play a role when deciding on whether to adopt CA, while regulators and professional organisations will set the rules within which CA will need to operate and society overall will (hopefully) reap the benefits[12].

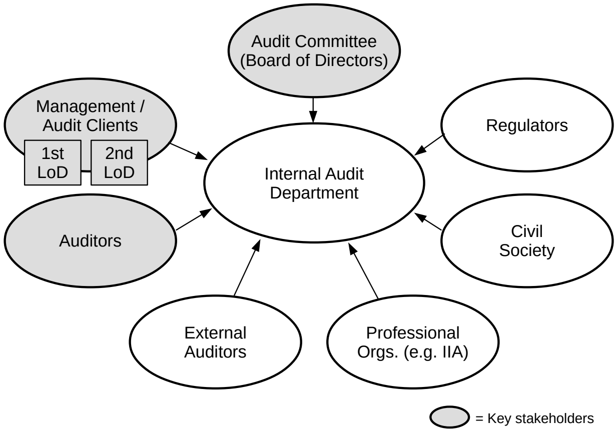
To better understand the potential factors of CA adoption requires an open, exploratory research approach. One source are the findings and case examples from existing literature (building on Table 3.1 and the literature reviews by Brown, Wong, & Baldwin, 2007, Chiu, Liu, & Vasarhelyi, 2014, and Kiesow et al., 2016). These were augmented through individual, semi-structured interviews with experts among the key stakeholders to unearth potentially new, additional factors influencing CA adoption.

The interviews covered key stakeholder groups as listed in Table 3.3, both within the partner organisation for the case study (see section 3.2.2) as well as outside of it for a broader perspective. All interviews were conducted semi-structured and analysed using an open-coding scheme to identify drivers and inhibitors for CA adoption, taking the environment and characteristics of the different interview partners into account. The existing literature as well as the interview results informed both the choice of additional interviewees as

[11] In the sense of Ahn and Skudlark (1997)'s definition as "a group of people sharing a pool of values that define what the desirable features of an information system are and how they should be obtained". The categorization builds on Guener (2008, Exhibit 2)'s view of corporate governance, with shareholders' needs being implicitly recognised through the board of directors and accounting for the importance of professional organisations in shaping audit work. The key stakeholder correspond to what Kyburz (2016, p. 28) identifies as a "narrow" definition of internal stakeholders. Also compare Ruud (2003).

[12] Weins (2012) argues that regulators could also directly benefit from and act as users of an integrated CA platform. However, his study focusses on banking regulators in Germany, whereas in Switzerland most regulatory oversight is conducted by external auditors on behalf of the supervisory authority.

Figure 3.7: Internal audit's stakeholders regarding CA adoption (adapted from Freeman, 1984).



well as ultimately the kernel theory on CA adoption for the CA front-end system design.

Table 3.3: Key stakeholder groups included in the interview process.

Key Stakeholders	Explanation
Board of Directors (BoD)	In Swiss corporate governance structure, the BoD is responsible for overseeing the internal audit function, a responsibility often exercised through its audit committee (AC; see section 2.1). Many BoDs also have dedicated committees for oversight over the organisation's IT environment, which deal with IT capabilities but also IT risks and controls and which are thus relevant for CA both as potential facilitators and beneficiaries. The interviews thus covered both ACs and IT committees.

Table 3.3: Key stakeholder groups to be included in the interview process.

Key Stakeholders	Explanation
1st Line of Defence	The first LoD will experience CA as auditees for continuous auditing as well as by employing and being subject to CM, e.g. for management controls.
2nd Line of Defence	The second LoD can also be exposed to CA as auditees as well as users. In addition, they might play a role as providers of data and systems for CA, as they might already have CM systems in place that can be leveraged for CA. An important focus for interviews in this area is the cooperation and split of roles and responsibilities between second and third LoD in a CA set-up. Relevant functions in this area include Compliance, Risk Management, Health & Safety and IT Security.
Auditors	Internal auditors will combine continuous auditing and assurance over CM to achieve CA and will thus be key users of any system used in CA. They will also be responsible for operating or overseeing such systems. The interviews thus addressed a broad range of enablers and inhibitors of CA, the quantitative importance of which was then evaluated in a survey among this stakeholder group. Within this group, there are be different sub-groups – while the CAEs and audit management will primarily be interested in how CA changes and improves overall audit practice, auditors will be more interested in whether the system in their day-to-day interactions with it actually makes their work easier and more effective.

To better quantify the impact of the such identified adoption factors, accounting for contextual differences, a survey was conducted, surveying internal auditors from companies in Switzerland. Internal auditors were sourced from among the SVIR[13] members. As the SVIR focusses on internal auditing, this will provide a more targeted sample than in Gonzalez et al. (2012), who as pointed out by Curtis (2012) send their survey to management accountants who might be neither familiar with nor responsible for internal audit developments. While many companies are SVIR members and at most other companies individual auditors will be members, this selection process excluded internal audit departments without any SVIR affiliation. Most likely, those would be smaller departments with less developed CA practices[14]. This sampling process can thus be expected to slightly overstate CA adoption among the overall population but can also be expected to cover the most developed CA practices.

The survey focussed on internal auditors. Experience shows that it is difficult to obtain reasonable response rates from audit committee members and senior management (Kyburz, 2016). This holds especially true in this case, as CA is a very specific topic that has been widely discussed in internal auditor circles but far less in broader management practice. Semi-structured interviews have the advantage of being able to dynamically adapt to the knowledge of CA of the interviewee and are thus expected to provide more tangible results for these stakeholder groups.

The survey was deployed as a self-administered, web-based online form. In a corporate setting, self-administered forms have the advantage that “busy people can respond at any time that is convenient to them” (Fowler, 2002, p. 61) but should be complemented by extensive follow-up, ideally using different channels (Dillman, Smyth, & Christian, 2014, pp. 331-332, 419). It is important to achieve sufficiently low nonresponse rates, as otherwise self-selection means that recipients who are more interested in the research topic of CA (and thus also more likely to apply or be interested in CA methods) are more likely to respond, biasing the results (Fowler, 2002, p. 42). Vasarhelyi

[13] *Schweizerischer Verband für Interne Revision (SVIR)* is the Swiss chapter of the IIA with 148 corporate and 476 individual members as of May 17, 2016.

[14] Byrnes, Ames, et al. (2012, p. 4) note that “[i]t is, however, generally larger firms that emphasize hiring individuals with CA/CM backgrounds and skills”.

et al. (2012) note that “continuous auditing is a concept rather than a well-defined technological tool or practice and hence it is not clear what the responding firms actually mean when they say that they: ‘had a continuous auditing or monitoring in place”’ (pp. 268–269). To address this concern, the survey form clearly delineated what is understood by “continuous auditing” for this study and provided corresponding definitions.

For behavioral research, the proper definition of the constructs to be measured is crucial. In general, it is not possible to directly measure what a person thinks, so one has to rely on answers to a questionnaire as indirect proxies for the actual variables of interest. If the survey questions are understood differently by different people or do not properly relate to the actual construct that is to be measured, survey results will be misleading (Nunnally & Bernstein, 1994, pp. 84–112). To ensure the validity of the results in this study, existing constructs that have been validated in earlier studies were used where possible. For the constructs based on UTAUT, the questions developed by Gonzalez et al. (2012) were re-used. For the more specific factors from Table 3.2, new constructs needed to be developed and validated.

For evaluating the survey results, both generalized regression (Faraway, 2006) and/or partial least squares structural equation modeling (PLS-SEM) can be suitable modelling techniques. While generalized regression is very widely employed and well understood, PLS-SEM (Chin, 1998) has the advantage of being distribution-free and of being able to simultaneously model the measurement and the structural model of the data and more complex causal networks such as formative measures (Gefen, Straub, & Boudreau, 2000). Contrary to covariance-based SEM, PLS-SEM can also accommodate the smaller sample sizes encountered in this study (Chin, 1998, p. 311). It has also been used in the audit context before, e.g. by Gonzalez et al. (2012) or Henderson, Bradfor, and Kotb (2016).

3.2.2 Front-End System Design for ORA and OCA

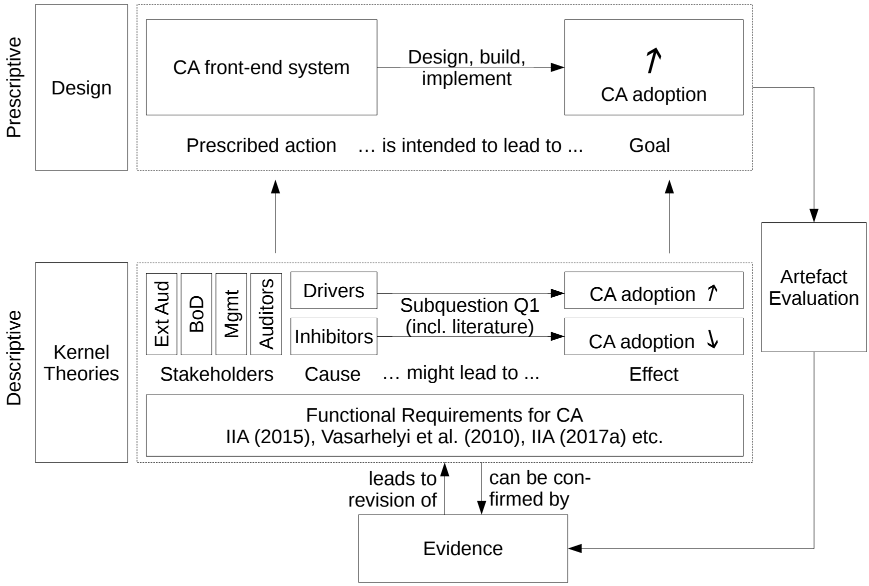
The work on front-end system design (research question Q2) followed a DSR approach. DSR has been established in the information systems field among others with the influential paper by Hevner et al. (2004) and can be defined as answering "questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence" (Hevner & Chatterjee, 2010, p. 5). Geerts, Graham, Mauldin, McCarthy, and Richardson (2013) highlight successful DSR in accounting and auditing and Alles et al. (2013) have shown that collaborative design science research can be successfully applied to CA research.

Effective DSR needs to be grounded in kernel theories (as defined in Walls, Widmeyer, & Sawy, 1992, relating to the design product) on what makes a specific artefact effective. Through what Hevner (2007) calls the "Relevance Cycle" in DSR, these theories inform the requirements and the necessary evaluation criteria for the artefact to be developed. They also ground the "Rigor Cycle", which ensures the project's innovation.

In this study's context, work on the front-end system design for ORA and OCA was informed by two distinct kernel theories which establish the requirements of our artefact (see Figure 3.8): Firstly, every reasonable CA front-end system will need to adhere to theory on what constitutes proper CA, i.e. its methodological underpinnings. This part was informed by the existing theoretical work such as Ames et al. (2015b), Vasarhelyi, Alles, and Williams (2010) and by the IIA International Standards for the Professional Practice of Internal Auditing (IIA, 2017a). As CA aims to provide assurance that matches or exceeds the assurance provided by established audit procedures it also needs to adhere to mandatory guidance relating to internal auditing in general.

Secondly, the CA front-end system aims to increase CA adoption. This is why a second set of requirements is guided by the theories tested and refined in the first phase of this study (in research question Q1). Based on the influence different factors have on CA adoption, the CA front-end system

Figure 3.8: The design-oriented part of this study is based on kernel theories on CA methodology and CA adoption drivers and inhibitors (adapted from Kuechler & Vaishnavi, 2008, p. 492).



should be designed such that it includes factors with a positive impact on CA adoption and avoids factors with a negative impact.

The provided artefact is a CA front-end system design together with an open-source reference implementation to demonstrate its viability. The reference implementation is being provided as open-source solution to support re-use by other researchers as suggested e.g. by Lombardi and Dull (2016).

Key to effective DSR is a rigorous evaluation of developed artefacts (Iivari, 2007, p. 50; March & Smith, 1995, p. 261). To achieve this, evaluation followed the guidelines proposed by Venable, Pries-Heje, and Baskerville (2016), adopting a "Human Risk & Effectiveness" evaluation strategy, culminating in a naturalistic, summative evaluation. According to Venable, Pries-Heje, and Baskerville (2012), such a strategy is recommended for socio-technical artefacts where effectiveness in real working situations is more important than isolating effects from confounding variables. This seems to be the case here, as CA lacks from real-world adoption and not from a lack of theory. The implemented CA front-end system was put to use in a corporate internal audit department and its effectiveness has been evaluated a) by observing and interviewing users on how they use the system and judge its effect on their attitude towards CA and likely CA adoption and b) interviewing internal audit management on observed changes in attitude with regards to CA.

What will set the proposed research project apart from just enhancing commercial software is its grounding in kernel theory as discussed above. By designing an artefact that embodies the existing theory, new insights can be expected on what drives CA adoption in a real-world setting, maybe refining CA theory in the process[15]. Given the large amount of theoretical literature compared to actual practical impact[16] and the existing gap on technology use in auditing, especially in Europe[17], bridging the gap from theory to practice seems to be a pressing need. This is confirmed by Geerts et al. (2013) who in their design-science-focussed review of continuous auditing research also note that continuous auditing "artifacts [...] developed largely in research drawing from multiple theories and methodologies in the knowledge base suggesting greater rigor, but slow implementation and lack of evaluation

[15]Kuechler and Vaishnavi (2008) believe among other authors that "artifact design projects are the best possible opportunities for refining theory from other fields for use in IS" (p. 499).

[16]As discussed in the introduction, see Byrnes, Ames, et al. (2012), Garrido (2011), Vasarhelyi et al. (2012), or Whitehouse (2011). In their literature review, Kiesow et al. (2016) also note that "the number of 20 publications describing implementations seems to be comparatively low considering the practical relevance of CA research" (p. 7).

[17]Cangemi (2015) finds that worldwide only 38% of auditors report an "appropriate" or higher use of technology. Europe (39%) lags behind North America (50%) and reports significantly below global average use of CAATs and "continuous/real-time auditing". Kiesow et al. (2015) similarly find that "awareness of the need for CA solutions is comparably low in Europe" (p. 13).

research suggests need for improving relevance of developed artifacts" (p. 835). Chan, Chiu, and Vasarhelyi (2018a) also argue that researchers "must be careful about developing theory and methodology in isolation without consideration of its actual practical use" (p. 323). This research will take up Kaplan (2011)'s call for accounting research that uses "research methods that help you understand the problems professionals face and attempt[s] to develop innovative solutions that they can apply" (p. 382).

By focussing not on generating alerts (which depend on the specific systems, policies and procedures in place at a specific company) but on presenting alerts to the user and on what has been termed the "feedback loop" above (and the "Audit Cockpit" by Kiesow et al., 2014, in Figure 3.5), the research aims to address the "process for handling alarms [which] is clearly a very complex subject that warrants further research" (Alles et al., 2008, p. 205). It would also counteract Baksa and Turoff (2011)'s observation that past approaches have "neglected the real-time response, which incorporates real-time human decisions, the measurement of the impact of those decisions and the determination of the effect of the responses" (p. 241). In a similar vein, Vasarhelyi, Alles, and Williams (2010, p. 21) find that while "ERPs bring together applications in common databases the area of automated work papers (and its obvious core database) is primitive to say the least. [...] The main sharing mechanisms currently used are office automation tools (eg. MS Office) which are powerful but not adapted to the dynamic needs of the assurance process". The expectation would be that by elevating CA from this "primitive" state, adoption might also increase.

As solid kernel theories form the basis of any DSR, a careful development and testing of CA adoption hypotheses is a necessary prerequisite to this phase of the work. These hypotheses – results of the literature review and conducted expert interviews according to section 3.2.1 – are discussed in the following chapter.

Chapter 4

Hypotheses on CA Adoption

Figure 4.1 shows an overview of the hypotheses which have been developed based on the literature discussed in section 3.1 and the results from the interviews conducted with Swiss internal audit practitioners. In detail, the following hypotheses will be tested in a survey design.

4.1 Performance Expectancy (H1)

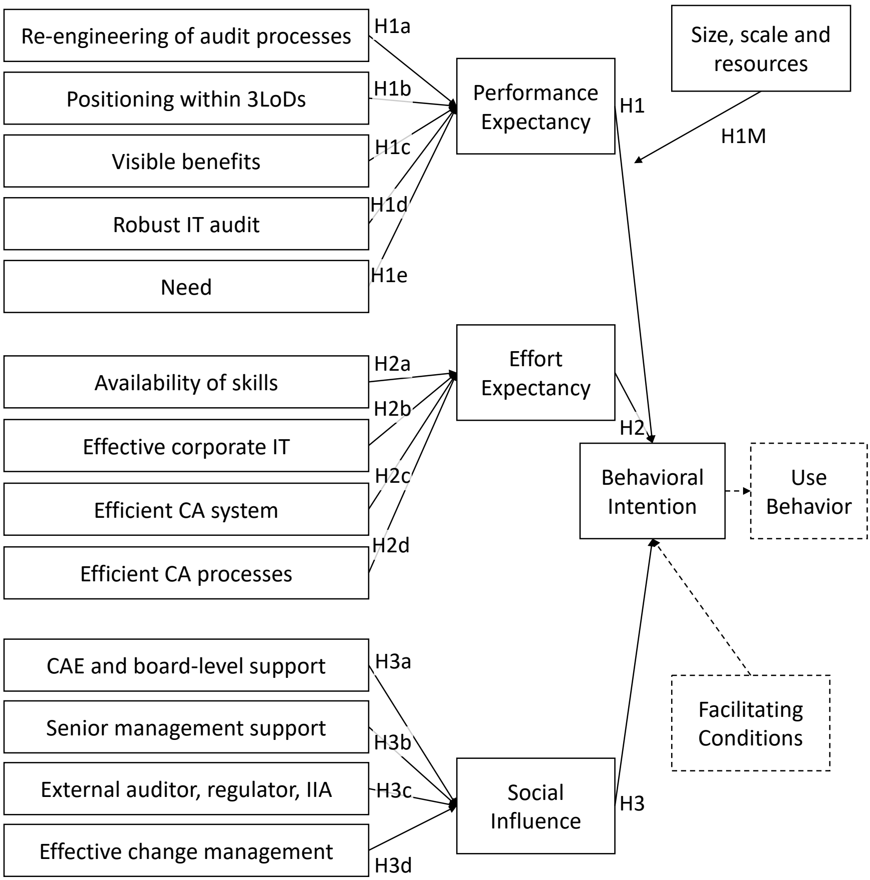
Following UTAUT (Gonzalez et al., 2012; Venkatesh et al., 2003), **Hypothesis H1** is that Performance Expectancy has a positive effect on Behavioral Intention, which drives usage.

Based on the literature and the conducted interviews, the following factors are expected to drive Performance Expectancy, which is defined by Venkatesh et al. (2003, p. 447) as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance".

4.1.1 Re-Engineering of Audit Processes (H1a)

It has long been understood across disciplines that the effective use of technological advancements requires a rethinking and re-engineering of existing processes (e.g. Hammer, 1990; David, 1990, p. 358). This has been confirmed in the CA context by Alles et al. (2006, p. 160), who find that a "certain level of reengineering of audit processes is inevitable due to the necessity to separate formalizable and non-formalizable parts of the program". Vasarhelyi et al. (2012, p. 273) similarly expect that CA reaching maturity and moving into further audit areas "will necessitate reengineering the audit to make more processes capable of being automated". Kiesow et al. (2016, p. 8) confirm through their literature review that the "adjustment of audit

Figure 4.1: Summary of hypotheses to be tested in internal auditor survey. Dashed lines indicate hypotheses from Gonzalez et al. (2012) not tested in this study.



procedures" is a major implementation challenge for CA.

In the practitioner interviews, a key message was that CA requires a systematic, risk-driven approach, in which CA measures are derived from an analysis of business processes, their associated risks and the existing controls landscape:

> "For me, one would likely have to approach this with a bit more structure and think about which are the core businesses of the bank and which risks do we have there in the first place. And which risks are worth it to try to monitor them somehow. And maybe also quantify this with technology somewhere." (Company 1, Audit Manager, translated from German)

This is in line with IIA guidance (Standard 2010, IIA, 2017a) but for many audit departments will require a much deeper analysis than is required for the current audit planning approach and also more flexibility:

> "We have been in kind of a rhythm; about every four, five years we need to go to Germany again, we need to go to Chile etc... And this they want to change. If today someone talks about an area, about this being a big risk, then they want that we are able to organise an ad-hoc audit within a few months to look at how this is operating now." (Company 5, Data Analytics Head, translated from German)

To keep CA manageable, this might also entail streamlining the existing audit universe and risk taxonomy:

> "We have the risks, they are too many, twenty-nine. We have about 350 assessment units. This in combination already yields comparatively many combinations. And then the controls behind that, where we don't even have the controls yet in a systematic form... I think this is also ongoing, to first look at getting the

> risks more compact and maybe a bit more divisible. And then get the next round done and say, ok, now we have to look at how to automate it." (Company 6, Audit Methodology Head, translated from German)

In the more advanced organisations, interview partners have also highlighted ways in which they have changed their organisations to account for re-engineered audit processes: Instead of a dedicated organisation for CA, smaller audit departments or those wanting to start small reserve time from select existing team members for CA, in a project or horizontal organisation for CA. Instead of hiring dedicated technical experts, resources are "borrowed" from the organisation's IT department or other parts of the organisation with technical and statistical know-how (e.g. the actuary department for insurance companies, risk management for banks, R&D departments for food or pharmaceutical companies; any such "borrowed" staff must of course adhere to the independence requirements set out in the IIA Code of Ethics and Standards).

In an intermediate development step, one company has put together a "tiger" team that has the resources to quickly respond to findings that come out of ORA and OCA procedures and require immediate attention. A dedicated CA team, combining the variety of skills needed for effective CA (business auditors knowledgable about internal processes and audit techniques, data analysts, IT auditors, visualisation and UX experts etc.), can be put in charge of developing and performing CA procedures. In this intermediate phase, CA will thus be fully operational but will not yet have permeated the whole audit department, with auditors outside of the CA function still operating in a "classical" manner. Newmark, Dickey, and Wilcox (2018) suggest implementing agile methods, and in particular Scrum, in internal audit to obtain the required agility for CA.

The interviews have not identified any organisation that would already operate a fully CA-driven, agile audit department, where self-organising, independent teams quickly would react to new areas where CA indicates audit needs, replacing the yearly or multi-year audit plans. However, some audit departments outside of Switzerland have moved into this direction (Daals, 2018).

Based on this, **Hypothesis H1a** is that a **re-engineering of audit processes** and the accompanying organisation will **increase** Performance Expectancy for employing CA methods.

4.1.2 Positioning Within 3LoDs (H1b)

How to differentiate between continuous auditing (performed by internal audit) and continuous monitoring (performed by the first and second LoD) is a long-standing issue within CA theory and practice. Alles et al. (2008, p. 212–213) find that "the biggest issue we have learned in this research project is the way in which continuous auditing tends to overlap with operational monitoring by management". This issue has a direct impact on the effectiveness and performance of CA, as "the overlap of assurance with the needs of management is both the greatest challenge and opportunity facing CA. Equating CA with CMM is an opportunity in the sense that it makes it possible to sell CA as a profit driver, with the same information used for both providing assurance and running the firm on a timelier basis. [...] On the other hand, the clear danger of CMM dominating CA is the potential to compromise auditor independence". This dilemma is confirmed by de Aquino et al. (2013, p. 53), which also find that "conflicts between the two functions [audit and business monitoring] and a subsequent blending of controls seem to be common dilemmas faced by leading organizations as they automate internal audit processes", suggesting that "future approaches may benefit from creating a clear distinction between the two centers of responsibility (monitoring and auditing)".

Successful, effective CA implementers often follow the guidance by Ames et al. (2015b) and cooperate between audit and the 2LoD, with the option of handing over successful tests from audit to the 2LoD for continuous monitoring (e.g. Hardy & Laslett, 2015, p. 190). Weins et al. (2017) propose an integrated CA platform that can be used by different audit and audit-like stakeholders inside and outside of the organisation.

In the interviews, the differentiation between the three lines of defence in a CA setting was a frequently discussed topic. There is a common understanding that clear roles and a separation of duties are necessary for effective CA, as exemplified by the following quotes:

> "What is probably still missing is the systematic coordination of activities with the second line." (Company 1, Chief Audit Executive, translated from German)

> "Concerning the Control Assessment, I see more whether one should not in general try to get a better cooperation with Compliance and Risk. These are also a bit the developments [...], integrated governance, risk, compliance framework. Where one tries to get the different control functions closer together." (Company 1, Audit Manager, translated from German)

To resolve ambiguity, some argue for a clearly delineated, limited role of continuous auditing:

> "I see the Continuous Risk Assessment in audit. But the [Ongoing Control Assessment] actually not. I see this in the second line of defence and in the first line of defence primarily. And audit... I mean, I also see it within audit, but I think, audit does not have to do it. Audit should actually only look at how this is set-up. Either in the second, first or in the business. There I find to be the big difference." (Company 4, Head of Data Analytics Internal Audit, translated from German)

In this view, if there is some area in risk analysis or controls monitoring that is not properly covered by continuous monitoring, audit should recommend to the business to address this shortfall, not cover this area themselves (deviating from the suggestion by Ames et al., 2015b):

> "And I say, no, if we really believe this is so important, that – if you don't have it – the [...] organisation is taking too much risk, because they don't know the risk or can't assess it, then we need to move the organisation to do that.
>
> Not we build it and hand it over, because then it must really have such a big impact that I can also convince the organisation that this is a risk. If we can't convince them of that we have failed as audit. Then you're taking the easy route, you're not going into conflict with the auditee." (Company 1, Audit Manager, translated from German)

Others see audit as being able to experiment, being more flexible by design than the first or second LoD, and, like a "research unit" to step into areas not currently covered by the first or second LoD, whetting their appetite:

> "We have to aim to push them a bit, and say, 'do more, do still more'. We have to be the pacemaker. And through this we need to show what is possible. And when one can show what can be done, the appetite will come. L'appétit vient en mangeant." (Company 1, Audit Manager, translated from German)

> "We see us more a bit as a research organisation, that tries to identify risk areas and areas where it needs better control mechanisms. To say, ok, this is now really relevant, we have to change this everywhere. Or, yes, that was just an ad-hoc problem in this market here, then it is fine." (Company 5, Data Analytics Head, translated from German)

While there seem to be multiple different ways of successfully structuring the cooperation between the first, second, and third LoD in a CA setting, a common theme is that this question needs to be addressed and clarified for successful CA implementations.

Based on this, **Hypothesis H1b** is that **a clear positioning and co-operation between audit and the first and second LoD** will **increase** Performance Expectancy for employing CA methods.

4.1.3 Visible Benefits (H1c)

Generating visible benefits early-on in the process of moving towards CA is maybe the most obvious way of highlighting the performance of CA and increasing intention to use. Hardy and Laslett (2015, p. 190) note in their case study that "[t]he 'small wins' arising from these routine tests [...] assisted in gaining buy-in from the business departments". Kuznik and Küppers (2015) also highlight that their CA solution is by now an accepted tool, valued by management for its reporting and targeted analysis capabilities. One of the interviewees summarises this as following when asked what has supported their CA program:

> "Success. And being able to show it. I mean, we have done a lot of stuff with senior people, executives. And where we have been able to demonstrate... I think it's more business acumen than compliance, if I am honest. We are looking at operations, where we save cash, where we can cut costs, where we can be more efficient. And by doing that, people talk. There is more advantage for me in terms of getting more budget, getting more support by going to these senior people. Because then they talk... It's good for the function, but we will then use that to further enhance our audit work program to how we use analytics." (Company 2, Head Analytics)

As this excerpt shows, targeting visible benefits for the business might mean that initial CA controls might not always be targeted to the most risk-sensitive areas, but to the areas where it is easiest to show a tangible business value (such as cost savings). This will then generate good-will and resource allocations that can be used to increase assurance in high-risk areas. Ideally, both targets converge, as here when asked about CA's success factors:

> “I believe the ‘Aha!’ effects in business. I believe this is a very strong success factor, where one says, oh, interesting, these are relationships that we were not aware of.” (Company 6, Audit Methodology Head, translated from German)

Business buy-in is often based on the results CA generates:

> “Also from the auditees, they have asked if they could get there and there more information and whether this had really been like that, because they almost couldn’t believe that. But what we had done there was all shown to be correct. And so, I believe, they see the added value”. (Company 1, Head of Management Support, translated from German)

Because of this, communicating and increasing the visibility of CA in the organisation is seen as an important next step:

> “One should communicate this much better, also the results. I don’t believe that it is sufficient to communicate our results in the best case in the yearly plan or in a quarterly report. One should present it in audit reports. One should really try to steer this using that, with communication and with audit reports. And to show the benefit there, of course.” (Company 1, Audit Manager, translated from German)

Based on this, **Hypothesis H1c** is that **visible benefits for the business early in the process** will **increase** Performance Expectancy for employing CA methods.

4.1.4 Robust IT Audit (H1d)

Most work on CA takes the integrity and security of the underlying enterprise IT platforms for granted, e.g. Lambrechts et al. (2011, p. 8) states that “using data that has been maintained manually can pose problems pertaining to data integrity as change controls might be lacking or ineffective” and "whenever possible, internal auditors should use automated data as the basis for the analysis", the implication being that automated data is always trustworthy. However, this requires robust IT general controls (ITGC; Arens et al., 2014, pp. 392–396), which ensure the reliability of the data (Schäfer, Steiner, & Keller, 2017) and need to be covered by a robust IT audit. Or, as one interviewee has pointed out:

> "Because the danger... The advantage, if one does everything IT-based, is that if everything works and everything runs optimally you just need one sample to find out whether it is correct or not. But if I trust this too much and there is an error, such that the sample is always correct, I might not discover it.
>
> I think this will increase the importance of the IT audit also in internal audit and the role of the IT specialists." (Company 1, Head of the Audit Committee, translated from German)

If the integrity of the data used for CA cannot be presumed, any results from CA cannot be trusted and CA will not be effective. Thus, **Hypothesis H1d** is that **robust IT auditing** in the organisation will **increase** Performance Expectancy for employing CA methods.

4.1.5 Need (H1e)

Successful CA projects often arise from a specific need that cannot be met with classical auditing alone. Hardy and Laslett (2015, pp. 189–190) discuss a project at Metcash, where "more timely risk and control assurance was required" to address a lack of control over stock shrinkage. Often the need is a lack of resources for random sample testing, requiring a more systematic, automated, and risk-based identification of issues. de Aquino et al. (2013, p. 52) write about a bank where "regulations required that the internal audit department perform annual audits in each of the more than 1,400 branches. Because each yearly branch audit entailed 160 hours of audit work, internal audit's capacity to handle this task was insufficient[...].

The solution to this problem involved creating a continuous auditing system that evaluated all branches based on 18 or more distinct monitoring indices, and dramatically increased audit efficiencies". Kuznik and Küppers (2015, p. 176) similarly implemented CA at a German retail chain as "due to the high number of branches in a multinational retail firm and the per se limited human resources in internal audit, branch audits can generally only be conducted via sampling. [...] Due to this, the selection of branches based on key figures, so-called Key Performance Indicators (KPIs), presents itself"[1]. Nigrini and Johnson (2008) cite the same reasoning for applying CA methods to franchisee audits.

This has also been mirrored in the interviews:

> "Also an internal audit needs to look at costs, needs to create efficiency, work effectively. And this is achieved best with a systematic approach, through certain data analyses." (Company 1, Audit Manager, translated from German)

In the last few years, this has been complemented by the general need and expectation of stakeholders to employ digital, data-based approaches in all areas of business. The interviewees find that sticking to business-as-usual is no longer an option:

> "Then also generally the expectations... the people always talk about digitalisation, Big Data, and there exists simply the expectation that in this area... that one also uses this area and also becomes active there." (Company 1, Head of Management Support, translated from German)

Based on this, **Hypothesis H1e** is that **the need for a new audit approach** will **increase** Performance Expectancy for employing CA methods.

[1] Translated from German.

4.1.6 Size, Scale and Resources (H1M)

Gonzalez et al. (2012) show that the size and resources of an organisation (which they measure by proxy of annual sales volume) act as moderator on the relationship between Performance Expectancy and intention to use.

This seems plausible given that CA requires significant start-up resources: to establish the conceptual basis, identify the in-scope processes, risks and controls, to gather knowledge on and obtain the required data feeds and to set-up or procure the analysis and front-end systems for the auditors to work with (Vasarhelyi & Halper, 1991, pp. 123–124). This still holds today, as confirmed in different interviews. When asked what is holding back CA:

> "Loss of responsibilities[...], *the unpredictable or high initial effort*, convenience." (Company 1, Chief Audit Executive, translated from German)

Similarly:

> "Because I believe, it costs... it will be a significant effort, financially, to get this thing off the ground." (Company 6, Head of Audit Methodology, translated from German)

One approach to deal with the high start-up costs is to start small and expand in scope later once CA has been proven, as Medinets et al. (2015, p. 149) explain the approach at Siemens. Baksa and Turoff (2011, pp. 248–249) also recommend to "start on a small scale, focusing on the audit procedures that are easiest to formalise and automate, which may help mitigate the initial cost objection". In the interviews:

> "And they start in one area. Not everywhere something, and fragmenting your effort, but in one area and then conclude this tidily, before you say, ok, and now what do we do next. But not try five or ten things in different areas, you can only lose there. Because then you also cannot build on the experience

> from the other areas." (Company 1, Audit Manager, translated from German)

> "Often the people are... have the opinion, well, one would need fifty risk indicators. That's now how I see it. I rather think, if you have twelve high-quality risk indicators, this is much better than if you have fifty that go wherever." (Company 4, Head of Data Analytics Internal Audit, translated from German)

Being able to assign dedicated resources to the CA project is seen as crucial for project success:

> "Because it is something that you don't do on the side, if in parallel you should work on two audits as well, then you cannot also develop a bit of something in the evenings. Then you have to say, this is worth it for us, we invest there. Now we will delegate someone for this, who can then for two, three months focus on such a topic, in each area." (Company 1, Audit Manager, translated from German)

Or, talking about the difficulties in getting CA off the ground:

> "Yes, this is again work that has come on-top. One is doing it... one of course still has the Macro Risk Assessment, the Micro Risk Assessment and this is now almost on-top every quarter. So, the difficulty is that the people again have more to do and, yes..." (Company 4, Head of Data Analytics Internal Audit, translated from German)

Due to the required investments, some argue that CA only makes sense for larger organisations (Whitehouse, 2012). A certain size is also a requirement to benefit from the economies of scale that can make CA sucessful (Garrido, 2011, p. 86).

Based on this, **Hypothesis H1M** is that **size and resources of the organisation** will act **as moderator** on Performance Expectancy for employing CA methods.

4.2 Effort Expectancy (H2)

Following UTAUT (Gonzalez et al., 2012; Venkatesh et al., 2003), **Hypothesis H2** is that Effort Expectancy has a positive effect on Behavioral Intention, which drives usage.

Based on the literature and the conducted interviews, the following factors are expected to drive Effort Expectancy, which is defined by Venkatesh et al. (2003, p. 450) as "the degree of ease associated with the use of the system".

4.2.1 Availability of Skills (H2a)

The availability of the right skills in internal audit for developing effective CA is the number one challenge mentioned in the interviews. Already CICA (1999, p. 79) realised that "changing the mindset of auditors and obtaining new skills" will be a prerequisite for successful CA. Similarly, Byrnes, Al-Awadhi, et al. (2012, p. 7) note that CA requires a "[h]igh degree of auditor proficiency in information technology and the audited subject matter".

The required skillset is specified by the interview partners as a combination of four pillars: (a) an analytical mindset and/or data science skills, (b) business and industry know-how, (c) audit skills, and (d) an understanding of the organisation-internal processes and systems:

> "For our people agenda 2018 it is clearly established that we only hire people that in general bring a data science configuration with them. And then, plug-on or bolt-on, whatever you want to call it, an audit specialisation. And additionally an [industry] specialisation." (Company 3, Chief Audit Executive, translated from German)

> "In the end they need all three skills. They need to know the

IT, this means data analysis, machine learning, artificial intelligence, all these topics now also come. Then they need to have the business know-how. Either in a certain division or in IT. And thirdly they also need to know the risk, the risk awareness of audit and the audit process a bit. This is I think the difficulty to find people there today." (Company 4, Head of Data Analytics Internal Audit, translated from German)

> "Knowledge of the [...] business. You need to have a specialist. Then you need someone who knows statistics, that can do analyses, that you are not far off doing analyses. And someone, who codes. And, logically, knowledge of the organisation itself. Not just the [...] business [in general], but also, how does it work at our company. One would need to have this combination." (Company 1, Audit Manager, translated from German)

This aligns with CICA (1999), who already argued that "auditors need both a sound grasp of the subject matter being audited and of various aspects of information technology" (para. 34), and Lambrechts et al. (2011), who note the need to understand key business processes to be able to perform audit data analytics. The required deep technical know-how varies between the organisations, probably depending on whether the analytics are completely developed within internal audit or whether they can leverage other resources outside of the audit department. All stress the importance of an analytical mindset, but only some also require programming and data science experience:

> "For me it is more a question of the mindset. That you think of such things in the first place. [...] [T]o think, what are we doing, where are the risks, can't we do this differently. Or where could we use the increasingly available data. For me this is more a mindset and not a skill." (Company 1, Chief Audit Executive, translated from German)

> “And we started doing this three, four years ago, under the topic ‘analytical mindset’. Guiding the people towards having a permanently alert eye and to try, recognising changes and then auditing adaptively. And we see, this is incredibly difficult.” (Company 3, Chief Audit Executive, translated from German)

This goes beyond hard skills or knowledge, including a different approach and soft factors, such as auditors being more creative, proactive, and curious for effective CA:

> “And then so the icing on the cake would be to have people which are working a bit exploratively and innovatively.” (Company 1, Head of Management Support, translated from German)

> “From your temperament, you need to be someone who always wants something new. And then you can say, then you have the best.” (Company 1, Head of 2LoD Function, translated from German)

> “And then, yes, business partner on the other side, who are, I would say, very ambitious and that can aid a lot there and who have good ideas.” (Company 4, Head of Data Analytics Internal Audit, translated from German)

The increase in available data means that this analytical mindest also needs to include an intuition about what is really material. During sample testing, every anomaly is worth looking at, because they might point to a systematic, significant issue. But with a large amount of data, you will always find anomalies, and the focus shifts to being able to interpret them and their significance:

> “And in the end, when you see something, oh, they had a lot of exceptions, then you need to be able to correctly judge the number of exceptions. Is this normal or is this not normal. And

> when is such an exception maybe no longer normal. Then you really also need to understand the business well. Not everyone can do this." (Company 1, Audit Manager, translated from German)

Researchers have looked into how accounting education can be reformed to better account for the new data-driven auditing techniques (Sledgianowski, Gomaa, & Tan, 2017; Vasarhelyi, Teeter, & Krahel, 2010).

Some of the interview partners have set-up sophisticated training programs for their auditors, with the goal of teaching them general IT know-how, data analytics basics and increase their (organisation-internal) process understanding. Bedard, Jackson, Ettredge, and Johnstone (2003) confirmed that training can positively influence system ease of use perceptions in an audit context. Others in the industry have changed their recruiting strategy, recruiting a different kind of employees using a dedicated web presence and new job profiles for their internal audit activity instead of relying only on their company-wide career sites (Daals, 2018).

Many internal audit activities with advanced data analytics capabilities have implemented a "champion" model, where interested auditors with an affinity for data analytics are being trained to champion the use of data analysis methods in their audit area and to support their colleagues in using data to answer audit questions.

Based on the high importance most interviewees assigned to this topic, it seems to be a crucial enabler of CA. Only auditors with the right skillset will experience CA as easy-to-use with the effort required to use it outweighed by its benefits. Based on this, **Hypothesis H2a** is that an increased **availability of the right skills** within the internal audit activity will lead to an **increase** in Effort Expectancy for employing CA methods.

4.2.2 Effective Corporate IT (H2b)

Modern, integrated IT systems such as ERP systems have already been identified as enabler of efficient CA by CICA (1999, p. 15). Alles et al. (2008) similarly contrast the possibilities of CA in an integrated ERP environment with the limits encountered when trying to apply CA to legacy, mainframe-based IT infrastructure. Garrido (2011, p. 85) notes that "the development of a Continuous Auditing project becomes a nightmare of interfaces which additionally have to be reprogrammed every time that there are modifications in the source applications" when systems are not integrated enough. Appelbaum et al. (2016) share their experience of implementing CA/CM in small businesses with "outdated application software and/or database systems where there is little if any external or internal knowledge or support available". They admit that "[u]nderstanding the design and function of little-known systems was a challenge to the project team, but had to be undertaken for a successful project". Baker (2012) notes that, from a technology adoption perspective, "a firm's existing technologies are important in the adoption process because they set a broad limit on the scope and pace of technological change that a firm can undertake" (p. 232). Majdalawieh, Sahraoui, and Barkhi (2012, p. 312) state that "quality of transactional data (accessibility, completeness, free-of-error, relevancy, security, timeliness, understandability, etc.; Kahn, Strong, & Wang, 2002) is a pre-requisite for the implementation" of continuous auditing. Langhein, Kiesow, and Thomas (2018, p. 1303ff) find that the "digital availability of data" and "taking full advantage of the available IT infrastructure" are crucial prerequisites for automated (external) audits.

For the interviewees, an effective corporate IT enables CA through (a) sufficient data quality, (b) digitalization of more and more business processes, (c) flexibility for auditors to use their own tools, (d) a simplified IT landscape with integrated and harmonised systems, and (e) standardized data formats:

> "And very often this is then the first finding, that one also reports, that one really needs better data... or needs to push data quality." (Company 6, Head of Data Analytics, translated from German)

Talking about barriers for CA adoption:

> "And partially also the human interface. Because not everything is implemented via IT systems. I think, this is the biggest [issue]. The more this is automated and the more the databases behind it are the same, on which this is implemented, the easier it is to put interfaces on top of it and to extract the data. I think this is primarily it." (Company 1, Head of Audit Committee, translated from German)

> "The [company] still needs to become much, much more digitalised. Because only then one can really leverage what we now see as a potential. As said before, if the stuff is still on paper, then I first have to scan it, then the scan has to be readable electronically before I can do anything useful with it. If everything is digitalised in the system, then I can already do much, much more." (Company 6, Head of Data Analytics, translated from German)

On one hand, in some way digitalised processes seem to be a prerequisite for effective CA: only digitalised processes yield the kind of logging and transaction data you need for data analysis (Chan, Chiu, & Vasarhelyi, 2018b). On the other hand, digitalisation of processes also makes CA more necessary: when processes are moving faster, less visible and without a paper trail, classical observation and sample testing methods of auditing will no longer provide the necessary visibility into these processes.

Interviewees also note the importance of auditors having the flexibility to use their own IT tools and software:

> "But I find, the independence that we have, the freedom that we have to do this, is great. Today, for example, wenn I want to bring in a new software [...] I need to file a request with the IT department[...]. But now here, this, this audit tool, I can... [...] Within ten minutes I can provide a new version. And this makes

> us very free." (Company 5, Data Analytics Head, translated from German)

On the importance of simplified, integrated systems:

> "But if you, like here, have lots of interfaces in between, where everything is a bit in flow again and again... then you start from scratch every year. Then the effort will be quite large. Even during the year you will then suddenly have, oh, now again the data isn't coming anymore, because something has changed again and there again..." (Company 1, Audit Manager, translated from German)

Based on this, **Hypothesis H2b** is that a more modern, more **effective corporate IT** will enable CA and thus lead to an **increase** in Effort Expectancy for employing CA methods.

4.2.3 Efficient CA System (H2c)

Already the very first documented CA system included an "auditor platform, accessible at any level, which can include a series of different functions" (Vasarhelyi & Halper, 1991, p. 121). It provided graphical process representations and visual indicators of key statistics to support auditors in spotting anomalies. Singh and Best (2015, p. 310) also stress the importance of visualisation to "make complex data understandable and visually appealing, and to reduce the amount of information presented" and provide examples in Singh and Best (2016). Alles et al. (2006) focus on the need of an efficient CA system to allow auditors to reduce or efficiently deal with "alarm floods", or too many false positives. Lins et al. (2016) suggest to implement decision support systems to aid auditors in dealing with the large volume of exceptions. Medinets et al. (2015) stress any CA system must be easy to use, which "requires finding a balance between complexity and flexibility. It must be simple enough for all personnel to use it correctly, but capable of being tailored to the needs of customized data sets, disparate system platforms, and unique business rules". Weins et al. (2017) show that an integrated CA platform can also increase efficiency by being shared with other internal or external audit (or audit-like) stakeholders.

In practice, as Marks (2009b, p. 37) points out, IT budgets for most audit departments are limited and thus it makes sense to leverage enterprise platforms which already exist in the organisation for an efficient CA system implementation. Hardy (2015, p. 4737) finds that organisations heed this advice, as "[d]ecisions about how to progress CA were largely influenced and challenged by the types of business intelligence (eg. Oracle BI) and audit analytics tools (eg. ACL, IDEA) already used in the organization, multiple vendor offerings and modest budgets".

These observations, that efficient CA systems will provide (a) an integrated platform for auditors, (b) use visualisations to support auditors in distilling a large amount of information, (c) provide support to deal with alarm floods, (d) need to find the right balance between features and ease-of-use, and (e) should leverage existing platforms where possible, are shared by the interviewees. In addition, they pointed out that an efficient CA system will not be a one-way street, but will also (f) provide support for CA workflows including four-eye principles for quality assurance and (g) allow auditors to capture work performed and their findings within the system:

> "What I could imagine, is that [...] one would be able to have some workflow tools, that also nudge people via push that the review is now due, these are the deadlines, automatically calculated, and this is the data, we have the list... or... please validate a parameter, then we can connect it." (Company 1, Chief Audit Executive, translated from German)

> "Tableau is basically just a system where you can show things, but it cannot interact with the user... You cannot receive anything from the user in Tableau, like you could in a self-developed system. That would be nice, if one would have something sim-

> ple there." (Company 4, Head of Data Analytics Internal Audit, translated from German)

In addition, (h) analytics self-service is gaining prominence, meaning that the system should support auditors without coding skills to adapt existing or create ad-hoc new analytics to answer their questions without having to refer to analytics specialists:

> "I would prefer to have an integrated tool. Where it is also easy to quickly do queries. I myself could go there and say, now I would like to know, how does that look like. For me at the moment it is always, I have an idea, I hand it over to [the data specialists]. They think about it [...] or try something. And then it works or it does not. The required effort is high." (Company 1, Audit Manager, translated from German)

> "And the governance we have built [...] is really that we value a lot that the auditors can da lot themselves. This pillar here, 'Self-service Analytics', is very important. Because, we believe, there we really have value creation, there we add value for the auditors." (Company 5, Data Analytics Head, translated from German)

Based on this, **Hypothesis H2c** is that an **efficient CA system** with the characteristics given above will make CA more usable for auditors and thus lead to an **increase** in Effort Expectancy for employing CA methods.

4.2.4 Efficient CA Processes (H2d)

On the implementation level, CA needs effective processes that define how to set-up and design new ORA and OCA measures, tests, and analytics; how to maintain the existing ones; and how to decommission those which are no longer needed. Garrido (2011, p. 86) stresses the importance of "a careful selection of the indicators to be supervised, [and] a constant feedback and adjustment of those indicators".

On the operating level, CA needs effective processes that detail how to deal with the results produced by the analytics, how to separate real from false positives, and how to process and report on the results from ORA and OCA (Lambrechts et al., 2011). Baksa and Turoff (2011) suggest to learn from emergency response systems about how to deal with CA alerts.

How to set-up CA processes also influences and is being influenced by the organisational set-up for CA within the audit department. The most common approach seems to be to have a dedicated team (or at least person) that is responsible for CA with regards to the conceptual work, driving and coordinating the process, ensuring the technical implementation and reporting on results. The definition of CA indicators and measures as well as the review and analysis of their output, however, is then most often performed decentralised by regular auditors who know the respective business area:

> "For me it needs a central unit, that has a supporting function, a coordinating function. That provides the tools on a technical level, steers and accompanies the process. That also ensures that this is actually done in the right frequency. The reporting I could also more easily imagine as centralised. That someone is then responsible for this centrally, that there is also a reporting about it.
>
> For me it would be the wrong approach if we would build this up centrally, a monitoring, CA function where in the end there are five people there and we say, you are now all doing CA. Because then... I do believe that this will work very well conceptually, but the question is, if you are then operating in the right place. If you then really still have the proximity to the individual business areas that you need." (Company 1, Audit Manager, translated from German)

Based on this, **Hypothesis H2d** is that **efficient CA processes** covering the implementation and operating level of CA, supported by a compatible organisational setup, will make CA more usable for auditors and thus lead to an **increase** in Effort Expectancy for employing CA methods.

4.3 Social Influence (H3)

Following UTAUT (Gonzalez et al., 2012; Venkatesh et al., 2003), **Hypothesis H3** is that Social Influence has a positive effect on Behavioral Intention, which drives usage.

Social Influence is defined by Venkatesh et al. (2003, p. 451) as “the degree to which an individual perceives that important others believe he or she should use the new system”. The hypotheses on Social Influence are thus informed by internal audit’s stakeholder universe, as depicted in Figure 3.7. This stakeholder view has been combined with the findings in literature and the conducted interviews on the importance of the support of individual stakeholder groups.

4.3.1 CAE and Board-Level Support (H3a)

Byrnes, Ames, et al. (2012, p. 4) highlight the need for support at the highest levels, in particular the CAE and at board-level, for CA initiatives to be successful.

This has been supported by the interviews, particularly the personal buy-in from the CAE is seen as crucial:

> “He [the CAE] likes it a lot. He thinks it’s the future. And obviously he has put his money where his mouth is, because he has invested.” (Company 2, Head Analytics)

> “Here, look... This is [our] Global Head of Internal Audit, who really... I would say... shows a very strong personal engagement. To make it clear, this is the future that we need. Because the world doesn’t get any simpler, correspondingly we have to see that we can manage the complexity of the system and we can then really focus on understanding the business. And dealing with the data flood becomes automated. And correspondingly

> he is also very active in marketing this. And to be convincing about the benefits." (Company 6, Head of Audit Methodology, translated from German)

On the board- and audit-committee-level, the support is mainly passive (they support the CAE in pushing for CA, but don't actively demand more in this area) but can also become enthusiastic:

> "There is support, yes. They [the Audit Committee] don't have clearly defined expectations, but what they see always fully satisfies them. [...] Passive support, yes, we are not being forced." (Company 1, Chef Audit Executive, translated from German)

> "For sure the finance, audit, compliance committee. Because this thing sells. It's got all the right... you know, it's frequent, it's 100%, it's quality, it looks good. So it has all the selling points. It is easy to sell to these guys. Yeah, let's do that. So, the very senior people, yes." (Company 2, Head Analytics)

They also might influence their organisation's approach to CA by appointing a CAE that is open for new approaches and technologies, focusing on outcomes for them instead of methodology:

> "I mean, they [the Audit Committee] are of course very big supporters, that's also why I have come here, they wanted change, [...] this means, we have very strong support here. But of course one also has to say, what is meant with 'support'? Support means, that the AC very clearly articulates the demand to get timely information that is well-researched and reconciled with management." (Company 3, Chief Audit Executive, translated from German)

Based on this, **Hypothesis H3a** is that visible **CAE and (to a lesser extent) board-level support** will show to auditors the weight important stakeholders assign to CA, thus leading to an **increase** in Social Influence for employing CA methods.

4.3.2 Senior Management Support (H3b)

Organisational independence of internal audit (IIA, 2017a, Standard 1110) should ensure that business management cannot directly influence the work of internal audit. However, senior management in the business is still an important stakeholder for audit (Kyburz, 2016, p. 28). As auditors have no authority over business decisions, they need to establish credibility with senior management to add value (Kiesow et al., 2015, p. 6).

Thus, senior management support for CA is listed as important enabler by Coderre (2006, p. 26). Hardy and Laslett (2015, p. 191) confirm that senior management support "was critical in progressing CA and CM initiatives". The interviews also point to the support of business stakeholders for CA initiatives:

> "The business people get it quickly. They get it far quicker. Particularly the... [...] They know this stuff inside out. It's what they do, it's their job, they can see the worth when they see the results, and they can question and understand root-causes. [...] They are very supportive". (Company 2, Head Data Analytics)

> "[The business], they are impressed. [...] And there we have already gotten very good statements also from business, yes." (Company 4, Head of Data Analytics Internal Audit, translated from German)

Based on this, **Hypothesis H3b** is that **senior management support** will show to auditors the weight important stakeholders assign to CA, thus leading to an **increase** in Social Influence for employing CA methods.

4.3.3 External Auditor, Regulator, IIA (H3c)

Internal audit's external stakeholders are the external auditors, the IIA which publishes the Standards and (depending on the industry of their organisation) regulatory bodies such as financial or pharmaceutical regulators. We could thus expect the opinion of those external stakeholders also to influence the perception of social influence on CA. However, in practice, few of those stakeholders seem to argue for organisations to adopt CA.

There has been some evidence on the influence of regulators on adopting CA in the interviews:

> "In addition also the FINMA [the Swiss Financial Markets Supervisory Authority] is now [...] also very interested in what we are doing in Continuous Auditing. This is of interest to them, but I would not say that we are under pressure to move ahead here." (Company 1, Head of Management Support, translated from German)

> "If the regulator, the Fed is always very active there, if the Fed comes, and says, you need to change something there and there... I mean there are many, I would say, drivers around it or people, that are saying something there, for you to adapt again and again." (Company 4, Head of Data Analytics Internal Audit, translated from German)

Also, Ames et al. (2015b) and the increasing risk-focus of the Standards seem to have lead to a reversal in which the IIA is seen as supportive of CA, while earlier literature such as Vasarhelyi, Alles, and Williams (2010) has seen audit standards primarily as a hindrance to CA:

> "I think they [the IIA guidance] are pretty supportive. I don't think they… they are always behind a little bit, if I am honest, but it's clear that most people who are industry experts in the audit function are now selling analytics like crazy, right. And I think the CA concept and methodology has been about for a while, technology has now kept up so it can become feasible." (Company 2, Head Data Analytics)

Thus, based on their role as standard setters for internal auditors, **Hypothesis H3c** is that perceived **external auditor, regulator and IIA support** will lead to an **increase** in Social Influence for employing CA methods.

4.3.4 Effective Change Management (H3d)

Alles et al. (2008, p. 206) note that "technological capability has to be preceded by a clear change-management plan that takes into account the various important stakeholders, such as the external auditors and senior management, which in the case of Siemens, meant those at the corporate HQ in Germany". They compare CA implementation to the challenge of implementing ERP systems in organisations. This observation is mirrored in the interviews, where the need for changing the mindest of auditors and the application of change management to CA implementation were repeat topics:

> "I think it's just general change management. Because... it's a fundamental shift from traditional or typical audit to CA. It's a shift in methodology... it's actually a shift in every single conceivable element. So it's a shift in the process, it's a shift in the people skill, it's a shift in position. [...] So it's... the resistance is just basically change management. I guess if you take a triangular shape, it changes your position, it changes your process and it changes your people." (Company 2, Head Data Analytics)

When asked what they wish for in their CA projects:

> "I would wish to have already completed the People Transformation." (Company 3, Chief Audit Executive, translated from German)

Or when asked about the biggest challenge in implementing CA:

> "Humans. I think in many cases we have certain... we have still sceptics who refer to the old way of doing things, in the sense of, as a human I can better judge this than a system." (Company 6, Head of Audit Methodology, translated from German)

Thus, solid change management to bring the people on board seems to be crucial. **Hypothesis H3d** is that **change management** will lead to an **increase** in Social Influence for employing CA methods.

The following chapter will discuss how these hypotheses have been tested in a survey among Swiss internal auditors and whether the survey results were able to confirm them.

Chapter 5

Survey Results on Factors Influencing CA Adoption

The hypotheses developed in Chapter 4 have been tested in an online survey among Swiss internal auditors (see section 3.2.1 for a detailed discussion of the methodology). These results served as input for the front-end system design in the second part of this thesis.

5.1 Survey Set-up and Questionnaire

The survey was conducted online using the LimeSurvey[1] open source tool. The survey was conducted anonymously to encourage honest participation and all survey data was fully stored in Switzerland to improve confidentiality.

The survey was prepared in English, German and French, covering the majority of languages used in Swiss organisations. See Appendix A for tables with all questions in all three languages and Figure 5.1 for how they relate to the constructs used in our structural model. Most questions (except where noted otherwise below) were framed as statements for which respondents were asked whether they disagree or agree with them on a 7-point Likert scale and a separate "No answer" option (see Table A.1 for the scale points in all survey languages). The translation was prepared based on the English questions and validated with native speakers and by back-translating the German and French questions to English using the DeepL[2] online translator and comparing the output to the original questions. To reduce the need to come up with new translations, where possible terms were taken from IIA

[1] `https://www.limesurvey.org/`

[2] `https://deepl.com/`. DeepL is the machine translation service with the highest available accuracy for German and French (One Hour Translation, 2018; Ziegert, 2018).

literature also available in the respective language[3].

To address the issue of past surveys on CA which have suffered from unclear definitions of what CA does and does not entail (Vasarhelyi et al., 2012, pp. 268–269), this survey presented specific definitions from Ames et al. (2015b) for the key areas CA, continuous auditing, ORA, and OCA at the start of the survey and then again as mouseover popups when those terms were used in questions. The questions itself were structured along the relevant IIA standards (IIA, 2017a), a familiar shared structure and nomenclature for internal auditors.

To increase the quality of the survey, the questions have been discussed in advance with academic and practitioner experts and cognitive interviews (following Fowler, 2002, p. 108, and Presser et al., 2004) have been conducted with audit practitioners at two Swiss companies from the financial services and manufacturing industries, covering the English, German and French version.

The survey invitation was distributed via email by IIA Switzerland to their email distribution list of corporate and individual members in June. Mid-July a reminder was sent to the same target audience, also to inform them that the survey would remain open until August. This long survey period was chosen as it allowed participants to answer after their return from summer vacations. The distribution was fully managed by IIA Switzerland and the researchers at no point had access to the address lists used. While this ensured the privacy of the recipients, it also made it impossible to use more advanced mixed-mode follow-ups such as combining email, letter and phone (as suggested by Dillman et al., 2014).

[3]E.g. the IIA standards contain many terms specific to internal audit and are available in English, German and French on the IIA website. Ames et al. (2015b) covers many terms specific to CA and is also available in French (Ames et al., 2015a).

5.2 Survey Responses

The original survey invitation was sent via email to the corporate and individual members on file at IIA Switzerland. It was received and opened by 537 potential respondents.

From these potential respondents, 64 (11.9%) completed the survey. Two responses needed to be dropped as they did not include answers to more than 15% of the questions, leaving 62 (11.5%) usable responses.

Of these 62 respondents, 27 (43.5%) indicated that overall, their "internal audit activity has Continuous Assurance methods in place". The other 35 (56.5%) indicated that overall they were not using CA yet. Due to probable non-response bias (see below) this is more likely an upper bound on the use of CA in Swiss internal audit practice and not a representative estimate. The use of ORA is slightly[4] more common than the use of OCA: While the average agreement to "our internal audit activity is employing Ongoing Risk Assessments" is 4.45 (median of 5), the average agreement to "our internal audit activity is employing Ongoing Control Assessments" is only 3.94 (median of 4).

Of the 62 respondents, 35 (56.5%) reported their organisation's industry as "Financial and insurance activities", 9 (14.5%) as "Public administration and defence" and 7 (11.3%) as "Manufacturing". The others reported other industries or declined to answer (see Table 5.1). 16 (25.8%) of the respondents identified themselves as Chief Audit Executives (CAEs) while 18 (29.0%) identified as Audit Managers outside of IT audit (see Table 5.2). 19 (30.6%) respondents work in organisations with 1'000 to 4'999 full-time equivalents (FTEs), while 14 (22.6%) respondents work in organisations with 5'000 to 9'999 FTE and also 14 (22.6%) respondents work in organisations with more than 10'000 FTE. 13 (21.0%) respondents work in organisations with less than 1'000 FTE (two respondents declined to answer this question).

32 (51.6%) respondents work in internal audit activites with between 4 and 19 FTEs, while the audit departments of 17 (27.4%) respondents employ

[4] A Welch t-test on the difference of the means shows a p-value of 0.126.

Table 5.1: Survey respondents by industry.

C.	Manufacturing	7	11.3%
D.	Electricity, gas, steam and air conditioning supply	1	1.6%
G.	Wholesale and retail trade	3	4.8%
H.	Transportation and storage	2	3.2%
J.	Information and communication	1	1.6%
K.	Financial and insurance activities	35	56.5%
O.	Public administration and defence	9	14.5%
Q.	Human health and social work activities	1	1.6%
R.	Arts, entertainment and recreation	1	1.6%
	Other / do not want to answer	2	3.2%
		62	100.0%

20 to 99 FTEs. 6 (9.7%) respondents work in audit departments with 100 FTEs or more, while five (8%) respondents work in audit departments with 1-3 FTEs (two respondents did not answer this question). As expected, larger internal audit activities are more likely to have CA methods in place: while only 29.7% of internal audit activites with less than 20 FTE have CA methods in place, this climbs to 58.8% for activites with between 20 and 100 FTEs and to 100% for activites with 100 FTEs or more[5].

26 (41.9%) respondents note that their internal audit activity has no staff member dedicated to CA. At 23 (37.1%) respondents' internal audit activity, one to three staff members are dedicated to CA. In 9 (14.5%) cases, four or more staff members are dedicated to CA. (Four respondents did not answer this question.)

Survey respondents overwhelmingly feel that internal audit has a role to play in the digital transformation of their organisations: 52 (83.9%) of respondents assigned a score of 6 or 7 (with 7 being "strongly agree" on the

[5]This result is significant in the sense that Welch t-tests on the difference of means between a) activites with less than 20 FTEs and between 20 and 100 FTEs as well as b) between activites with less than 100 FTEs and activities with 100+ FTEs are both significant at the 5%-level.

Table 5.2: Survey respondents by their role.

A2	Chief Audit Executives (CAEs)	16	25.8%
A3	IT Auditing Director	6	9.7%
A4	IT Auditing Manager	2	3.2%
A5	IT Auditing Staff	3	4.8%
A6	Director of Auditing (outside of IT Auditing)	4	6.5%
A7	Auditing Manager (outside of IT Auditing)	18	29.0%
A8	Auditing Staff (outside of IT Auditing)	7	11.3%
A9	Head of Data Analytics (as dedicated function)	0	0.0%
A10	Dedicated Data Analytics Specialist	2	3.2%
	Other / do not want to answer	4	6.5%
		62	100.0%

7-scale Likert scale, see Table A.1) to the statement "We need to participate in the digital transformation of our business". Only one respondent assigned a score at or below 4 to this statement.

5.2.1 Survey Non-Response

The survey's response rate is lower than in previous studies of Swiss internal auditors (e.g. Kyburz, 2016, obtained a net response rate of 52.6% among auditors) but higher than comparable international studies: Gonzalez et al. (2012) report a response rate of 2.33%[6] while ECIIA (2009) obtained a 10.8% response rate for Switzerland. This fits the trend of declining survey response rates in the audit profession, with Nkansa and Bailey (2018) reporting that the studies they analyzed report response rates from "as high as 94.0 percent in 1984 to as low as 6.7 percent in 2009" (p. A14).

The 62 usable responses are a relatively small sample but sufficient for the application of PLS-SEM to our hypothesized model: According to the

[6]Note that their response rate is calculated based on emails sent while the 11.9% reported above is a net response rate excluding emails not received. Based on emails sent this survey's response rate would be between 3-4%, but it is expected that this would include invalid, blocked, or duplicate email addresses and so would overestimate the number of recipients.

"10 times" rule of thumb (Hair, Hult, Ringle, & Sarstedt, 2017, p. 24; Barclay, Thompson, & Higgins, 1995, p. 292), the sample size needs to exceed "ten cases per predictor" (Barclay et al., 1995, p. 292) for the most complex regression encountered in the PLS-SEM computation, which means the larger of "10 times the largest number of formative indicators used to measure a single construct; or 10 times the largest number of structural paths directed at a particular construct in the structural model" (Hair et al., 2017, p. 24). For our initial model, this requires a sample size of at least 50, as the relevant number are the five structural paths pointing toward the Performance Expectancy and Effort Expectancy constructs each (see Figure 5.1). The minimum sample sizes listed by Hair et al. (2017, p. 26) also show that for detecting a minimum R^2 of 0.25 at a 5% significance level, the minimum sample size for PLS-SEM given our model is 45. For the adapted model developed below, these minimum sample sizes change to 60 and 48 respectively, as the new model has six structural paths pointing towards Effort Expectancy (see Figure 5.2). These minimums are also exceeded.

While it is permissible to use PLS-SEM given the available sample size, any conclusions still need to account for the impact of the relatively small sample: many (especially smaller) effects which do exist in reality might not yield statistically significant results given a small sample, so special care must be taken not to (mis-)interpret a lack of statistical significance as evidence for the absence of effects ("Statistical hypotheses, verification of", n.d.). Also, any analysis must account for a possible response bias of the results: low response rates make it likely that the survey will have been completed in larger numbers by auditors with an interest in CA (the effect of "topic saliency"; Dillman, Eltinge, Groves, & Little, 2002, p. 9), an effect that might have been exacerbated by the promise to share the survey results with respondents. Such a response bias should be less of an issue for the goal of this study, which is to investigate how the way companies are implementing or would expect to implement CA affects their intention to use it and thus in a way relies on respondents to have at least thought about CA before. However, it does mean that one should not draw conclusions on the prevalence or distribution of CA among Swiss internal audit activities overall based on these survey results. The sample is likely not a representative sample of Swiss internal audit activities.

While the high number of 56.5% of respondents in financial services might also indicate non-response bias, in fact about 41% of IIA Switzerland corporate members are financial services companies and those in general (due to regulatory requirements) will have larger audit teams than comparable companies (and thus more potential respondents). Hence it is possible that the 56.5% in fact are corresponding well to the overall survey population.

As the survey was conducted anonymously and due to the way it was distributed (via IIA Switzerland without direct access to the address data used) it was not possible to use tokens or other mechanisms to identify which mail recipients answered the survey and which did not. As a consequence of this, it was not possible to conduct follow-ups with non-respondents to better understand their composition and the reasons for them not completing the survey. Thus, the reasons for non-response can only be speculated about. It seems likely that a mixed-mode approach in which the survey invitation would have been distributed using both email and regular mail and for which follow-ups might even have been conducted via phone could have improved response rates, as this phenomenon is well-documented in the literature (Dillman et al., 2014). Unfortunately, this was not possible here due to the lack of access to the underlying address data. Also, the timing of the survey was probably not ideal: it was sent relatively close to the beginning of the summer holidays (about 1-3 weeks prior to the school holidays in most Swiss cantons) with the follow-up falling within the vacation period. Keeping the survey open until after the holidays probably only partially mitigated this.

In addition, CA is a topic that has been discussed for more than 25 years now[7]. Practitioners might be reluctant to answer a survey on a topic that

[7]Starting with the influential discussion by Vasarhelyi and Halper (1991) of continuous

"has been the future of our function for over twenty years, though it is not clear when it will form part of the present" (Garrido, 2011, p. 83). This thesis, however, argues that CA is an important part of what has become known as the digitalization of internal audit (Wiedemann, Spjelkavik, & Hoppe, 2018) or "Audit 4.0" (Rausenberger & Prenrecaj, 2017), a topic which encompasses both internal audit's role in the digital transformation of the audited organisation as well as the digitalisation of the internal audit activity itself. It is possible that the survey might have attracted additional responses if it would have focussed more on the link of CA to digital auditing and would have been promoted using this more recent terminology.

Of the 537 recipients that opened the original invitation, only 90 (16.8%) clicked on the link to access the survey. In addition, 54 (10.1%) clicked on the link in the reminder that was sent. Only 94 (17.5% of the original 537 recipients) potential participants progressed past the survey introduction to at least the second page of questions. As of those 64 completed the survey, it means that only 30 (5.6%) participants stopped responding while they were working on the questions itself. It can thus be concluded that the main issues affecting survey response were not the design or quantity of the questions but getting the mail recipients interested in the survey in the first place.

5.3 Model Results

The proposed structural equation modeling (SEM) model shown in Figure 5.1 based on UTAUT and the initial interviews was analyzed using the PLS-SEM method. SEM is a way to jointly estimate a measurement model for unobserved, latent variables and a structural model for the relationships between these latent variables (Bollen, 1989). PLS-SEM is one of two main methods to evaluate structural equation models and, compared to covariance-based SEM (CB-SEM), it is especially suitable for exploratory research (Barclay et al., 1995, p. 302; Hair et al., 2017, p. 45; Lohmöller, 1989, p. 213) and can be used with lower sample sizes (see section 5.2.1).

auditing at AT&T.

As part of the survey tries to replicate the findings of Gonzalez et al. (2012), the use of PLS-SEM increases comparability as they also used PLS-SEM for model estimation.

5.3.1 Measurement Model

PLS-SEM is flexible in supporting models that contain both reflectively and formatively measured constructs, another advantage compared to CB-SEM (Hair et al., 2017, p. 41). Reflective constructs are based on the assumption that the measured variables are observable manifestations of the underlying construct and are thus determined by the strength of the underlying construct. This also implies that the measurement variables of a reflective construct should be strongly correlated among each other. Formative constructs, however, are based on the assumption that the measured variables all describe one part or area of the overall construct, i.e. that the construct is composed of the individually measured variables (Petter, Straub, & Rai, 2007). For formative constructs, measured variables do not need to (and in fact should not; Hair et al., 2017, p. 203) be highly correlated among each other.

In the hypothesized model, the UTAUT constructs Performance Expectancy, Effort Expectancy, Social Influence and Intention to Use are reflectively measured. Their hypothesized drivers, however, are formatively measured: for example, the construct "Visible Benefits" for hypothesis H1c is measured using the three measurement variables VISIBLE_AUDITORS, VISIBLE_BOARD, and VISIBLE_MGMT which capture how visible the benefits of CA are for, respectively, the auditors themselves, the board, and the senior management. It is clear that those variables need not be highly correlated, as the visibility of CA can be different for the different stakeholders, but that instead the construct of visible benefits overall is composed out of the visibility of CA for these stakeholder groups. This is also shown in Figure 5.1, where for reflective constructs the paths point from the construct toward their measurement variables while for formative constructs the paths point from the measurement variables towards the construct.

5.3.2 Measurement Model: Missing Values and Suspicious Patterns

All responses were visually inspected for suspicious response patterns such as straight lines or obvious patterns, but no such irregularities were identified.

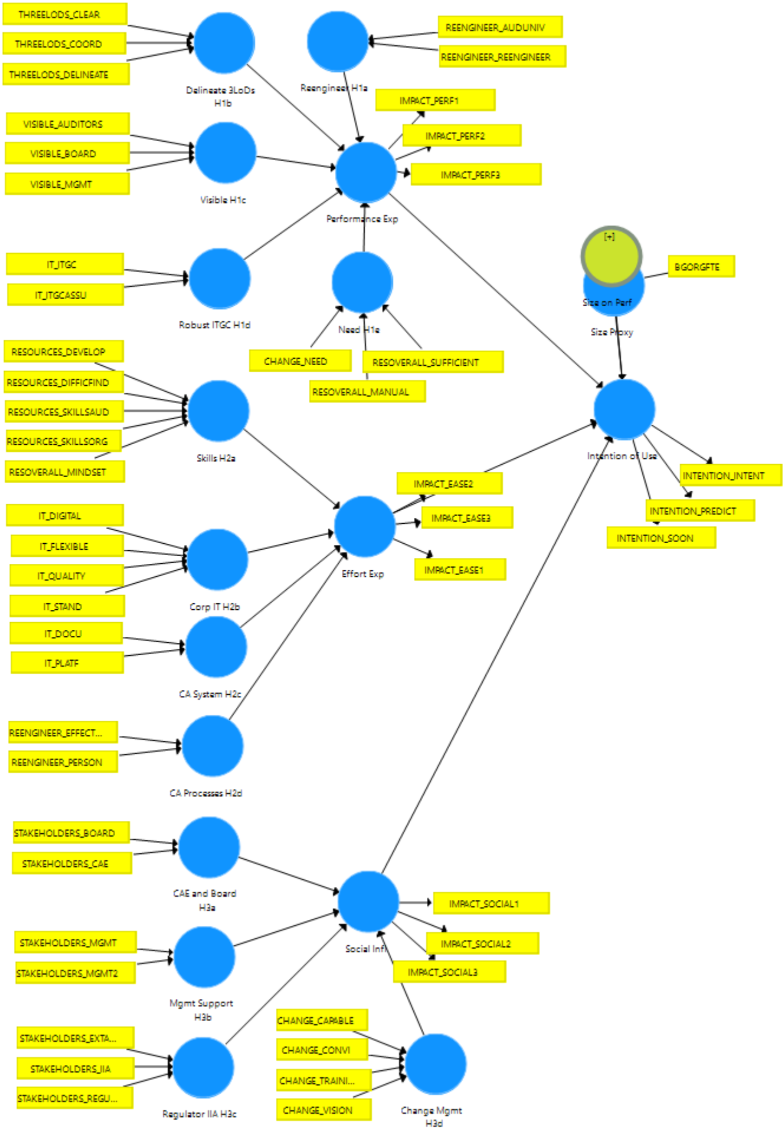
PLS-SEM does not deal with missing values in the data, so missing values either need to be removed (by removing samples or variables) or imputed. Two responses with more than 15% missing values have been removed from the data. Variables with more than 10% missing values were also removed, which affected STAKEHOLDERS_REGULATOR, STAKEHOLDERS_EXTAUD and STAKEHOLDERS_IIA. These variables are the measurement variables for the "Regulator IIA" construct of hypothesis H3c, which thus also needed to be excluded from further analysis.

For the remaining missing values, data was imputed using linear regressions based on the non-missing responses of the given respondent. The regression was defined using background and CA adoption variables of the model that had sufficiently high response rates to ensure that this imputation yielded non-missing results for most variables and samples; the remainder where imputed using mean-value replacement. Mean-value replacement is seen as adequate for variables with less than 5% missing values, for variables with more missing values more sophisticated procedures should be used (Hair et al., 2017, p. 80). The imputation used thus primarily aims to alleviate concerns about the following variables, for which between 6% and 9.7% of values are missing: IMPACT_SOCIAL1, IMPACT_SOCIAL2, STAKEHOLDERS_BOARD, STAKEHOLDERS_MGMT2, and IMPACT_EASE1.

5.3.3 Measurement Model: Indicator Reliability, Internal Consistency, Convergent and Discriminant Validity for Reflective Constructs

For reflective constructs, indicator loading should exceed 0.708 and correlation measures should indicate high internal consistency (Hair et al., 2017, p.

Figure 5.1: The original model (pictured in SmartPLS, the software used for estimating the PLS-SEM model).



155–158). Indicator loadings exceed 0.708 for all reflective constructs except for the IMPACT_PERF3[8] indicator of Performance Expectancy (0.618, see Table 5.3). Internal consistency can be measured using Cronbach's alpha or composite reliability, with the former providing a lower and the latter an upper bound (Hair et al., 2017, p. 155). They exceed the commonly suggested threshold of 0.70 for all reflective constructs except for Performance Expectancy, where Cronbach's alpha is 0.691 (see Table 5.4).

Table 5.3: Indicator outer loadings for reflective constructs of the original model (including IMPACT_PERF3).

	Performance Expectancy	Effort Expectancy	Social Influence	Intention to Use
IMPACT_PERF1	0.862			
IMPACT_PERF2	0.867			
IMPACT_PERF3	0.618			
IMPACT_EASE1		0.752		
IMPACT_EASE2		0.893		
IMPACT_EASE3		0.826		
IMPACT_SOCIAL1			0.718	
IMPACT_SOCIAL2			0.859	
IMPACT_SOCIAL3			0.867	
INTENTION_INTENT				0.916
INTENTION_PREDICT				0.959
INTENTION_SOON				0.947

Based on these results, it can be argued that IMPACT_PERF3 should be dropped from the analysis. Hair et al. (2017, p. 157) recommend, however, that indicators should only be removed based on low indicator loadings if their removal improves other statistics such as the average variance explained (AVE), a measure of convergent validity on the construct level. The removal of IMPACT_PERF3 increases AVE of the Performance Expectancy construct from 0.625 to 0.829 and also leads to Cronbach's alpha to increase

[8] Agreement to the statement "Continuous Assurance methods increase our chances of improving our financial position".

Table 5.4: Internal consistency and convergent validity for reflective constructs of the original model (including IMPACT_PERF3).

Reflective Construct	Cronbach's α	Composite Reliability	AVE
Performance Expectancy	0.691	0.830	0.625
Effort Expectancy	0.763	0.865	0.681
Social Influence	0.747	0.857	0.668
Intention to Use	0.935	0.958	0.885

to 0.797, above the 0.70 threshold. Dropping IMPACT_PERF3 is also supported by the pre-testing results, in which respondents also voiced confusion about this question and saw a too narrow focus on the (short-term) financial position as risking the internal audit activity's independence. It was not dropped at that stage in order to keep the original constructs from Gonzalez et al. (2012).

The model has thus been re-estimated without IMPACT_PERF3. For the re-estimated model, indicator loadings, internal consistency and AVE all exceed commonly accepted thresholds (see tables 5.5 and 5.8). This model has been used going forward.

Table 5.5: Indicator outer loadings for reflective constructs of the modified model without IMPACT_PERF3. Also shows cross-loadings of reflective construct indicators with all other constructs to evaluate discriminant validity.

	Performance Expectancy	Effort Expectancy	Social Influence	Intention to Use	Re-engineer (H1a)	Delineate 3LoDs (H1b)
IMPACT_PERF1	**0.941**	0.240	0.190	0.241	0.523	0.271
IMPACT_PERF2	**0.877**	0.299	0.011	0.125	0.312	0.179
IMPACT_EASE1	0.310	**0.752**	0.295	0.352	0.331	0.193
IMPACT_EASE2	0.186	**0.893**	0.145	0.221	0.205	0.196
IMPACT_EASE3	0.216	**0.826**	0.165	0.179	0.190	0.254
IMPACT_SOCIAL1	0.031	0.233	**0.718**	0.353	0.286	0.102
IMPACT_SOCIAL2	0.068	0.246	**0.859**	0.147	0.148	0.155
IMPACT_SOCIAL3	0.199	0.134	**0.867**	0.346	0.221	0.083
INTENTION_INTENT	0.284	0.313	0.196	**0.917**	0.236	0.428
INTENTION_PREDICT	0.206	0.324	0.379	**0.958**	0.142	0.270
INTENTION_SOON	0.113	0.227	0.381	**0.946**	0.112	0.291

Table 5.6: Indicator outer loadings for reflective constructs of the modified model without IMPACT_PERF3. Also shows cross-loadings of reflective construct indicators with all other constructs to evaluate discriminant validity.

	Visible (H1c)	Robust ITGC (H1d)	Need (H1e)	Skills (H2a)	Corp IT (H2b)	CA System (H2c)
IMPACT_PERF1	0.519	0.081	0.137	0.012	0.169	0.193
IMPACT_PERF2	0.437	0.157	0.044	0.003	0.076	0.195
IMPACT_EASE1	0.304	0.099	-0.072	0.416	0.326	0.207
IMPACT_EASE2	0.212	0.154	-0.147	0.535	0.231	0.035
IMPACT_EASE3	0.291	0.068	-0.283	0.416	0.289	0.031
IMPACT_SOCIAL1	0.011	-0.011	-0.086	0.152	0.047	-0.147
IMPACT_SOCIAL2	0.203	-0.056	-0.080	0.167	-0.150	0.033
IMPACT_SOCIAL3	0.259	-0.094	-0.122	-0.056	0.053	0.098
INTENTION_INTENT	0.193	-0.058	0.287	0.305	0.146	-0.177
INTENTION_PREDICT	0.092	-0.048	0.091	0.233	0.176	-0.166
INTENTION_SOON	-0.064	-0.069	0.117	0.178	0.156	-0.234

Table 5.7: Indicator outer loadings for reflective constructs of the modified model without IMPACT_PERF3. Also shows cross-loadings of reflective construct indicators with all other constructs to evaluate discriminant validity.

	CA Processes (H2d)	CAE and Board (H3a)	Mgmt Support (H3b)	Change Mgmt (H3d)
IMPACT_PERF1	0.371	-0.032	0.124	0.163
IMPACT_PERF2	0.326	-0.118	0.037	0.085
IMPACT_EASE1	-0.113	0.262	0.254	0.043
IMPACT_EASE2	0.132	0.280	0.257	0.043
IMPACT_EASE3	0.208	0.192	0.167	0.096
IMPACT_SOCIAL1	0.039	0.554	0.536	0.306
IMPACT_SOCIAL2	0.020	0.545	0.640	0.574
IMPACT_SOCIAL3	0.077	0.508	0.672	0.484
INTENTION_INTENT	0.047	0.337	0.255	0.113
INTENTION_PREDICT	-0.031	0.476	0.441	0.161
INTENTION_SOON	0.010	0.516	0.392	0.176

Table 5.8: Internal consistency and convergent validity for reflective constructs of the modified model without IMPACT_PERF3.

Reflective Construct	Cronbach's α	Composite Reliability	AVE
Performance Expectancy	0.797	0.905	0.827
Effort Expectancy	0.763	0.865	0.682
Social Influence	0.747	0.857	0.668
Intention to Use	0.935	0.958	0.885

There are no indications of a lack of discriminant validity: All cross-loadings are smaller than the construct outer loadings (see tables 5.5ff). And PLS-SEM bootstrapping indicates that for none of the potential paths between the constructs the 5%-confidence-intervals of their Heterotrait-monotrait ratio of correlations (HTMT) ratios includes 1 (see Table 5.9), which would indicate a lack of discriminant validity (Hair et al., 2017, p. 164–169; Henseler, Ringle, & Sarstedt, 2015).

5.3.4 Measurement Model: Content Validity, Collinearity, Significance, and Relevance of Formative Indicators

In contrast to reflectively measured constructs, there is no standard way to quantitatively evaluate content validity of formative indicators. Thus, content validity of the formative indicators has been established primarily through the careful development of the constructs based on the initial literature review and interviews conducted with various practitioners on what they see as important or impactful with regards to their CA implementation progress.

Collinearity between formative indicators can boost standard errors and can lead to incorrectly estimated weights and sign reversals (Hair et al., 2017, p. 204). One measure of indicator collinearity is the variance inflation factor (VIF), the inverse of the indicator's tolerance (TOL). VIF values of 5 and higher indicate a potential collinearity problem (Hair, Ringle, & Sarstedt, 2011; Hair et al., 2017, p. 207). For the formative indicators in the model,

Table 5.9: HTMT ratios for reflective construct paths and their 95%-confidence intervals (bias-corrected using PLS-SEM bootstrapping).

Path	Original Sample	2.50%	97.50%
Intention → Effort	0.359	0.165	0.575
Performance → Effort	0.378	0.155	0.646
Performance → Intention	0.235	0.078	0.532
Size Proxy → Effort	0.282	0.101	0.528
Size Proxy → Intention	0.034	0.006	0.044
Size Proxy → Performance	0.089	0.003	0.177
Size on Perf → Effort	0.097	0.027	0.120
Size on Perf → Intention	0.023	0.002	0.031
Size on Perf → Performance	0.044	0.001	0.075
Size on Perf → Size Proxy	0.385	0.014	0.878
Social → Effort	0.331	0.120	0.541
Social → Intention	0.406	0.166	0.630
Social → Performance	0.213	0.085	0.358
Social → Size Proxy	0.265	0.087	0.424
Social → Size on Perf	0.074	0.009	0.121

none exceed a VIF of 3.414 (see Table 5.10), indicating that there are no major collinearity issues.

Table 5.10: VIF figures for formative indicators.

Indicator	VIF
CHANGE_CAPABLE	1.239
CHANGE_CONVI	1.609
CHANGE_NEED	1.037
CHANGE_TRAINING	1.941
CHANGE_VISION	2.388
IT_DIGITAL	1.685
IT_DOCU	1.818
IT_FLEXIBLE	1.676

Table 5.10: VIF figures for formative indicators.

Indicator	VIF
IT_ITGC	1.346
IT_ITGCASSU	1.346
IT_PLATF	1.818
IT_QUALITY	1.324
IT_STAND	2.592
REENGINEER_AUDUNIV	1.183
REENGINEER_EFFECTIVE	1.037
REENGINEER_PERSON	1.037
REENGINEER_REENGINEER	1.183
RESOURCES_DEVELOP	1.575
RESOURCES_DIFFICFIND	1.712
RESOURCES_SKILLSAUD	1.633
RESOURCES_SKILLSORG	1.410
RESOVERALL_MANUAL	1.365
RESOVERALL_MINDSET	1.243
RESOVERALL_SUFFICIENT	1.323
STAKEHOLDERS_BOARD	1.429
STAKEHOLDERS_CAE	1.429
STAKEHOLDERS_MGMT	3.414
STAKEHOLDERS_MGMT2	3.414
THREELODS_CLEAR	1.208
THREELODS_COORD	1.258
THREELODS_DELINEATE	1.082
VISIBLE_AUDITORS	1.765
VISIBLE_BOARD	2.637
VISIBLE_MGMT	2.726

The outer weights and their statistical significance for the formative indicators are shown in Table 5.11. Probably also due to the small sample, only relatively few weights are statistically significant. However, Hair et al. (2017, p. 148) caution against dropping indicators due to nonsignificant weights: while weights inform us about the relative importance of an indicator, the loadings can indicate the absolute importance of that indicator. Indicators should only be dropped if the loadings are also small (< 0.50) and the theoretical underpinnings of the constructs support this. Based on this guidance, indicators not printed in bold in Table 5.11 are candidates for removal. As differently from reflective constructs the removal of indicators will always lead to a loss of information with regards to formative constructs, any removal must be evaluated based on the underlying theory. The following indicators might be removed:

Table 5.11: Outer weights and loadings for the indicators of formative constructs. Indicators listed in bold satisfy the criteria from Hair et al. (2017), namely that the weights are significant or the loadings are at least 0.5. Significance levels: * = 10%, ** = 5%, *** = 1% level.

Construct	Indicator	Weights	Loadings
Re-engineer (H1a)	REENGINEER_AUDUNIV	-0.138	0.273
Re-engineer (H1a)	**REENGINEER_REENGINEER**	1.046***	0.992***
Delineate 3LoDs (H1b)	**THREELODS_CLEAR**	1.054	0.769
Delineate 3LoDs (H1b)	THREELODS_COORD	-0.703	-0.270
Delineate 3LoDs (H1b)	THREELODS_DELINEATE	0.010	0.011
Visible (H1c)	**VISIBLE_AUDITORS**	1.169***	0.972***
Visible (H1c)	VISIBLE_BOARD	-0.238	0.413*

Table 5.11: Outer weights and loadings for the indicators of formative constructs. Indicators listed in bold satisfy the criteria from Hair et al. (2017), namely that the weights are significant or the loadings are at least 0.5. Significance levels: * = 10%, ** = 5%, *** = 1% level.

Construct	Indicator	Weights	Loadings
Visible (H1c)	VISIBLE_MGMT	-0.081	0.468**
Robust ITGC (H1d)	IT_ITGC	-0.929	-0.387
Robust ITGC (H1d)	**IT_ITGCASSU**	1.070	0.599
Need (H1e)	CHANGE_NEED	-0.400	-0.226
Need (H1e)	**RESOVERALL_MANUAL**	0.923	0.911**
Need (H1e)	**RESOVERALL_SUFFICIENT**	0.124	0.559
Skills (H2a)	**RESOURCES_DEVELOP**	0.514**	0.543***
Skills (H2a)	RESOURCES_DIFFICFIND	-0.309	0.359*
Skills (H2a)	**RESOURCES_SKILLSAUD**	0.426*	0.791***
Skills (H2a)	**RESOURCES_SKILLSORG**	0.412**	0.561***
Skills (H2a)	**RESOVERALL_MINDSET**	0.397*	0.665***
Corp IT (H2b)	IT_DIGITAL	-0.862	-0.165
Corp IT (H2b)	**IT_FLEXIBLE**	0.731	0.725*
Corp IT (H2b)	IT_QUALITY	-0.189	0.089
Corp IT (H2b)	**IT_STAND**	0.683	0.504*
CA System (H2c)	**IT_DOCU**	1.251	0.938**
CA System (H2c)	IT_PLATF	-0.466	0.373
CA Processes (H2d)	**REENGINEER_EFFECTIVE**	1.018*	0.984*
CA Processes (H2d)	REENGINEER_PERSON	-0.180	0.011
CAE and Board (H3a)	**STAKEHOLDERS_BOARD**	1.105***	0.982***
CAE and Board (H3a)	STAKEHOLDERS_CAE	-0.225	0.381*
Mgmt Support (H3b)	**STAKEHOLDERS_MGMT**	0.238	0.904***

Table 5.11: Outer weights and loadings for the indicators of formative constructs. Indicators listed in bold satisfy the criteria from Hair et al. (2017), namely that the weights are significant or the loadings are at least 0.5. Significance levels: * = 10%, ** = 5%, *** = 1% level.

Construct	Indicator	Weights	Loadings
Mgmt Support (H3b)	**STAKEHOLDERS_MGMT2**	0.792***	0.992***
Change Mgmt (H3d)	**CHANGE_CAPABLE**	1.008***	0.777***
Change Mgmt (H3d)	CHANGE_CONVI	0.252	0.328
Change Mgmt (H3d)	***CHANGE_TRAINING***	-0.634**	0.095
Change Mgmt (H3d)	**CHANGE_VISION**	0.509**	0.381

- **REENGINEER_AUDUNIV** has a statistically not significant, but slightly negative weight and a positive, also not statistically significant, loading. It could be possible that a reverse causality is at play here (see also section 5.5.1 which focusses on these effects): the hypothesis underlying the model formulation is that re-engineering is a good thing, which increases the performance effects of CA. For re-engineering of audit processes to benefit from CA, this is supported by the data (see section 5.5). However, it is possible that CA-driven changes to the audit and risk universe are not seen by auditors as a good thing, but as a negative consequence of CA, a nuisance which thus decreases performance expectancy. If this is the case, the inclusion of REENGINEER_AUDUNIV will not add information but will confound the “Re-engineer (H1a)” construct. **Dropped.**

- **THREELODS_COORD** has a negative but not significant weight, which might be explainable with the different formulation compared to THREELODS_CLEAR and THREELODS_DELINEATE: while the latter focus on a clear understanding of the 3LoD and each LoD’s duties, THREELODS_COORD focusses on coordination. While it is necessary for effective and efficient CA for each actor to know its responsibilities (captured by the remaining THREELODS_CLEAR and THREELODS_DELINEATE) to avoid gaps and duplication of effort, it is less clear whether this understanding should lead to more coordination. In fact, it could be argued that where roles are clearly delineated, less coordination is necessary. It is thus possible that THREELODS_COORD confounds the intent of the "Delineate 3LoDs (H1b)" construct, which (as its name implies) focusses primarily on clearly delineated responsibilities. **Dropped.**

- **THREELODS_DELINEATE** is not significant on both its weights and loadings. However, as THREELODS_CLEAR focusses only on CA while THREELODS_DELINEATE focusses on the general setting of the 3LoDs in the organisation, it adds important conceptual information to the construct. Thus, even though the statistical analysis might argue for removing this indicator, conceptually the indicator should be kept. This also avoids turning "Delineate 3LoDs (H1b)" into a one-indicator construct, which should be avoided. **Kept.**

- **VISIBLE_BOARD** and **VISIBLE_MGMT** have insignificant negative weights but relatively large loardings. The negative weights could be the result of a sign-reversal due to the relatively high collinearity between the VISIBLE_-indicators (with VIFs of 2.637 and 2.726, respectively, see Table 5.10; see Hair et al., 2017, p. 205–206, for a discussion of this phenomenon). It is reasonable that VISIBLE_AUDITORS is the much stronger indicator than the other two as the former is observable for all respondents while junior auditors might not have insights into interactions with the board or senior management and thus might have struggled to respond to these questions. However, conceptually it is very clear that the visibility of CA's benefits is the combination of the visibility of CA for the three stakeholder groups auditors, board and management. Thus, conceptually the construct would be incomplete without all three indicators and the indicators will be kept even though their statistical properties are not ideal. **Kept.**

- **IT_ITGC** has insignificant negative weight and a moderately negative loading. The indicator is probably confounded by auditor's professional skepticism and independence. "Relying" on the organisation's IT general controls (ITGC) might sound like compromising independence to some. The indicator can also be affected by possible inverse relationships (see below): if auditors are skeptical about the organisation's controls, they might increase their testing and thus adoption of OCA. Or increased adoption of OCA might highlight issues in the corporate IT systems that were hidden before (a common theme from the interviews), thus reducing the trust in the ITGC. Due to this range of possibly confounding relationships, the indicator will be dropped from further analysis. **Dropped.**

- **CHANGE_NEED** measures whether respondents say they "need to participate in the digital transformation of our business". As discussed above (see section 5.2), the agreement here is so overwhelming that this indicator provides little differentiating information for the model, it is thus not surprising that the weights and loadings confirm this. The indicator can thus be dropped without losing much information. In retrospect, there is also a conceptual issue with this indicator: the construct it should measure is meant to focus on "need" in the sense of operational needs, i.e. CA is necessary for the audit function to conduct its work efficiently and effectively. Given the current discussion about digital transformation, it seems reasonable, however, to assume that the CHANGE_NEED indicator actually measures primarily social pressure from stakeholders to act on the imperative of a digitally transforming business. **Dropped.**

- **RESOURCES_DIFFICFIND** has insignificant negative weight but a moderately positive loading. A problem with this indicator is that junior auditors who have replied to the survey might not have much insight into how difficult it is to hire people with the right skills. As the construct is also well-covered by four other, significant indicators, it is possible to drop this indicator without losing much conceptual content. **Dropped.**

- **IT_DIGITAL** has both negative weight and loading, both not significant. This is puzzling, since the question of whether the organisation's processes are digitalised enough to make effective CA possible came up repeatedly in our interviews and on first sight seems to be quite clear: If an organisation's processes are highly manual and do not leave a digital audit trail, how can data analysis support more frequent auditing? However, the data indicates that this relationship is not as clear cut. IT_DIGITAL seems to behave differently from the other indicators on the "Corp IT (H2b)" construct, which conceptually could be explained by it focussing more on process management at the organisation while IT_FLEXIBLE and IT_STAND focus more on the quality of the IT function itself. To better evaluate this interesting, unexplained effect, IT_DIGITAL should be evaluated as a separate construct in its own right, which can (still) be hypothesized to have a positive effect on Effort Expectancy. **Turned into separate construct.**

- **IT_QUALITY** has a slight negative weight but positive loading, both not significant. Potentially, IT_QUALITY is affected by the same negative reverse relationship as other indicators (see section 5.5.1): by implementing CA, the auditor will get a direct view into data quality issues in the organisation's data. This means that more progress in implementing CA might reduce the auditors estimate of the organisation's data quality. This would confuse the hypothesized relationship that higher data quality makes it easier to apply CA effectively. To avoid these issues, the indicator will be removed going foward. **Dropped.**

- **IT_PLATF** has insignificant negative weight and a moderately positive loading. The indicator might be confounded by the merging of respondents who are already using CA and those who do not yet use CA and were asked about their expectations instead: users of CA are agreeing significantly less[9] with the statement that they "use an integrated IT system for their Continuous Assurance work" than auditors who do not yet use CA and were asked whether they would expect to use an integrated system instead. So while potential future users are optimistic with regards to the availability of good tooling, actual users are less sanguine but use CA nonetheless. Due to these potentially confounding effects, the indicator was removed. The topic of features for a CA front-end system is also investigated more in-depth with the separate questions prepared for that purpose (see section 5.6.2), rescuing some of the conceptual content that might be lost by removing this indicator. **Dropped.**

- **REENGINEER_PERSON** has insignificant negative weight and low positive loading. Conceptually, this indicator also overlaps partially with organisation size, which Gonzalez et al. (2012) use as moderator for Performance Expectancy. It seems thus reasonable to focus the construct of CA Processes (H2d) on the processes itself and not the enabling resources, which is achieved by limiting the construct to the indicator REENGINEER_EFFECTIVE. **Dropped.**

- **STAKEHOLDERS_CAE** has insignificant negative weight and moderate positive loading. Conceptually, this indicator can be misleading for respondents who themselves *are* senior audit management: the construct "CAE and Board (H3a)" is hypothesized to be a factor for social pressure, i.e. pressure to adopt CA *external* to the respondent. STAKEHOLDERS_CAE for some respondents measures whether *they themselves* encourage CA, however. It makes thus conceptual sense to

[9] A Welch t-test on the difference of the means shows a p-value of 0.040.

restrict "CAE and Board (H3a)" to fully external influences by limiting it to the STAKEHOLDERS_BOARD indicator. **Dropped.**

- **CHANGE_CONVI** conceptually suffers from the same issue as STAKEHOLDERS_CAE above: some respondents *are* the CAEs and are thus not reporting how they experience (or expect to experience) the change management process at their organisation but are reporting how convinced they are about CA, which is conceptually different. **Dropped.**

A different issue arises with **CHANGE_TRAINING**: This indicator has significant weight, but contrary to expectations the weight is negative on its construct "Change Mgmt (H3d)". It can be argued that training will have less direct impact on Social Influence and more impact on Effort Expectancy, as more training makes systems easier to use (Venkatesh, 1999; Xia & Lee, 2000). The indicator would thus have been mis-allocated to the "Change Mgmt (H3d)" construct. As we will see (see section 5.5), however, the data does not fit this more classical expectation that training will increase ease-of-use expectancy either. To be able to better analyze this potential effect, CHANGE_TRAINING will be split up in a separate construct "Training (H3d2)", which will be used to test the hypothesis that more training should lead to higher Effort Expectancy.

Based on the discussion above, an **adapted model** can be proposed (see Figure 5.2 and Table 5.12). The indicator weights and loadings for the formative indicators of the adapted model are shown in Table 5.13. For evaluating the structural model, this adapted model will always be compared to the originally proposed, purely theoretical model; this allows to identify potential unintended consequences or misrepresentations from the model changes.

Table 5.12: The adapted model constructs based on the initial results on measurement model validity. Construct descriptions have been amended where the indicators no longer encompass the original breadth of the construct.

Construct and Indicators	Adapted Construct Description
Re-engineer (H1a) REENGINEER_REENGINEER	Re-engineering of audit procedures in order to adopt CA methods.
Delineate 3LoDs (H1b) THREELODS_CLEAR THREELODS_DELINEATE	Clear delineation of responsibilities between the 3LoD in the organisation and a clear understanding of how CA fits into this picture.
Visible (H1c) VISIBLE_AUDITORS VISIBLE_BOARD VISIBLE_MGMT	Visible benefits early on in the process of adopting CA for the internal auditors, the Board and senior management.
Robust ITGC (H1d) IT_ITGCASSU	Strong assurance by IT auditors over the effectiveness of the organisation's IT general controls.
Need (H1e) RESOVERALL_MANUAL RESOVERALL_SUFFICIENT	Lack of resources for manual sample testing and/or to achieve the required audit coverage.
Skills (H2a) RESOURCES_DEVELOP RESOURCES_SKILLSAUD RESOURCES_SKILLSORG RESOVERALL_MINDSET	Availability of (or ability to develop) skills within the audit function and the organisation overall to provide Continuous Assurance.
Digitalization (H2b2) IT_DIGITAL	Level of digitalisation of the organisation's processes.
Corp IT (H2b) IT_FLEXIBLE IT_STAND	Standardised and integrated IT function which is flexible to adapt to internal audit's needs.
CA System (H2c) IT_DOCU	The technology the auditors (would) use supports them in documenting their work.

Table 5.12: The adapted model constructs based on the initial results on measurement model validity. Construct descriptions have been amended where the indicators no longer encompass the original breadth of the construct.

Construct and Indicators	Adapted Construct Description
CA Processes (H2d) REENGINEER_EFFECTIVE	Effective CA processes.
Board (H3a) STAKEHOLDERS_BOARD	The audit committee (or the board) are promoting CA.
Mgmt Support (H3b) STAKEHOLDERS_MGMT STAKEHOLDERS_MGMT2	Senior management is promoting and/or supporting CA.
Change Mgmt (H3d) CHANGE_CAPABLE CHANGE_VISION	The change ability of the organisation is strong and adopting CA is (or would be) driven by a clearly articulated vision for the future.
Training (H3d2) CHANGE_TRAINING	The change towards CA was (or would be) accompanied by training of relevant staff.

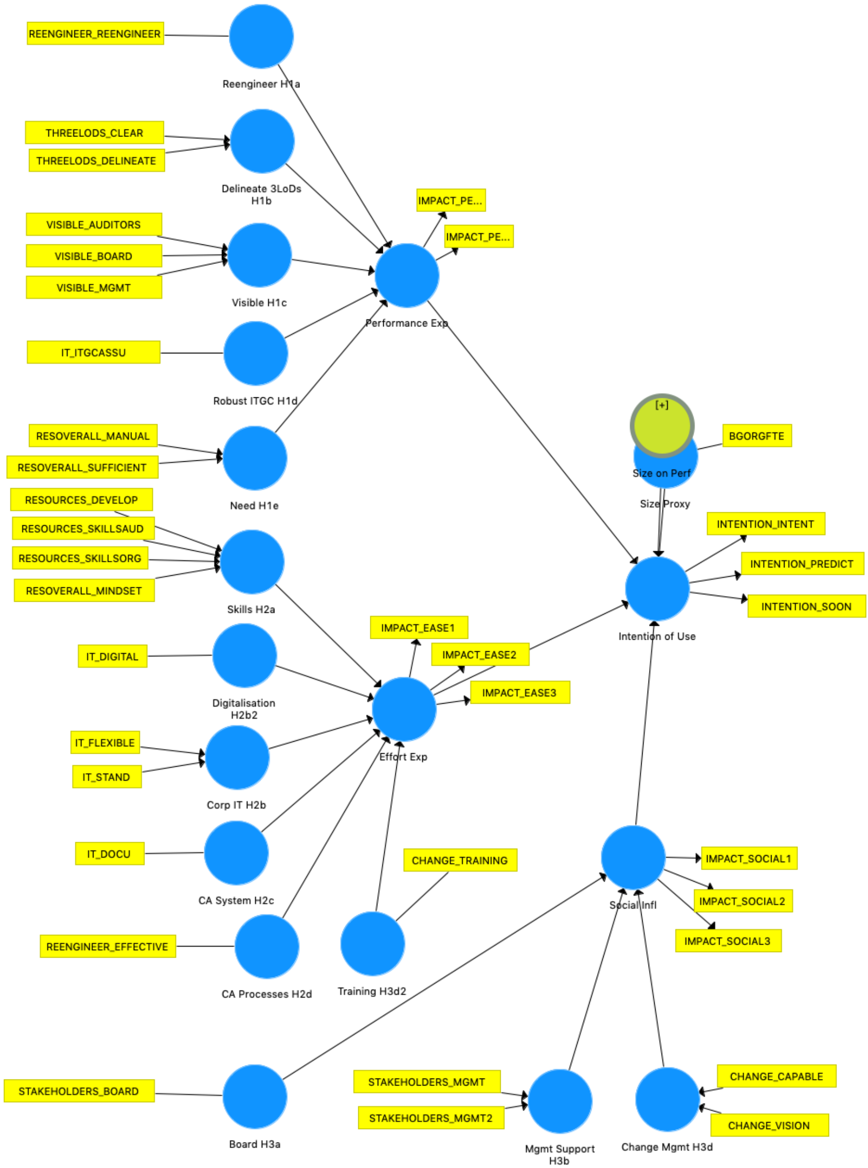
Table 5.13: Adapted model: Outer weights and loadings for the indicators of formative constructs. Indicators listed in bold satisfy the criteria from Hair et al. (2017), namely that the weights are significant or the loadings are at least 0.5. Significance levels: * = 10%, ** = 5%, *** = 1% level.

Construct	Indicator	Weights	Loadings
Re-engineer (H1a)	**REENGINEER_REENGINEER**	1.000	1.000
Delineate 3LoDs (H1b)	**THREELODS_CLEAR**	0.618**	0.645**
Delineate 3LoDs (H1b)	THREELODS_DELINEATE	0.180	0.304
Visible (H1c)	**VISIBLE_AUDITORS**	1.081***	0.932***

Table 5.13: Adapted model: Outer weights and loadings for the indicators of formative constructs. Indicators listed in bold satisfy the criteria from Hair et al. (2017), namely that the weights are significant or the loadings are at least 0.5. Significance levels: * = 10%, ** = 5%, *** = 1% level.

Construct	Indicator	Weights	Loadings
Visible (H1c)	VISIBLE_BOARD	-0.193	0.408**
Visible (H1c)	VISIBLE_MGMT	-0.075	0.452**
Robust ITGC (H1d)	**IT_ITGCASSU**	1.000	1.000
Need (H1e)	**RESOVERALL_MANUAL**	0.352*	0.577***
Need (H1e)	**RESOVERALL_SUFFICIENT**	0.451	0.613*
Skills (H2a)	**RESOURCES_DEVELOP**	0.358*	0.537***
Skills (H2a)	**RESOURCES_SKILLSAUD**	0.366*	0.753***
Skills (H2a)	**RESOURCES_SKILLSORG**	0.321**	0.528***
Skills (H2a)	**RESOVERALL_MINDSET**	0.368**	0.633***
Digitalization (H2b2)	**IT_DIGITAL**	1.000	1.000
Corp IT (H2b)	**IT_FLEXIBLE**	0.742**	0.848***
Corp IT (H2b)	**IT_STAND**	0.171	0.640**
CA System (H2c)	**IT_DOCU**	1.000	1.000
CA Processes (H2d)	**REENGINEER_EFFECTIVE**	1.000	1.000
Board (H3a)	**STAKEHOLDERS_BOARD**	1.000	1.000
Mgmt Support (H3b)	**STAKEHOLDERS_MGMT**	0.263	0.899***
Mgmt Support (H3b)	**STAKEHOLDERS_MGMT2**	0.761***	0.985***
Change Mgmt (H3d)	**CHANGE_CAPABLE**	0.833***	0.881***
Change Mgmt (H3d)	CHANGE_VISION	0.384*	0.455*
Training (H3d2)	**CHANGE_TRAINING**	1.000	1.000

Figure 5.2: The adapted model based on our measurement model discussion.



5.3.5 Structural Model Validity

As in the measurement model, excessive collinearity between predictor constructs in the structural model can limit the interpretability of the model coefficients (Hair et al., 2017). For the adapted model, all of the VIF values in the structural model are well below 5, giving no indication of excessive collinearity (see Table 5.14).

Table 5.14: Adapted model: VIF values for structural model paths.

	Performance	Effort	Social	Intention
Re-engineer (H1a)	1.293			
Delineate 3LoDs (H1b)	1.144			
Visible (H1c)	1.411			
Robust ITGC (H1d)	1.029			
Need (H1e)	1.015			
Skills (H2a)		1.059		
Corp IT (H2b)		1.411		
Digitalisation (H2b2)		1.361		
CA System (H2c)		1.251		
CA Processes (H2d)		1.053		
Training (H3d2)		1.190		
Board (H3a)			2.325	
Mgmt Support (H3b)			2.578	
Change Mgmt (H3d)			1.179	
Effort				1.276
Performance				1.096
Social				1.202
Size Proxy				1.418
Size on Perf				1.223

The explanatory power of the structural model can be evaluated using the R^2 values of explained variance of the dependent variables. As PLS-SEM directly tries to maximize explained variance, R^2 values are the best approach to evaluate model fit, as compared to CB-SEM which aims to optimise the fit of the estimated covariance matrix, leading to different fit measures (Hair et al., 2017, pp. 191–192). Interpretations of different R^2 levels vary between and within disciplines and also depend on the number of independent variables for a construct. Chin (1998, p. 323) provides an example where he describes R^2 values of 0.67, 0.33, and 0.19 as substantial, moderate, and weak. Based on this, Henseler, Ringle, and Sinkovics (2009, p. 303) note that “certain inner path model structures explain a endogenous latent variable by only a few (e.g., one or two) exogenous latent variables, ‘moderate’ R^2 may be acceptable. However, if the endogenous latent variable relies on several exogenous latent variables, the R^2 value should exhibit at least a substantial level”.

Based on this discussion, only the model for the Social Influence construct shows substantial explanatory power with an R^2 of 0.628 (see Table 5.15). The models for Performance Expectancy and Effort Expectancy (R^2 of 0.355 and 0.414 respectively) show moderate R^2 values[10]. However, given the relatively large number of independent variables for these constructs (at five and six respectively) this does not indicate large explanatory power. The explanatory power for Intention to Use is very low at 0.184, which is interesting as this relationship follows the established UTAUT model whose applicability has been confirmed by Gonzalez et al. (2012) in a continuous auditing context. This finding will be discussed further in the next section.

Table 5.15: Adapted model: R^2 values for structural model constructs.

Construct	R^2
Performance	0.355
Effort	0.414
Social	0.628
Intention	0.184

[10]The original model shows similiar R^2 values of 0.621, 0.371, 0.383, and 0.184 for Social Influence, Performance Expectancy, Effort Expectancy, and Intention to Use respectively.

5.4 Explanatory Power of UTAUT Model

The low R^2 value of 0.184 (see Table 5.15) for the explanatory power of Performance Expectancy, Effort Expectancy and Social Influence on Intention to Use is interesting as this part of the model is not new but follows Gonzalez et al. (2012), who have applied the UTAUT model to continuous auditing in a survey of members of the Institute of Management Accounts (IMA). Their model showed a higher R^2 of 0.443. It has been adapted for this study only by removing constructs found to be insignificant for Intention to Use, which meant dropping the Facilitating Conditions construct from the analysis. Also, instead of Sales as a proxy for corporate size, this model uses number of FTEs as a more direct measure of available resources. Voluntariness of Use has been excluded as a moderating factor on Social Influence, as it is difficult to capture properly in a survey which covers both CAEs and regular auditors.

It seems unlikely that these model changes explain the large drop in R^2, as Facilitating Conditions were non-significant overall and Voluntariness of Use was only significant for Middle Eastern respondents. Gonzalez et al. (2012, p. 259) explain this using Hofstede (1980)'s concept of "power distance"; however, the power distance in Switzerland is much closer to the United States than to the Middle East[11], so we would not expect Voluntariness of Use to be a significant moderator in the Swiss context either.

An obvious difference between Gonzalez et al. (2012) and this study is that Gonzalez et al. (2012) were evaluating continuous auditing while this study analyses the broader concept of CA. As continuous auditing is an important and integral part of CA, however, it can be expected that the dynamics around continuous auditing and CA are not that highly different, especially considering that the underlying UTAUT model has been successfully applied in various areas (Williams, Rana, & Dwivedi, 2015).

It seems possible that the difference in R^2 could be explained by cultural differences as the majority of respondents in Gonzalez et al. (2012) were

[11] And according to Hofstede, 1980, Figure 5, even a bit lower than in the United States.

located in North America while this study focuses on Switzerland. However, the model is basically a modified version of UTAUT, which has been tested and confirmed also in many European settings (Oshlyansky, Cairns, & Thimbleby, 2007; Williams et al., 2015). Thus, it seems unlikely that cultural differences explain the very different results. Gonzalez et al. (2012)'s study was also broader in respondents' job profiles: while this study is limited to the internal audit profession, Gonzalez et al. (2012) contacted IMA members "whose membership profile listed one of the following responsibilities: internal auditing, risk management, information systems or general accounting" (this was also noted by Curtis, 2012). It seems likely that accounting professionals (as auditees) might have a different perspective on continuous auditing than the auditors themselves, with respondents further away from auditing responding to questions about adopting a technological solution more in line with generic expectations on technology adoption than respondents who have intimate knowledge about the peculiarities of continuous auditing and who have invested a lot of thought into their use of it. On the other hand, a more homogenous population in general would lead to a decrease in unexplained variance rather than an increase.

A likely explanation seems to be the different time this survey has been conducted in: in 2012, when Gonzalez et al. (2012) conducted their study, there was not yet widespread discussion of "digital transformation", which today is on everyone's mind as evidenced by the overwhelmingly affirmative responses to the statement that "We need to participate in the digital transformation of our business" (see section 5.2). It seems possible that this means CA is no longer perceived as a merely possible innovation that can be freely evaluated based on its merits, but is confounded by whatever a given respondent thinks about the digital transformation and its impact on internal auditing, including CA. This could lead to a breakdown of the link between the expected benefits and the intention to use which is the foundation of the model.

A related effect might be that the five years from 2012 to 2017 also gave more companies more time to evaluate the benefits and downsides of CA by actually using it. While the number of respondents who self-identified as having CA methods in place remained relatively stable[12], those that already did use CA in 2012 will now have more maturity and experience on which to base their intention to continue (or discontinue) their use of CA on. Hence, at least for these companies, models on continuous use of information systems might be more relevant. Bhattacherjee (2001) argues that models for continuous use will have to differ from acceptance (first use) models. He proposes a model based on expectation-confirmation theory (ECT) which argues that users are more likely to keep using a system if it is not only perceived as useful but also satisfies or exceeds the users' initial expectations (see section 3.1).

This lack of explanatory power of UTAUT in CA adoption is an important result, as it indicates that one might need to focus on and explore other theories if one aims to improve CA adoption. This finding also informed the subsequent case study, whose focus was consequently put more on continuous use decisions.

5.5 Significant Coefficients and Hypothesis Testing

PLS-SEM bootstrapping indicates that only some of the hypothesized relationships to the UTAUT antecedents are significant (see Table 5.16): Reengineer (H1a) and Visible (H1c) to Performance Expectancy, Skills (H2a) and Corporate IT (H2b) to Effort Expectancy, as well as Board (H3a), Management Support (H3b), and Change Management (H3d) to Social Influence show significant relationships in the hypothesised direction. Digitalisation (H2b2) and Training (H3d2) show a significant relationship to Effort Expectancy but with a negative coefficient, indicating that more digitalized

[12] The questions asked are not directly comparable, however Gonzalez et al. (2012) report that 21% of respondents reported that continuous auditing was "fully operational in one or more of [their] company's systems" while an additional 22% state that it is "in place but not yet fully developed". In this study, 43.5% of respondents indicated that overall, their "internal audit activity has Continuous Assurance methods in place".

business processes and more training would actually *lower* Effort Expectancy (see section 5.5.1 for a discussion on this).

Within the UTAUT model, only the path from Social Influence to Intention to Use is significant at the 5% level, which further highlights the lack of explanatory power already discussed in section 5.4.

Table 5.16: Path coefficients in adapted model. Shown are coefficient bootstrapping sample means and p-values from PLS-SEM bootstrapping. Significance levels: * = 10%, ** = 5%, *** = 1% level.

	Coefficient	p value
Re-engineer (H1a) → Performance	0.252	0.011**
Delineate 3LoDs (H1b) → Performance	0.003	0.410
Visible (H1c) → Performance	0.414	0.002***
Robust ITGC (H1d) → Performance	0.044	0.304
Need (H1e) → Performance	0.094	0.260
Skills (H2a) → Effort	0.541	0.000***
Corp IT (H2b) → Effort	0.276	0.010***
Digitalisation (H2b2) → Effort	-0.251	0.003***
CA System (H2c) → Effort	0.010	0.487
CA Processes (H2d) → Effort	0.090	0.218
Training (H3d2) → Effort	-0.197	0.030**
Board (H3a) → Social	0.178	0.030**
Mgmt Support (H3b) → Social	0.531	0.000***
Change Mgmt (H3d) → Social	0.239	0.004***
Performance → Intention	0.120	0.223
Effort → Intention	0.190	0.080*
Social → Intention	0.268	0.043**
Size Proxy → Intention	0.048	0.480
Size on Perf → Intention	0.040	0.467

The survey results thus lend support to the following hypotheses and relationships which will be used and further tested in the subsequent case study:

- A **re-engineering of audit processes** will **increase** Performance

Expectancy for employing CA methods (Hypothesis H1a).

- **Visible benefits** for the business and/or the auditors early in in the process will **increase** Performance Expectancy for employing CA methods (Hypothesis H1c).

- An increased **availability of the right skills** within the audit function will lead to an **increase** in Effort Expectancy for employing CA methods (Hypothesis H2a).

- A more modern, **more effective corporate IT** will enable CA and thus lead to an **increase** in Effort Expectancy for employing CA methods (Hypothesis H2b).

- **Board-level support** will show to auditors the weight important stakeholders assign to CA, thus leading to an **increase** in Social Influence for employing CA methods (Hypothesis H3a).

- **Senior management support** will show to auditors the weight important stakeholders assign to CA, thus leading to an **increase** in Social Influence for employing CA methods (Hypothesis H3b).

- **Solid change management** to bring the people on board will lead to an **increase** in Social Influence for employing CA methods (Hypothesis H3d).

Note that while the path coefficients discussed above are statistically significant, they only show significant relationships between the hypothesised influence factors and the intermediate constructs Performance Expectancy, Effort Expectancy and Social Influence. As only Social Influence has a significant relationship with Intention to Use, however, the data does not yield strong results on the actual goal of this study, which is to establish antecedents to acceptance and intention to use. In fact, PLS-SEM bootstrapping indicates that none of the first-level constructs show significant total effects on Intention to Use (see Table 5.17).

Table 5.17: Total effects (direct plus indirect effects) in adapted model. Shown are bootstrapping sample means and p-values from PLS-SEM bootstrapping. Significance levels: * = 10%, ** = 5%, *** = 1% level.

	Total effect	p value
Board (H3a) → Intention	0.05	0.114
CA Processes (H2d) → Intention	0.015	0.259
CA System (H2c) → Intention	0.001	0.488
Change Mgmt (H3d) → Intention	0.06	0.068
Corp IT (H2b) → Intention	0.054	0.106
Delineate 3LoDs (H1b) → Intention	0.005	0.444
Digitalisation (H2b2) → Intention	-0.05	0.090*
Mgmt Support (H3b) → Intention	0.146	0.064
Need (H1e) → Intention	0.02	0.384
Re-engineer (H1a) → Intention	0.032	0.239
Robust ITGC (H1d) → Intention	0.003	0.381
Skills (H2a) → Intention	0.104	0.095*
Training (H3d2) → Intention	-0.037	0.121
Visible (H1c) → Intention	0.045	0.242

The results may still be useful, however, if the discussion in section 5.4 holds true and intention to use is more externally influenced by the overall digital transformation while continuous use might still rely on concepts such as perceived usefulness and user satisfaction (which are related to Performance and Effort Expectancy; Bhattacherjee, 2001). More work was invested as part of the case study to address this issue.

To evaluate the effect of the model changes performed in section 5.3.4, the original model has also been estimated using PLS-SEM bootstrapping (see Table A.3 in the appendix). While the significant relationships for Re-engineer (H1a), Visible (H1c), Skills (H2a) and Mgmt Support (H3b) persist, the indicators that have been removed in the adapted model confound some of the other relationships which cease to be significant in the original model.

5.5.1 Possibility of Inverse Relationships

Speculating on the reasons behind the unexpected, significant negative relationship between Process Digitalisation (H2b2) and Effort Expectancy yields four potential explanations:

1. A topic that has come up in the interviews[13] was that better coverage of CA can lead to more findings and thus to more initial work for the auditors: as CA helps unearth more issues, dealing with these issues increases workload and decreases Effort Expectancy. This could explain the negative relationship: as more and more processes of organisations become digitalised, more and more issues in these processes become visible to CA procedures, initially increasing the workload of internal auditors, reducing Effort Expectancy. However, if a new model is estimated with a path from Process Digitalisation (H2b2) to Performance Expectancy, this path is also being estimated with a negative coefficient, although it is not significant at the 5% level[14]. This would indicate that the increased effort is not compensated by higher audit performance.

2. Similarly, a possible explanation would be that in organisations whose processes are already highly digitalised and thus potentially highly controlled in an automated fashion, there remain fewer areas where even relatively simple CA measures could yield visible benefits. For example, if invoice payments are manually processed by accounting staff, a simple duplicate payment analysis is likely to find multiple examples of duplicate payments due to human error, providing a quick way to present potential savings through CA to stakeholders. However, if invoice processing is fully digitalised with application controls that prevent duplicate payments, such a simple analysis – which has been

[13] One auditor framed it as follows: "I actually think initially it creates more work. Particularly if you add on artificial intelligence and doing something with analytics. Because it gives you more questions."

[14] It is significant at the 10% level, with a p-value of 0.057.

given in interviews as an example of visible benefits early on in CA adoption – might not yield any results.

3. The two constructs might also be linked in opposite ways to the technical affinity of individual survey respondents: it is conceivable that "digital natives" would both judge CA as easier to apply (due to them being used to data-driven technologies) and the digitalisation of their organisations' processes as less advanced (due to their higher expectations) than would less technically inclined respondents.

4. A fourth explanation would point to a reversed causality: as CA becomes more effective and efficient, auditors will better understand how business processes flow through the IT systems and will learn about weaknesses in these digital process flows, which might lead to them evaluating the digital maturity of their organisations more sceptical than peers who do not use CA as effectively and thus do not have the same insights into issues in their organisations' digitalisation efforts. Thus, more effective CA will lead to lower scores on perceived process digitalisation.

It would be possible to isolate these effects by using a multi-group analysis comparing organisations with established CA to organisations without CA. At least within the group of respondents without established CA the final reversed causality effect should disappear. And by asking respondents about how they judge their knowledge of digital technologies, the third causality effect could be isolated. Unfortunately, the survey did not yield sufficient responses in these groups to perform a valid multi-group analysis, so further evaluations of these phenomena will remain limited to follow-ups in the case study and left to future research work in this area (see section 9.3).

An unexpected relationship is also observed with the significantly negative coefficient on the path from Training (H3d2) to Effort Expectancy: theory would predict that more training should make it easier for users to apply CA, increasing Effort Expectancy (Venkatesh, 1999; Xia & Lee, 2000), not decreasing it. It seems possible that inverse causality is an issue here: maybe what can be observed is that respondents who think CA is (or found it to be) more challenging will have introduced more training while respondents who think CA is “easy” don’t see the need for training measures.

5.6 Additional Results

The survey included certain questions which were not intended for the SEM constructs but to gather additional information about the current state of internal auditing as it is relevant for the development CA.

5.6.1 Cooperation with Other Assurance Providers

Figure 5.3 shows how much respondents coordinate or would coordinate their CA efforts with other assurance providers inside and outside of their organisation. As the IIA Standard 2050 “Coordination and Reliance” (IIA, 2017a) states that CAEs should “share information, coordinate activities, and consider relying upon the work of other internal and external assurance and consulting service providers to ensure proper coverage and minimize duplication of efforts”, the mean levels of coordination around 6 (on a 0 to 10 scale) seem to be rather low – respondents seem to indicate that more would be possible with regards to coordination[15].

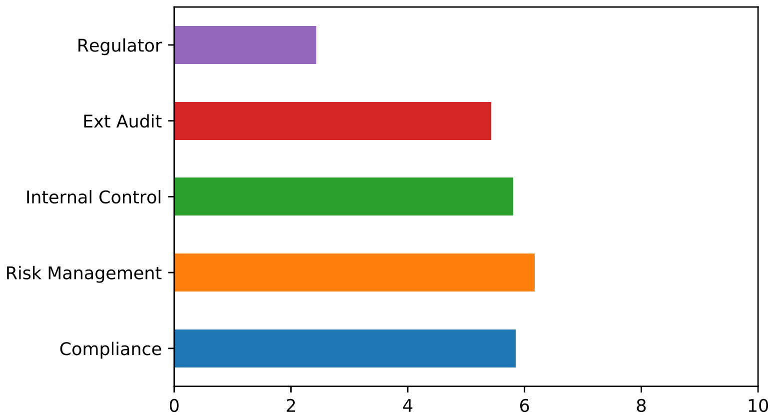
When asked about which other assurance providers respondents coordinate their work with, the overall finance department, the Quality Assurance function and the IT security function were mentioned.

5.6.2 CA Front-End Tool Features

The survey asked respondents to weigh the importance of certain potential features of a CA front-end system, the results of which are shown in Table 5.18 and Figure 5.4. To obtain a baseline on which features are more impor-

[15] Coordination with the external regulator is very low, which probably reflects that internal audit primarily serves the organisation and confidentiality requirements will also restrict the level of coordination there (also, not all regulators will be willing to coordinate their work with internal audit).

Figure 5.3: Level of respondents' coordination between internal audit and other assurance providers. Respondents were asked to rate their level of coordination on a scale from 0 to 10 for each other assurance provider that exists for their organisations.



tant, pair-wise Welch t-tests on the difference of means have been conducted between the top-ranked feature ("Right balance between capabilities and complexity") and each other feature. Features whose 5% means difference confidence interval does not include zero are significantly less important for the respondents than the top-ranked feature. This means that according to the survey responses "Workflow support for CA work, including quality assurance processes" and "Can be accessed by first or second line of defence staff" are less important than the most important feature (see Table 5.18).

Table 5.18: Average importance attached by respondents to individual features of a potential CA front-end system. Scale: 0 = "not important", 1 = "slightly important", 2 = "moderately important", 3 = "important", 4 = "very important". The p-value indicates the p-value of a Welch Two Sample t-test on the means difference, evaluating whether this feature is significantly less important than the most important feature. The line indicates where features start to be significantly less important than the highest ranked one.

Feature	Mean	p-value	
BALANCE – Right balance between capabilities and complexity	3.158	1.000	
VISUALISATION – Visualisation of large data sets	3.121	0.781	
SELFSERVE – Self-service analytics for users without programming skills to analyze data	3.102	0.698	
EXISTING – Built on existing IT platforms within your organisation	2.966	0.244	
HITS – Support processing large number of potential exceptions from imprecise analytics	2.931	0.107	
CAPTURE – Ability to capture audit work performed and conclusions directly within the system	2.895	0.101	
INTEGRATED – Integrated platform for all CA processes	2.857	0.057	*
WORKFLOW – Workflow support for CA work, including quality assurance processes	2.618	0.000	***
LODS – Can be accessed by first or second line of defence staff	2.000	0.000	***

Figure 5.4: Average importance attached by respondents to individual features of a potential CA front-end system. Scale: 0 = "not important", 1 = "slightly important", 2 = "moderately important", 3 = "important", 4 = "very important".

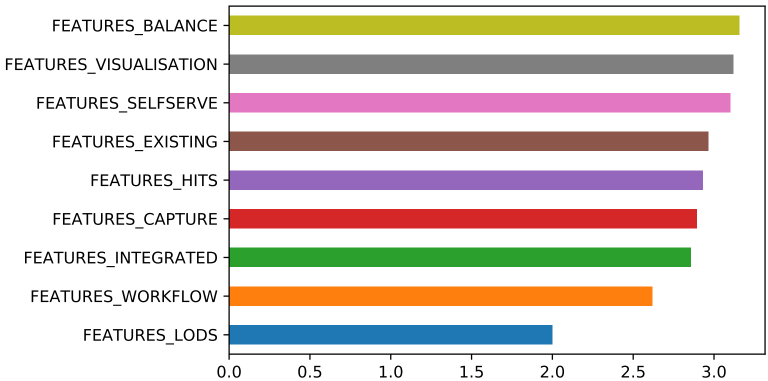


Table A.4 in the Appendix lists all open form answers provided on features they would want to see in a CA front-end system. The responses ask for the inclusion of a variety of data sources such as ERP and HR systems, 2LoD data, or past audit results. Some respondents also asked for a feedback loop that allows to easily store, use and re-emerge past data from the system and a strong focus on data security.

The opinions provided here will be used for the case study part of this thesis and the design of the CA front-end system, expending more effort on features judged to be more important by the survey respondents.

5.6.3 Continuing Professional Development Options

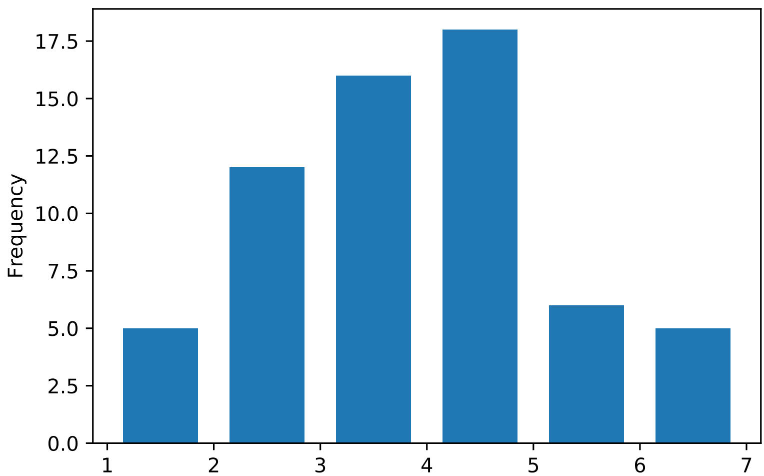
The survey also asked respondents about whether they deemed the continuing professional development (CPD) options available to auditors in Switzerland (provided e.g. by IIA Switzerland) sufficient in the area of CA and – if not – which CPD options they would like to see offered. This is an especially important topic given that the SEM analysis shows that the availability of the right skills is a significant driver of Effort Expectancy (see section 5.5).

Figure 5.5 shows how respondents agreed (7) or disagreed (1) with the statement "Available continuous development options (e.g. from IIA Switzerland) are sufficient to provide Continuous Assurance". The mean response score was 3.452 and the distribution is skewed towards the "disagreement" end of the scale. This indicates that there exists an at least partially unmet demand for education options with regards to CA. The open form answers to the question on what CPD options respondents would expect (see Table A.5) focus on three topics which appear in various combinations:

- Examples from practice, exchange of experiences, case studies and practice-oriented implementation guidance: Respondents stress that they are interested in practical examples that have been proven in the real-world instead of "high theory". This is the primary point repeated in 11 of 33 answers.

- Examples for and introductions of existing and proven tools and so-

Figure 5.5: Agreement given by respondents to the question "Available continuous development options (e.g. from IIA Switzerland) are sufficient to provide Continuous Assurance". See Table A.1 for scale.



lutions to implement CA, also showing what is possible (in 7 of 33 answers).

- Data analytics and Big Data trainings (in 7 of 33 answers).

This mirrors the discussion on CA quoted before, e.g. by Garrido (2011), that there is a lot of talk and theory about CA but not enough practical know-how on how to actually implement CA in the real world. Any work on a CA front-end tool will thus have to account for this by providing real-world applicability and practical implementation guidance.

5.7 Conclusions based on Survey Results

Surprisingly, the UTAUT model does not seem to be a good model to predict intention to use of CA. While Gonzalez et al. (2012) found UTAUT to be a good model for continuous auditing adoption in 2012, it seems that either the geographical focus (Switzerland instead of the United States) or the different point in time means that the dynamics around CA adoption have shifted. In particular, respondents note a strong urgency to participate in the digital transformation of their organisations, which might have turned CA from a distinct technology into a confounded side-effect of digital transformation. Maybe CA adoption has also reached a level that means it is better explained by "continuous use" models (Bhattacherjee, 2001; Bischoff, Aier, Haki, & Winter, 2015).

The survey results also indicate that the factors influencing CA adoption are not primarily technology-related: in fact, no significant relationship was observed between the maturity of the CA systems (Hypothesis H2c) and Effort Expectancy for CA. Instead, Performance Expectancy, Effort Expectancy, and Social Influence are driven by contextual and social, not technological factors:

- Re-engineered audit processes to fully leverage the capabilities of CA

- Visible benefits early on in adopting CA to keep stakeholders on board

- Auditors (and the organisation overall) with the right skills to be able to efficiently implement CA
- A highly capable and supportive IT function in the organisation
- Support from the Board and senior management to make auditors aware that CA is judged as important by their stakeholders
- Thorough change management strategies

This highlights that any CA front-end system needs to be embedded in an overall implementation strategy that addresses these contextual factors to be successful (e.g. building on Kiesow et al., 2015).

For the CA front-end system itself, the analysis of expected features (section 5.6.2) shows that only a strong workflow support and an integration with the 1/2LoD assurance providers are seen as significantly less relevant to the CA system. The CA front-end system design should thus focus on the other feature areas[16]. In addition to these, the design should focus on characteristics which might indirectly influence the factors identified above: While the direct impact of CA system design on Effort Expectancy did not yield a significant relationship, it still seems possible that a good CA front-end system design might indirectly yield benefits for the significant influence factors: for example, a well-designed, visual platform might increase the perceived "Visible (H1c)" benefits to stakeholders. Based on this idea, special attention was directed to the following areas during the iterative design process:

- Features that provide visible benefits ("wow" effects) to the auditors using the CA front-end system, for example social features for interacting with their colleagues and/or machine learning functionality that helps in outlier identification

[16] While also not over-reacting to these results. Asking users directly for features they would like to have is so famously unreliable (Zaltman, 2003) that it has lead to a large body of works build on the alleged Henry Ford quote "If I had asked people what they wanted, they would have said faster horses" (even though there does not seem to be any evidence that he actually said this, Vlaskovits, 2011).

- Features that provide visible benefits (“wow” effects) to all stakeholders, for example dynamic and visual audit reports
- Features that support the re-engineered audit processes and make CA easier to use for unskilled users, such as a clear alignment of system features along ORA and OCA theory
- A SharePoint-based design that can be deployed as end user application on existing enterprise infrastructure to reduce the dependence on the IT organisation for support

Note that due to the unexpected lack of predictive power of UTAUT on CA adoption shown in the survey, the case study on CA adoption is all the more important to close these new gaps in understanding of CA adoption antecedents. A case study can also identify other influencing factors, which is important given that the only moderate R^2 values for Performance and Effort Expectancy indicate that also for these constructs additional explanatory factors exist that are not captured in the above model.

To test CA adoption also in a real-world case study, a CA front-end system was designed, implemented, and deployed at the case study partner. The following chapter will discuss how design principles for this system have been derived from these survey results and IIA guidance on CA.

Chapter 6

Continuous Assurance Front-End System Design

The front-end system design is being informed by two main sources of needs:

- The theoretical foundation of CA as a combination of ongoing risk and control assessments and testing of 2LoD continuous monitoring, based on established processes (Ames et al., 2015b) and embedded into the IIA's International Professional Practices Framework (IPPF) which provide mandatory and supplementary guidance on internal auditing in general (IIA, 2017a)
- The practical findings on which factors support CA adoption from the survey results detailed in Chapter 5

As the iterative design and implementation process was based on agile principles, these needs were formulated as user stories, a common form of agile requirements formulation (Inayat, Salim, Marczak, Daneva, & Shamshirband, 2015). User stories formulate requirements as concrete statements on who wants to do what with the system and why (Carlson & Matuzic, 2010). They are supplemented with clear acceptance criteria that indicate when the solution meets the user story needs.

By design, user stories only provide a high-level view of needs, as in the agile approach requirements are no longer fully formulated at the outset of the project but are instead refined as part of a conversation between users and developers while the project is ongoing, based on incremental releases of the product (Wirdemann & Mainusch, 2017). The user stories in this chapter reflect the initial view at the outset of the case study. Their refined versions, after the conversations encouraged by the agile methodology, are presented in Chapter 8 as part of the summative evaluation of the system.

6.1 User Roles for a CA Front-End System

Effective user stories depend on a complete set of user roles for the future users of the system, as needs will differ between different roles (Wirdemann & Mainusch, 2017). Building on the IIA Standards, the audit stakeholders identified in section 3.2.1, and our case study partners, user stories will be developed for the following user roles:

1. *Audit management* and in particular the chief audit executive (CAE) “must effectively manage the internal audit activity to ensure it adds value to the organization” (Standard 2000). Their user stories will focus on overall management and planning of audit work and on high-quality, standards-conforming execution.

2. The *audit universe entity owners* are responsible for the risk assessment (and in some internal audit activities also for planning) of a certain area of the audit universe, “which consists of all risk areas that could be subject to audit”. They need tools to perform the ORA and to ensure that audit planning is based on a documented risk assessment (Standard 2010).

3. The *auditors* are using information from the CA system to plan and perform their audits. They are also responsible to execute and document the OCA within the system.

4. The *Audit Committee* benefits from the assurance provided by internal audit and wants an effective, efficient internal audit activity. Often, they are also interested in internal audit’s risk assessment and their view of changing and emerging risks within the company. Thus, they are benefiting from ORA and OCA outputs.

5. *Audit clients* or *auditees*, including management and the 1LoD, are interested in efficient audits that take up as little of their time as

possible. In particular management might also have an interest in the assurance provided over their business area. In addition, audit clients might have privacy expectations and do not want to be "watched" by internal audit all the time.

6. The *second line of defence (2LoD)* is interested in coordinating their work with internal audit to avoid duplication, regarding OCA in particular. They might also want to benefit from audit's risk assessment without compromising internal audit's independence.

7. The *external auditors* are interested in internal audit's risk assessment and ORA and OCA results for their own risk analysis and planning.

Note that a single person can have multiple roles, e.g. an auditor can also be an audit universe entity owner.

6.2 User Stories Based on Theory and Internal Audit Standards

The CA front-end system will implement the CA processes detailed in Chapter 2 based primarily on the IIA's guidance in Ames et al. (2015b). The user stories have thus been developed along the two distinct ORA and OCA processes. IIA mandatory and recommended guidance on planning, performing and documenting audit work apply to both ORA and OCA and inform additional user stories.

6.2.1 Ongoing Risk Assessments (ORAs)

ORAs are "the ongoing identification and assessment of risks to the achievement of business objectives through the use of technology-based audit techniques" (Ames et al., 2015b). IIA Standard 2010.A1 requires the audit plan to be based on a "documented risk assessment, undertaken at least annually". The risk assessment will be performed on the audit universe, "which consists of all risk areas that could be subject to audit[...]". The structure of the audit universe needs to be sufficiently flexible, as the "audit universe includes projects and initiatives related to the organisation's strategic plan, and it may be organized by business units, product or service lines, processes, programs, systems, or controls" (IIA, 2016a).

To prepare the risk assessment, the preparation "usually involves reviewing the results of any risk assessments that management may have performed. The CAE may employ tools such as interviews, surveys, meetings, and workshops to gather additional input about the risks from management at various levels throughout the organization, as well as from the board and other stakeholders". In an ORA setting, this should include data-driven inputs such as "leading indicators, performance measures, quality control, and segregation of duties" (Ames et al., 2015b). Any front-end system supporting such a risk assessment thus needs to be able to gather and document these various qualitative and quantitative inputs to establish conformance with IIA Standard 2010 (IIA, 2016a).

When adopting ORA instead of a more static risk assessment, audit should become more data-driven, in order to "examine and analyze trends, comparisons, and outliers" with the ultimate goal of adding "value as a trusted adviser by assessing emerging enterprise risks" (Ames et al., 2015b). Any CA front-end system must be able to report on this data-driven analysis, as it "is preferable to report continuous auditing results through a website rather than sending large, sensitive files via email" (Ames et al., 2015b).

Note that ORA findings should also be available to auditors when planning their individual engagements, as they will "typically begin with an understanding of the organization's annual internal audit plan, an awareness of the planning and discussions that led to its development" (IIA, 2016c).

Based on these observations, the following user stories can be derived:

1.1 ORA on the audit universe

As audit universe entity owner, I want to perform the ORA structured along the audit universe entities, so that I can discharge my duties as *per IIA Standard 2010 and ensure complete audit coverage.*

Acceptance Criteria

- ☐ The audit universe can be flexibly configured and changed
- ☐ ORA functionality is structured according to the audit universe
- ☐ No specific type of audit universe entities is enforced

1.2 Review management's risk monitoring

As audit universe entity owner, I want to receive and evaluate management's risk monitoring in the ORA system, so that I can review and use it without having to switch systems.

Acceptance Criteria

- ☐ Qualitative 1/2LoD reports can be stored and pushed into the system
- ☐ Quantitative 1/2LoD risk monitoring data can be visualised
- ☐ 1/2LoD risk monitoring can be assessed and commented on

1.3 Capture interviews, surveys, meetings, and workshops

As audit universe entity owner, I want to store interview notes, survey results, meeting memos and other qualitative inputs for my ORA in the system, so that I do not have to context switch when working with them.

Acceptance Criteria

- ☐ Qualitative notes can be stored in the system
- ☐ Arbitrary files can be stored in a structured form
- ☐ Files and notes are filed in a structure following the ORA process

1.4 Data-driven ORA with trends, comparisons, outliers

As audit universe entity owner, I want to work with and interactively visualise quantitative data in my ORA, so that I can quickly identify trends and outliers and perform comparisons.

Acceptance Criteria

- ☐ Data can be loaded and interactively visualised
- ☐ Available visualisations allow to identify trends and outliers
- ☐ Data visualisations are integrated into the ORA process

1.5 Assessing emerging enterprise risks

As audit management, I want to gather and aggregate all the individual inputs from the audit universe entity level, so that I can get a big picture view and identify emerging enterprise-wide risks.

Acceptance Criteria

- ☐ Risk inputs flow bottom-up along the audit universe hierarchy
- ☐ Qualitative assessment tools enable a systematic discussion of risks
- ☐ Inputs from different sources (qualitative, quantitative) can be merged

1.6 Document risk assessment

As audit universe entity owner, I want to document all the work performed for the risk assessment in a way that adheres to data retention requirements, so that I can document conformance to the ORA process and IIA Standard 2010.

Acceptance Criteria

- ☐ Arbitrary work performed and thoughts need to be captured
- ☐ An audit trail needs to exist for changes and removals
- ☐ Document retention and removal requirements need to be followed

1.7 ORA available for engagement planning

As auditor, I want to access relevant ORA results and the thought process behind them, so that I can use this information for planning my engagements conforming to IIA Standard 2200.

Acceptance Criteria

- ☐ Access rights enable access to relevant ORA results for auditors
- ☐ The thought process behind risk assessments stays visible

6.2.2 Ongoing Control Assessments (OCAs)

OCAs are the "ongoing evaluation of internal controls against a baseline condition and subsequent changes to control configurations, through the use of technology-based audit techniques" (Ames et al., 2015b). To perform OCAs, auditors may examine "transactional data (e.g., flagging all purchase card transactions that are greater than the authorization limit or that involve prohibited merchants)" or evaluate configurations with a focus on configuration changes that might indicate control failures (Ames et al., 2015b).

As OCAs are audit procedures which are just performed on a more timely schedule, they have to conform to the same requirements as regular work programs. In particular, work programs must be documented and must "include the procedures for identifying, analyzing, evaluating, and documenting information during the engagement" (IIA Standard 2240). This is also necessary for auditors to know what they are supposed to do and what they should look out for, ensuring high-quality and repeatable audit performance.

When auditors perform OCAs, IIA Standard 2330 on documenting information applies, thus a CA front-end system should support auditors in documenting “sufficient, reliable, relevant, and useful information to support the engagement results and conclusions” (IIA Standard 2330). Workpapers should be cross-referenced to the work program (IIA, 2016d) and “standardized, yet flexible, workpaper formats or templates” can improve “the efficiency and consistency of the engagement process” (IIA, 2016e). The IIA notes that “use of internal audit software may enhance consistency and efficiency” (IIA, 2016e), which is a benefit that should not be surrendered when switching to OCA. As audit documentation from past audits can serve as input for planning future engagements (IIA, 2016c), data from past OCAs should be made available where relevant in future OCAs.

Also, engagements “must be properly supervised to ensure objectives are achieved, quality is assured, and staff is developed” (IIA Standard 2340). Engagement supervision can take many forms that should be supported by a CA front-end system, typically including “ongoing communication with the internal auditor(s)” and review of the engagement workpapers (IIA, 2016f). Evidence of appropriate supervision needs to be documented (IIA Standard 2340), typically by electronic approval records (IIA, 2016f).

Based on these observations, the following user stories can be derived:

2.1 Examining transactional data, configurations for OCA

As an auditor, I want to access OCAs assigned to me and load and examine transactional and configuration data, so that I can evaluate controls against a baseline condition and obtain more timely assurance on key controls.

Acceptance Criteria

- ☐ Open OCA tasks can be assigned to auditors and displayed
- ☐ OCA tasks include transactional and configuration data
- ☐ Auditors can perform and document an evaluation of this data

2.2 Display work program and procedures

As an auditor, I want to access the work program and procedures behind a given OCA, so that I know what I am supposed to do and what to look out for.

Acceptance Criteria

- ☐ OCA tasks are stored together with their work program
- ☐ The OCA work program is displayed to the auditor accessing it

2.3 Documenting work performed

As an auditor, I want to document the work I have performed and the conclusions I have drawn within the OCA data set, so that I can document conformance to the IIA Standards.

Acceptance Criteria

- ☐ Work performed can be documented within OCA procedure
- ☐ Conclusions can be documented within OCA procedure

2.4 Cross-reference past OCA results

As an auditor, I want to get access to past OCA results concerning the same data elements (transactions, configurations etc.) when conducting an OCA, so that I can take these past findings into account when planning and performing my work.

Acceptance Criteria

- ☐ Past OCA results are displayed if they concern the same data object
- ☐ Auditors can access details of past OCA results for the same ob-

ject

2.5 Support quality assurance workflow

As audit management, I want to conduct my quality assurance within the CA front-end system including documenting approvals and sign-offs, so that I can document conformance to IIA Standard 2340 and all internal quality assurance and improvement program (QAIP) measures.

Acceptance Criteria

- ☐ Quality assurance workflows exist within the system
- ☐ Sign-offs, approvals can be documented on OCA tasks, workpapers

2.6 Support quality assurance conversations

As audit management, I want to be able to engage with and discuss review points with my auditors on the OCA platform, so that I do not have to switch context for my ongoing communication as per IIA Standard 2340.

Acceptance Criteria

- ☐ Electronic discussions are possible on OCA tasks, workpapers
- ☐ Discussions are kept separate from audit findings (IIA, 2016f)
- ☐ Auditors get notified about new review discussions

6.2.3 Documentation Requirements

Audit work, be it ORA or OCA, is subject to documentation requirements (IIA Standard 2330). Once documentation has been established, this also includes controlling access to these records (IIA Standard 2330.A1) and adhering to retention requirements, which must be “consistent with the organization's guidelines and any pertinent regulatory or other requirements" (IIA Standard 2330.A2).

3.1 Data security

As audit management, I want to control access to the OCA and ORA platform and prevent any unauthorized access to the data, so that I can ensure the confidentiality of our work and adherence to IIA Standard 2330.

Acceptance Criteria

- ☐ Access can be controlled for ORA and OCA tasks
- ☐ No unauthorized access to the platform is possible

3.2 Retention requirements

As audit management, I want my CA front-end system to adhere to the organisation-wide data retention requirements, so that I ensure adherance to IIA Standard 2330.A2.

Acceptance Criteria

- ☐ Data stored in the system is stored and deleted
- ☐ Data retention requirements follow organisation-wide policies

6.3 User Stories Based on CA Adoption Survey

Section 5.5 details the findings on which factors have a significant impact on the UTAUT antecedents. A re-engineering of audit processes, visible benefits for the business and/or the auditors early on, the availability of the right skills, an effective corporate IT function as well as board-level and senior management support and solid change management were found to be relevant. Based on these, a set of user stories have been derived below that transform these findings into needs for an effective CA front-end system.

Note that no user stories have been derived from the significant paths for board-level and senior management support and change management requirements, as those are outside of the scope for a CA front-end system. They have, however, influenced the subsequent implementation strategy used in the case study, as detailed in section 7.3.

The survey also directly asked respondents how important they judged potential features of a CA front-end system (see section 5.6.2). As these potential features have been derived from the same sources and discussions that informed the user stories in this chapter, they were not used to define additional user stories. However, the final system has been evaluated against the priorities identified by survey respondents (see Chapter 8).

6.3.1 Re-Engineering of Audit Processes (H1a)

Performance Expectancy for CA depends on a re-engineering of audit processes, towards a more structured, risk-oriented, agile process. This also entails identifying which audit procedures can be automated and/or supported with quantifiable data and which procedures require qualitative judgement.

Based on this understanding, the following user stories have been identified:

4.1 Structured focus on risks

As audit management, I want to capture risks in the ORA in a structured form organised along the audit universe, so that I can aggregate the risks throughout the organisation and know where to focus my audit resources.

Acceptance Criteria

- ☐ ORA structure follows a (configurable) audit universe
- ☐ ORA allows capturing risks in a structured form
- ☐ ORA supports aggregating risk information

4.2 Support for agile auditing

As audit management, I want to update and converse about risks in both ORA and OCA channels all the time, so that agile auditing practices can be supported outside of fixed planning periods.

Acceptance Criteria

- ☐ Risk assessments can be updated and documented continously
- ☐ Dynamic conversations on risk and control are possible
- ☐ The system must not enforce fixed long-term planning periods

4.3 Quantitative and qualitative data

As audit universe entity owner, I want to use, capture, and mix both quantitative and qualitative data for my risk assessment, so that I can use the right type of data for the right audit area.

Acceptance Criteria

- ☐ Quantitative data can be loaded and displayed
- ☐ Qualitative data can be captured and displayed
- ☐ Quantitative and qualitative data can be mixed

4.4 Guide auditors along CA processes

As auditor, I want structured guidance along the new CA processes of ORA and OCA, so that I am both forced to and supported in adopting my way of working to the new ORA and OCA world.

Acceptance Criteria

- ☐ Separate processes for ORA and OCA exist
- ☐ Where needed, the system shows the auditor what to do

☐ The system documentation describes ORA and OCA processes

6.3.2 Visible Benefits (H1c)

As the interview partners have highlighted, CA always requires an initial investment. However, patience for costs without benefits is often limited, which is why it is important to be able to show visible benefits of CA early on. This is easier if implementation can be done step-by-step in an incremental fashion and if the CA front-end system supports presenting risks and information in novel ways that might be able to impress stakeholders.

5.1 Possible to start small

As audit management, I want to be able to start small with data analyses only in specific areas, so that I do not have to spend a lot of resources before I have anything to show for it.

Acceptance Criteria

☐ ORA is useful even if quantitative data only exists in some areas
☐ OCAs can be rolled-out independently for each analysis

5.2 Visualisation of complex data

As Audit Committee member, audit management and/or auditor, we want to see large data sets in a visual form, so that we can better spot trends, emerging risks and unusual patterns or changes.

Acceptance Criteria

☐ Common visualisations of data can be used
☐ Visualisations can be manipulated to support identifying anomalies

6.3.3 Availability of Skills (H2a)

A key topic in the interviews was the need for auditors with the right skills for successful CA implementation. While a CA front-end system will not be able to solve a shortage of skills, it can at least not impose any additional needs on the available skillset by being easy-to-use and configurable without programming know-how.

6.1 Easy-to-use without documentation

As auditor, I want to be able to understand and use the system right away without having to consult documentation, so that I do not have to spend a lot of time learning how the system works.

Acceptance Criteria

- ☐ Users can discover main features without reading any documentation
- ☐ System uses common, known UI/UX patterns where possible

6.2 Configurable without programming

As audit management, I want to be able to configure the system without needing technical or programming skills, so that I do not have to hire staff with special skills to support this system.

Acceptance Criteria

- ☐ System configuration is possible without programming skills
- ☐ System adopts to different audit functions with configuration alone

6.3.4 Effective Corporate IT (H2b)

The effort required for effective CA is lower if an effective corporate IT function cooperates with internal audit, providing the necessary IT infrastructure and data sources. Unfortunately, slow-moving IT departments are a common challenge when adopting CA (Hardy, 2014). Thus, the less requirements a CA system imposes on the IT department the better. This includes both installing the system itself and leveraging data sources and analytics systems already in place at the organisation.

7.1 Does not require IT involvement

As audit management, I want to be able to install the system myself, so that I do not depend on our slow IT department to get us set-up.

Acceptance Criteria

☐ Installation without IT involvement possible

7.2 Leverages existing analytics

As audit management, I want to be able to integrate results from our existing corporate analytics platforms, so that I conform to our IT architecture and do not duplicate organisation-wide systems already in place.

Acceptance Criteria

☐ Not limited to specific source systems
☐ Leverages existing analytics solutions instead of duplicating them

To test the practical validity of these theory-derived user stories, an actual CA front-end system following these user stories was developed as part of the subsequent case study, which will be discussed in the following Chapter

7 and the results of which will be presented in Chapter 8.

Chapter 7

Continuous Assurance Front-End System Case Study

To test whether the proposed CA front-end system design and the user stories really capture actual auditor's needs, it is necessary to turn the theoretical design into a practical implementation and let auditors use the system in their day-to-day CA work.

For this, this research has been conducted together with the internal audit activity of a case study partner in Switzerland. The implemented CA front-end system has been put to use for their ORA and OCA work and further refined in an agile development approach, which aligns nicely with the iterative nature of DSR. The overall case study lasted about two years including preparatory work and the system was in use for a bit more than one year when the case study ended. It is still being used today.

7.1 Iterative Design and Implementation Process

The implementation of the CA front-end system at the case study partner followed the iterative DSR process described in section 3.2.2. ORA and OCA functionalities were developed according to the user stories identified in Chapter 6 and released in stages:

1. The initial roll-out of the front-end system (named "The Dashboard") at the case study partner occured in May 2018, only with the ORA functionality. The roll-out was accompanied by process changes and training measures (see section 7.3). After that date, audit management and all about 40 audit universe entity owners started using the new system for their ORAs. The system was used for the ORA across the audit universe, even though only about a third of the audit universe

areas was covered with data-driven risk indicators. This incremental approach was supported by the design choices focussing on a qualitative risk analysis (see section 7.2).

2. In October 2018, an initial roll-out of the OCA functionality was tested with select OCA task owners. Some of them had performed their OCA work before using Excel spreadsheets, allowing a comparison between the old and new approach. Training for this trial roll-out was limited, which also allowed to learn about which features were self-discoverable and which were not. These trial runs were followed by interviews with the involved OCA task owners.

3. After the trial run, the full OCA functionality for all OCA tasks at the case study partner was released at the end of January 2019.

4. Interviews in early 2019 indicated that while in general, users appreciated the new system, audit managers noted that some users were not using it as "ongoing" as ORA and OCA would benefit most from, but are only using the system before and after the quarterly risk update meetings (see section 7.1.1). Suggestions included to increase the social interaction features in the systems and to highlight news and changes to users within the system, thus increasing engagement similar to successful social media apps. These new features were rolled out in May 2019 as a big update that included a complete UI redesign.

5. Final interviews for the summative evaluation were conducted in July and August 2019, concluding the case study.

Smaller interim releases were usually focussed on bug fixes of existing functionality instead of releasing new features.

The design and implementation process was guided by agile principles: the user stories were discussed and substantiated with auditors at the case study partner. After each intermediate release, auditors and other users of the system had the opportunity to provide feedback in person, via mail, or using the built-in "feedback" functionality of the system. Users were observed in how they interact with the system to gather potential improvements. Pending tasks were tracked on an electronic Kanban board with stages ranging from "to do" (not yet started) over "in progress" and "QA" (done but pending quality assurance) to "done".

Full interviews were conducted with audit management and CA users at the end of 2018 and early 2019 after the OCA release. For certain OCA functionality, different feature sets were tested with different users to observe whether there would be differences in user acceptance between the different feature sets.

7.1.1 Feedback Received

In total, 21 feedbacks were received using the built-in "feedback" functionality (see Table 7.1); overall, more feedback was received in-person than using the feedback tool, either unprompted or as a part of the intermediate interviews conducted. In addition to specific questions on how to use the system or on individual content items, intermediate feedback covered the following main areas:

1. Notifications for users outside of the system (e.g. via e-mail)
2. Usage of the system is too often limited to the quarterly ORA meetings, it should encourage more ongoing usage
3. Workflow process for the ORA to structure ORA processes and quality assurance
4. System-wide search functionality
5. More structure and metadata for notes in the ORA system
6. Lack of value-added for OCA tasks
7. Design should be improved

This feedback plus user observation have lead to a variety of measures and changes implemented in the system during the case study:

1. Early on, users asked for notifications from the system when elements in the system were added or changed, so that they would know about changes affecting their auditable entities or business areas. Unfortunately, the design choice to restrict the system to a front-end without any back-end server component means that it is technically not possible for the system to directly emit emails or mobile push notifications. Adding such external notifications would have needed a server or cloud component, violating the key design choice of being easily installable by the end users (see section 7.2.5). Thus, no external notifications were implemented. However, experiments with notifications *within* the system were conducted: in a first attempt, users could access a separate configuration page to set-up listeners that would trigger alerts for new notes which matched specific keywords. These would trigger a notification in the menu bar of the system. However, it turned out that the separate configuration page was not easily discoverable by the auditors, too complicated to use and so less than five users actually configured any triggers. Thus, it was decided to remove this functionality during the study. Based on these observations, it was decided that any new notification mechanism must make it easier to "subscribe" to events without having to set this up on a separate configuration page – similar to how you can easily "follow" users on social networks and subscribe to their content. This was implemented as part of the re-design and interaction rework (see section 7.2.4). Users can now "watch" notes keywords or risk matrices with one click and receive changes on the newsfeed on the main page. To mediate the lack of email support, a workaround was established where base SharePoint functionality can be used to subscribe to the newsfeed as an RSS feed, which can be subscribed to in Microsoft Outlook. This functionality was added towards the end of the case study and is thus discussed as part of the

summative evaluation in Chapter 8.

2. The most requested feature at the beginning of the study was a system-wide search functionality that would search all notes across all auditable entities in the audit universe instead of just searching within a specific auditable entity. This functionality was actually available from the start, but it was hidden on purpose as it was not clear how it would work performance-wise with a large number of notes in the system. However, performance has kept up, and so this feature has been advertised more widely.

3. During the first quarterly ORA meetings, where the dashboard was projected in the conference room and used "live" to discuss the risk assessment in the different business areas, it was observed that it was difficult to talk about individual risks, because the risk matrix and the description of these risks did not fit on the same screen. While this seems like a minor issue, it actually made the experience quite frustrating to the auditors in the room. Thus, an early change was to freeze the risk matrix on the screen, so that when the users scroll to a specific risk its rating on the matrix remains visible.

4. As multiple users complained about the stale design of the system, a complete re-design was undertaken towards the end of the case study (see section 7.2.4). The new design was inspired by Google's Material Design guidelines (Google, 2019), which should help users to get an experience that is familiar to them from their privately used systems (phones with Google Android and/or the Google web properties). The new release also included new social interaction features aimed at encouraging the auditors to use the system more frequently.

Some feedback did not lead to implementation changes: a conscious decision was made not to add additional metadata to the notes in order to avoid complicating the system and adding friction to the note-taking process. For the perceived lack of value-added for the OCA tasks in the system, no measures were implemented as the expectation was that the benefits will become clearer once more OCA work has been performed within the system: the key benefit of the new component over Excel spreadsheets is supposed to be that historic work performed is being shown to the auditors where they need it (see section 7.2.3). This functionality only becomes visible to the auditors once sufficient historic data is in the system. In fact, at the conclusion of the case study some auditors already started to see these benefits (see section 8.2).

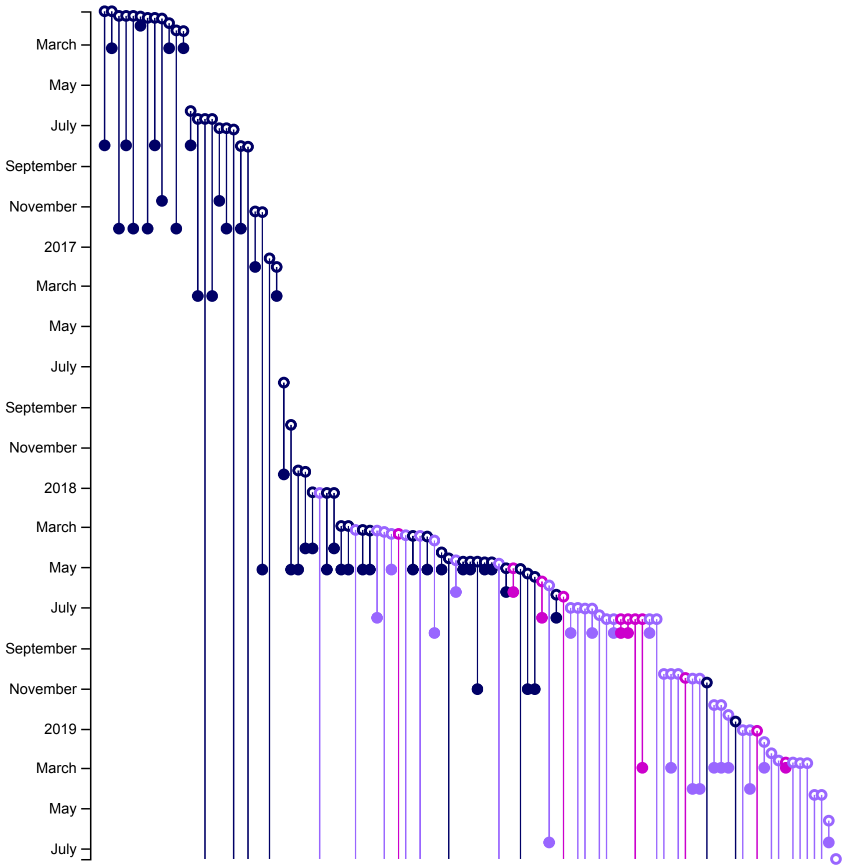
7.1.2 Task Tracking

The data from the electronic Kanban tool yield insights into the iterative development process. In total, 417 Kanban "cards" were filed regarding system development. A manual review has been performed to identify the development strains and the sources of design decision for the system. 314 cards concern technical details or bug fixes and are thus not influencing or influenced by larger design choices. Of the remaining, "larger" cards, 52 can be traced to the initial requirements for the system built on the user stories laid out above. 40 cards concern changes based on explicit user feedback, while 11 cards were driven by observations on how users use the system and which challenges they encounter.

Figure 7.1 shows a timeline of these 103 cards, indicating for each card when it was opened and when it was closed. Note that some tasks are not yet completed, which means that their effect could not be analyzed during the case study.

We can observe multiple waves of development in this timeline: a first wave was completed at the end of 2017. These contained the basic functionality and the lower parts of the system (e.g. routines to interact with the SharePoint server). In particular, those were not yet informed by the CA user stories, as the survey was still in the process of being set-up and thus no survey results were available. A second wave was completed mid-

Figure 7.1: Timeline of all Kanban cards during the case study. Each bar represents one Kanban card. Empty circles = creation date of card, filled circles = archival date of card (month end after completion). Dark blue = initial user stories, light blue = based on user feedback, violet = based on user observation.



2018. These covered the functionality based on the CA user stories derived from theory. Afterwards, additional features were implemented based on the survey results and then also on user feedback and observations which began after the roll-out of the system mid-2018. Note that some user feedback was obtained already before the system was rolled-out officially, as user pre-testing began in the first half of 2018. Finally, we see another wave of completed features between March and May 2019. Those concerned primarily the big re-design and the social interaction features which were rolled out in May 2019. Some Kanban cards are still open – those are either low priority items or items that now also feature on the final user stories but have not (yet) been implemented in the system (e.g. data drill-downs and data slicing).

7.2 System Design Choices

The user stories from Chapter 6 only provide a high-level view of user needs and do not reflect the discussions, feedback and observations that were part of the iterative DSR process. This section details the design choices implemented in the final CA front-end system as it is was used at the partner organisation at the conclusion of the case study, including why these choices were made and how they account for the user stories from Chapter 6. To illustrate certain choices, screenshots of the implemented system are being presented. A demo version of the system exists, further details of which are available on the accompanying website[1] and access to which can be requested from the author. The demo system (from which also the screenshots in this chapter are drawn) uses a fictional publishing company and publicly available datasets (Yeh & Lien, 2009) to demonstrate the system's capabilities.

7.2.1 Data Sources

Following user story 7.2 (leverages existing analytics), the front-end system does not implement any data analytics capabilities. Instead, it is possible to

[1] `https://www.the-dashboard.ch/`

load industry-standard comma-separated values (CSV) files into the system that can then be displayed as tables for ORA or OCA or used as inputs for various visualisations in the ORA section. This way, the system does not try to duplicate functionality that is already available in a variety of commercial[2] or open-source[3] software solutions.

As the system is built on Microsoft SharePoint (see section 7.2.5), data can be loaded using the various interfaces offered by Microsoft SharePoint: the data library can be accessed via WebDAV, via the SharePoint REST API, as network drive on Microsoft Windows, as SharePoint folder in Microsoft Office applications, or programmatically using workflows within SharePoint. Supporting the most widely used data format combined with a variety of input interfaces should ensure that data can be loaded from a variety of existing analytics solutions.

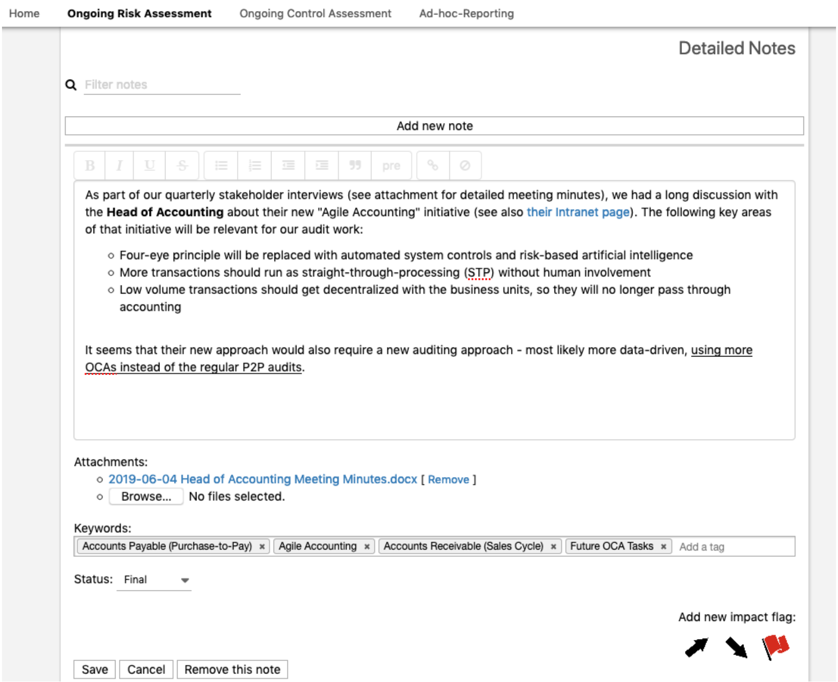
7.2.2 Ongoing Risk Assessments

Audit universe entity owners want to be able to perform their ORA structured along the audit universe (user story 1.1, ORA on the audit universe). The ORA part of the CA front-end system is thus entirely based on the configurable audit universe of the organisation. For each element of the audit universe, dashboards can be configured that combine functionality to capture qualitative information (user stories 1.2, review management's risk monitoring, and 1.3, capture interviews, surveys, meetings, and workshops) with quantitative data visualisation (user story 1.4, data-driven ORA with trends, comparisons, outliers). The audit universe is structured as a hierarchy, which enables dashboards both on the low-level entities as well as on higher entities for risk aggregation (user story 1.5, assessing emerging enterprise risks).

[2]For example ACL, SPSS, SAS, BusinessObjects, or Microsoft SQL Server.

[3]For example R, Python, KNIME, PostgreSQL.

Figure 7.2: Notes can be added on all audit universe entity dashboards. Notes can include formatting, links, and attachments. They can be assigned keywords to structure this qualitative information.

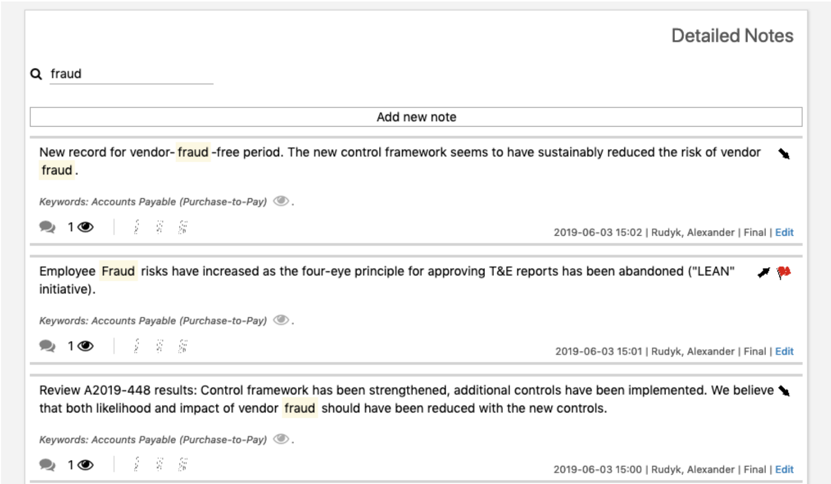


Note taking for qualitative analysis

To capture qualitative information, such as those from business documents (meeting minutes, risk reports, self-assessments etc.) or received in interviews or other discussions with business stakeholders, the CA front-end system provides what it calls “notes”. Dashboards for each audit universe entity can contain one or more notes sections where notes with background information and new developments in the given audit universe entity can be added by the auditor (see Figure 7.2).

Notes can be formatted and include pictures such as graphs or screen-

Figure 7.3: A full-text search searches all notes for the given keywords. Matches are highlighted in light yellow.

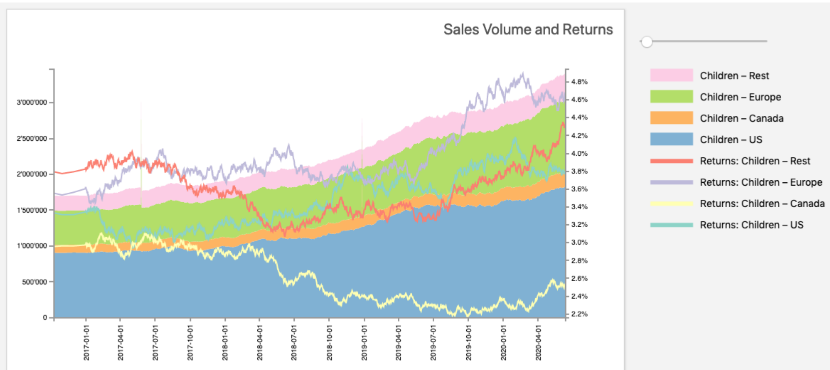


shots to provide context. It is also possible to add attachments to a note, which supports capturing management reports or meeting minutes received from the business as supporting background (user story 1.3, capture interviews, surveys, meetings, and workshops). As those notes and attachments are stored in Microsoft SharePoint (see section 7.2.5), they benefit from SharePoint's support for storing and working with documents in a variety of formats.

Keywords can be assigned to each note. This allows to group notes by topic and also to add notes that are relevant to multiple audit universe entities: such notes can be assigned the keywords for all relevant audit universe entities; they will then appear on the dashboards for all these entities. Notes can be filtered by keyword and full-text search (see Figure 7.3).

Beyond the text field, the keywords, and the status field (which allows auditors to mark notes as drafts which are still work-in-progress), a conscious choice has been made not to include any additional structured metadata.

Figure 7.4: A time series chart in the front-end system. The chart shows sales volume by category as a stacked area chart as well as returns by category as an overlaid line chart. The legend on the right is interactive, the user can click entries to hide or show them on the graph. The slider allows to smooth the graph in order to make long-running trends more visible.



The idea was to reduce friction and make adding notes as easy as possible to increase usage.

Visualisation of data sources

For ORA, visualisations are an important part to make sense of available data and to identify trends and emerging risks (user story 1.4, data-driven ORA with trends, comparisons, outliers). This is why the system implements the following visualisations for the loaded data:

- Time series as line charts where data are plotted as lines over time (which is given on the horizontal axis). Multiple lines can depict multiple data elements on the same chart and fixed lines can be used to depict benchmarks or thresholds.
- Time series as stacked area charts where data are plotted as areas above the horizontal axis and multiple data elements are stacked (added)

together. These can be combined with line elements on the same chart (see Figure 7.4).

- Stacked bar charts where data elements are depicted as bars with multiple data elements being stacked (added) on top of each other.

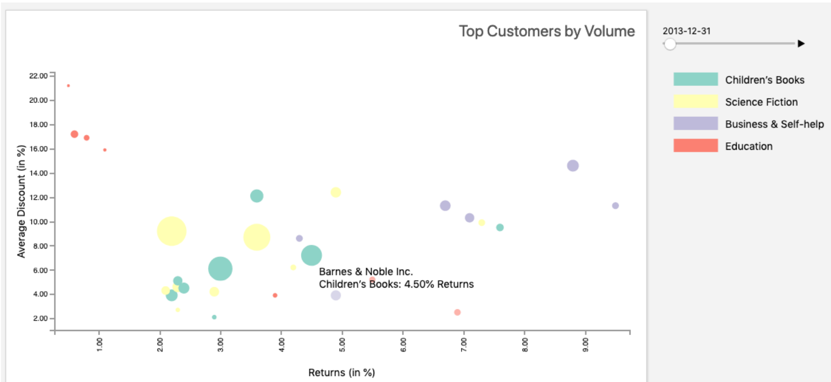
- Bubble charts where data elements are displayed as bubbles on an X-Y grid and each element can have four attributes: two attributes define the position on the X and Y axis, respectively, one attribute defines the size of the bubble and a fourth attribute specifies the group the element belongs to, which defines its color on the graph (see Figure 7.5).

- Portfolio diagrams are vertical-width bar charts, sometimes also called Bar Mekko charts (Mekko Graphics, 2019). They can show a portfolio of elements where the weight of each element (the size of the portfolio component compared to the overall portfolio) determines the X-axis width of the rectangle the element is displayed as. The variable to be observed determines the height of the rectangle on the Y-axis. If, for example, the observed variable is some kind of risk indicator, the area of a data element in such a chart is supposed to show the overall risk impact of this element, which is determined as the weight of the element times its riskiness (see Figure 7.6).

- Tables, which are in a way the simplest form by displaying data in its original format of columns and rows. Tables can include sparklines (Tufte, 2006, pp. 46–63) that summarize developments across rows or columns.

The visualisations are interactive: Data points can be hidden from view, the user can smooth timelines as needed, can zoom into parts of a time series or portfolio, and can animate visualisations to see how data has changed over time. This should support the exploratory nature of ORA and in particular the discovery of emerging risks (user story 1.5, assessing emerging enterprise

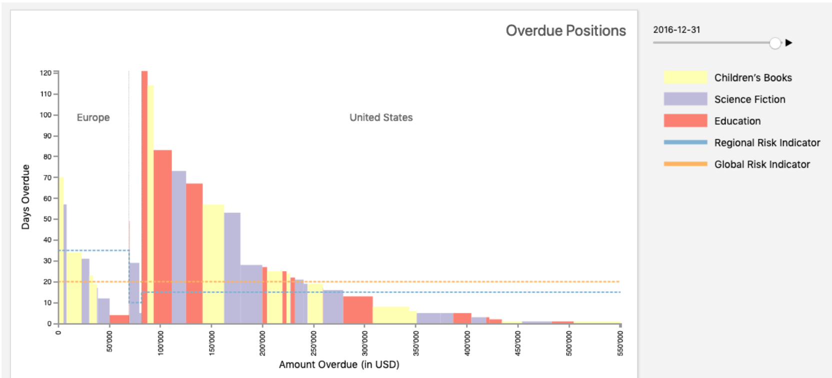
Figure 7.5: A bubble chart in the front-end system. The chart shows individual customers by their return rate, average discount (X-/Y-axis) and order volume (size of bubble). The slider on the top right allows the auditor to go back in time and its "play" button will show an animation over how these positions have developed over time.



risks) and improve decision-making (Tang, Hess, Valacich, & Sweeney, 2014). The implemented visualisations have been chosen based on the specific needs of the case study partner and what they wanted to see visualised, so they are informed by audit practice. Future work might add to this selection as there exists a variety of advanced visualisation techniques not yet exploited in this system (Tufte, 2011). Practice at the case study partner has shown that useful visualisations also provide the visible benefits (Hypothesis H1c) when the system is being used to present the audit's risk analysis to their stakeholders (following user story 5.2, visualisation of complex data) as it provides stakeholders with the confidence that the auditors are going beyond the reports generated by the business functions.

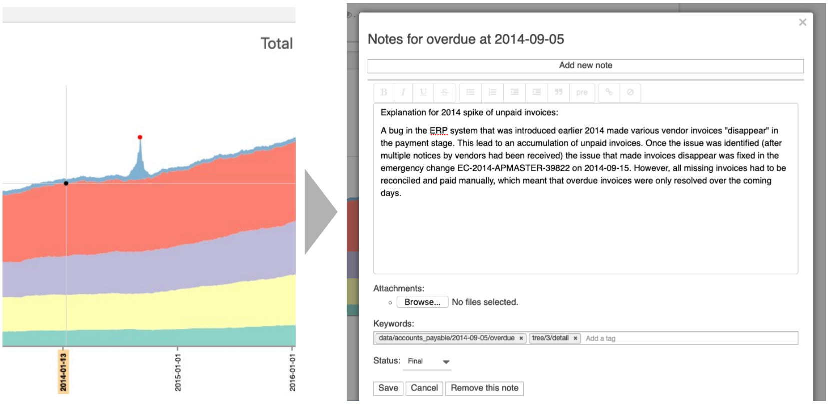
Contrary to many ORA approaches (e.g. D. Moon, 2014), the system as implemented at the case study partner does not use hard-coded thresholds to trigger warnings or "traffic light" displays of "orange" or "red" values re-

Figure 7.6: A portfolio chart in the front-end system. The width of the bars shows the volume of the outstanding receivable, while the height shows the days this receivable is already due. This type of chart reflects that very small receivables are not a big risk even if they have been outstanding for a very long time.



quiring attention. Instead, interactive visualisations (Tang et al., 2014) hand the power and responsibility to the auditor to make the call which trends and data values warrant further attention. For some visualisations, benchmarks are displayed to support the auditor. This is based on a conscious decision of the case study partner: The opinion of the case study partner was that emerging risks are better identified by the professional judgement of the auditors, and that automated thresholds or traffic lights could lead to auditors ignoring important inputs outside of these narrowly defined automatons. However, this discussion is still ongoing within the case study partner, so this decision might be revisited in the future. Due to the configurable nature of the CA front-end system, it would be possible to include traffic lights or threshold-based warnings as well.

Figure 7.7: Double-clicking on a visualisation (left) opens the notes editor (right) where a new note can be added to this point in the graph. Points with existing notes are marked with a red dot (see left picture).



Data-focussed knowledge management

The developed CA front-end system is unique in that the data visualisations are "two-way streets": The users can view and interact with them, but they can also directly attach notes documenting their work performed and their findings on individual data points within the data (see Figure 7.7). This avoids duplication of efforts by making past work easily visible, ensures that the documentation requirements can be fulfilled for ORA (user story 1.6, document risk assessment) and enables a feedback mechanism that is required for future supervised machine learning applications: only by recording audit work on a data point level can this work be used to train machine learning algorithms.

Notes added in this way can be tagged so that they also appear in the notes sections for qualitative analysis. This way, it is possible to merge the (qualitative) findings from the quantitative data with the qualitative findings from other sources (user story 4.3, quantitative and qualitative data).

This follows the case study partner's approach to turn quantitative data into qualitative assessments using auditors' professional judgement instead of quantifying qualitative data.

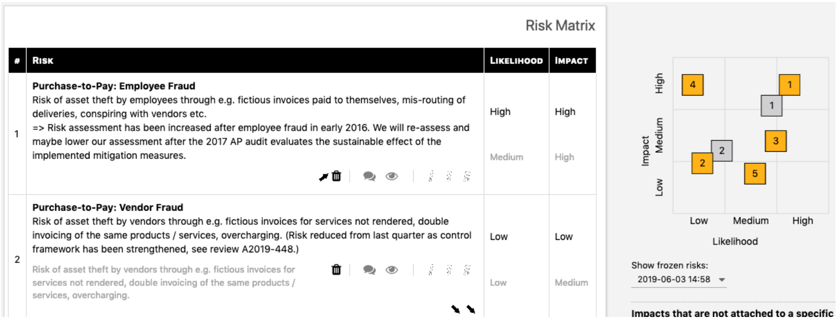
Risk matrices and qualitative risk aggregation

While ORAs are supposed to be technology-enabled and supported with data (Ames et al., 2015b), it is not necessarily the case that the resulting risk assessments need to be quantified or formula-driven. It is conceivable to implement ORAs in a quantitative manner, where individual risk factors are quantified and aggregated with a pre-determined aggregation formula onto the audit universe entities and along the audit universe hierarchy. However, it is also possible to use technology and data primarily to aid auditors in their professional judgement, leading to qualitative risk assessments which are then aggregated by auditors and audit management to the audit universe entities and hierarchy.

In discussions with the case study partner, it became clear that neither data availability nor their understanding of how ORA should be conducted would be compatible with a quantified approach. Thus, the CA front-end system as implemented focusses on a qualitative approach to risk analysis and aggregation. However, it would be possible to extend it with quantitative aggregation in a future release.

For recording the auditor's risk assessment, the system provides risk matrices (see Figure 7.8), which can be inserted at any point in the audit universe hierarchy (user story 1.1, ORA on the audit universe) and allow the auditors to record the main risks they have identified on an impact-likelihood plane (GSFC, 2009). The use of risk matrices follows Curtis and Payne (2008) and Rick A. Wright (2018). The auditors can describe the identified risk and assess its importance by visually dragging it on the impact-likelihood matrix, providing a structured way of qualitatively capturing risks (user story 4.1, structured focus on risks). As risk matrices have limitations (Louis Anthony Cox, 2008), risk matrix axes and grids are configurable in

Figure 7.8: Interactive risk matrix within the CA front-end system. Risks can be dragged around the risk matrix (right side). Grey icons depict the past position of the risk. Upward and downward pointing arrows depict impact notes for the risk.

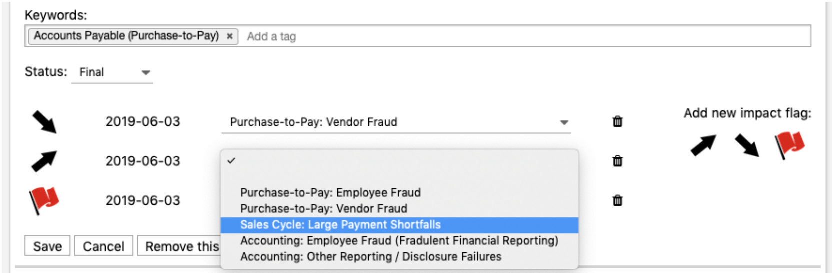


the system, so more complex matrix designs, e.g. as proposed by Dillon, Klein, Rogers, and Scolese (2018), could be configured in the future.

Risks can be "frozen", to create a snapshot of how risks looked like at a specific point in time. This allows comparing risks over time, visually inspecting movements of the risks on the risk matrix display.

To avoid information overload (Brown-Liburd, Issa, & Lombardi, 2015; Eppler & Mengis, 2004), the CA front-end system needs to aid the auditor in making sense of the various qualitative information recorded in the system (using the notes described before). Notes can be structured with keywords, which can aid in structuring information within an audit universe entity. However, auditors also need support in aggregating this qualitative information to higher-order risk entities along the audit universe hierarchy. For this, it is possible to link detailed notes to the higher-level risk matrices: every note can be marked to "impact" one or more risk items (see Figure 7.9), where an impact can be characterized as "risk increasing" (indicated visually by an upward-pointing arrow), "risk decreasing" (downward-pointing arrow) or otherwise "warranting attention" (red flag). It is also possible to mark

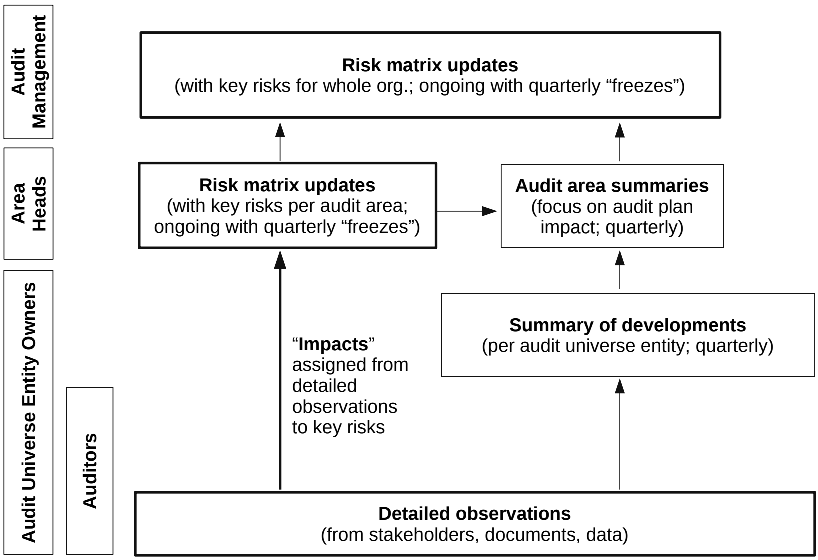
Figure 7.9: All notes can be linked via "impacts" with one or more of the risks defined in the risk matrices of the given audit universe section. It is also possible to link notes with the risk matrix itself to indicate that this impact is on a not yet identified emerging risk.



impacts which affect risks not (yet) written into the risk matrix to indicate emerging risks. In the risk matrix viewer, impact notes are shown that have been added since the last time risks have been frozen, to indicate the developments since the last risk assessment (the small upward and downward arrows in Figure 7.8). They are shown with pictograms, one icon for each impact note, which allows the auditor to quickly grasp the impacts acting on the risk items. Clicking on a pictogram opens the corresponding notes, so the auditor can review the detailed comments before deciding on how the risk item should be (re-)assessed.

A second, complementary, less structured venue to aggregate qualitative information to higher levels of the audit universe are summary notes: In practice, this is not a dedicated feature of the front-end system, but rather a possibility due to the flexible nature of the notes functionality that has been implemented in the case study: for each audit universe entity, the responsible entity owner is asked to complete a "summary" note about his or her entity once a quarter. Such a "summary" note is tagged with a specific keyword. At the higher level of the audit universe hierarchy, the most recent summary notes for all entities below this heading are shown on the dashboard. Thus,

Figure 7.10: Detailed observations can be aggregated "bottom-up" to higher-level risks. Bold lines and boxes indicate dedicated functionality provided by the system for this purpose (note-taking on data elements, assigning "impacts" and risk matrizes).



on a single page summaries from all the entities can be reviewed and used to reflect on the higher-level risk assessment.

This qualitative aggregation is shown in Figure 7.10. The advantage of this approach is that it works equally well across all areas of the audit universe, including areas which are currently not covered by data-driven risk analysis (which were the majority of entities at our partner during the study). It thus allows for a gradual roll-out of additional, data-driven ORA analyses instead of requiring a large initial investment, in line with user story 5.1 (possible to start small). It also fits well into the 3LoD model, as the second line is very active in obtaining and reporting on quantifying data, but only audit is in a position to draw fully independent conclusions from these quantitative data points.

7.2.3 Ongoing Control Assessments

The CA front-end system implements the following process for OCA:

1. A data analysis tool (outside of the front-end system) generates a list of potential control violations, which can occur on manual request, on a fixed schedule (e.g. weekly, monthly, quarterly) or triggered by specific events. It transfers this list as CSV file (see section 7.2.1) to the CA front-end system.

2. The system generates an OCA task for this list of potential violations. The task that is displayed to the auditor includes a pre-defined description of what the analysis does and what the auditor needs to do to validate the potential violations (these are audit procedures for the given OCA; see Figure 7.12).

3. The auditor can access the list of identified potential violations. The identified entries are displayed as a table with configurable columns, more details to a given violation can be included as part of the "audit forms" (see below).

4. For each potential violation element, the auditor can attach one or more *audit forms*, which are templates for the given audit task, laying out what needs to be investigated, providing additional detailed data where necessary, and allowing the auditor to document the work performed and the conclusion for the given element (see Figure 7.11).

5. Each audit form and the overall OCA task support a review workflow for quality assurance (see bottom of Figure 7.12).

6. Audit forms are automatically linked to the entities involved in a given potential violation (e.g. transactions, vendors etc.). This ensures that audit forms completed in the past can be displayed for future OCA

tasks, so that auditors have direct access to past investigations concerning the same entities (see Figure 7.13). This same linking could also be used for machine learning processes in the future, where the system learns from the conclusions entered by the auditors which potential violations are false positives and should thus not be shown again (feedback loop).

This process is informed by section 2.6 and discussions with the case study partner. It assumes that most OCA analytics will not be fully automated: they still need auditors to determine whether the identified elements are real control violations. This assumption is based on the argument that if the analyses could identify control violations with complete accuracy, they should not be 3LoD OCA tasks but should be implemented as ex-ante, first LoD controls that prevent such transactions from being executed. Also note that the process focusses on the overall list of potential violations for a given OCA task and not on rectifying the individual violations, in contrast to case management solutions[4]. This is motivated by the discussion in section 2.5, which notes that OCA as a third LoD activity does not focus on resolving individual results but on using the individual results to identify larger control failures and root causes.

Import and export functionality

OCA task details can be exported as Microsoft Excel files. Exported files contain a cover sheet which includes the audit procedures to be performed plus the table with the potential violations identified in the OCA task. This export allows auditors to work in a tool they are already used to, which can be helpful especially for OCA tasks with a large number of potential violations, as auditors might be more used to the filtering and sorting features of Microsoft Excel than the ones built into the CA front-end system. The export functionality can be disabled on a per-task basis for confidential task data, ensuring data security requirements can be met.

[4]Such as IDEA CaseWare.

Figure 7.11: Audit form for the Ongoing Control Assessment. The audit forms provide detailed information for the potential control violation to be evaluated as well as a checklist for the audit procedures to be performed.

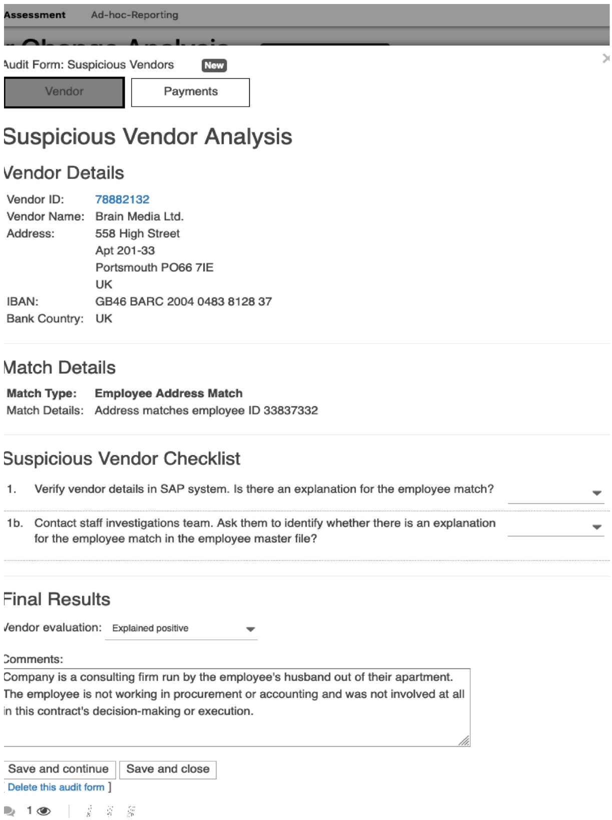


Figure 7.12: Ongoing Control Assessment task in the dashboard. Each task comes with an explanation of which analytics have been performed and the audit procedures the auditor needs to perform on the data points. At the bottom you see the integrated quality assurance process, where the responsible auditor will mark the task "Done" after all work has been performed and the audit manager can then mark it as "Reviewed" after quality assurance has been performed.

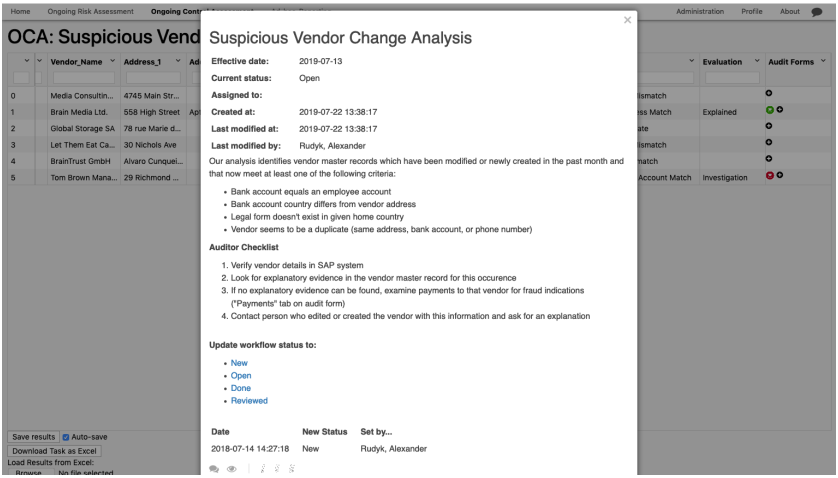
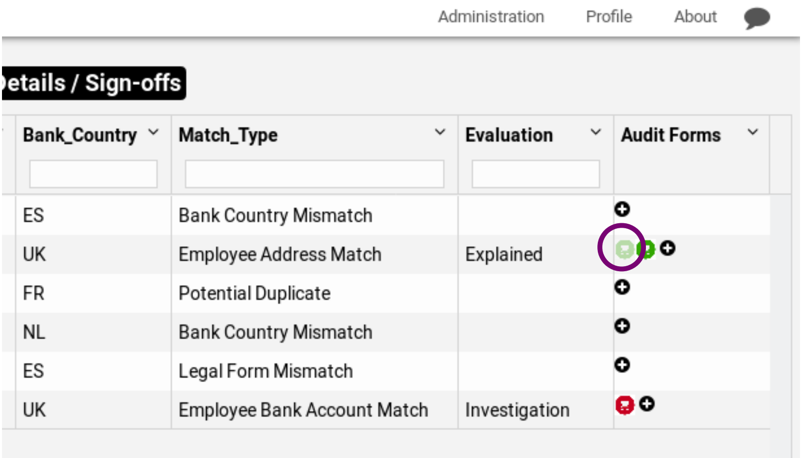


Figure 7.13: Audit form from a prior period. Such audit forms are shown using their icon in a greyed-out color (the icon within the purple circle). The user can click on this icon to see the content of the audit form as it was prepared in the prior OCA task. This way, information collected for other or prior OCA tasks can be re-used and repeat issues do not have to be analyzed multiple times.



The auditors can record the summary conclusions directly into the exported Excel spreadsheet and can subsequently re-import this spreadsheets with their conclusions into the system. This ensures that this data is not lost for the feedback loop the system is supposed to enable.

Enabling user story 5.1 (possible to start small), the full completed OCA task with the original data plus the conclusions and all audit forms can be exported in HTML or PDF format. This enables a smooth transition from an existing, "classic" electronic working paper solution to the new CA front-end system: it is possible to stark working in the new system for some OCA tasks, while using the PDF export at the end to document the work performed also in the classic working paper system.

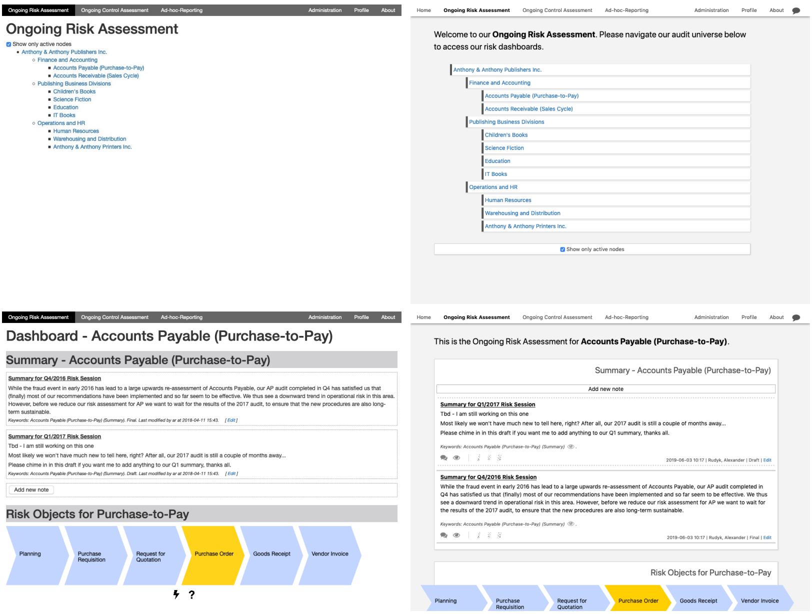
7.2.4 Interaction Features and App-Inspired Design

The first interviews indicated that while people liked the new system and saw it as a big improvement over prior processes, it was still often used only prior to the quarterly meetings where the CA results are being discussed and not on a really continuous basis. At the same time, audit managers indicated that they believe a more continuous usage would be desirable, highlighting the need to focus on continued use ("continuance" as defined by Bhattacherjee, 2001). Interview partners suggested that social-media-like features such as commenting, voting, "likes", and a newsfeed of interactions and new elements would increase continuous use, as would a more modern design ("it needs to be fun to use"). One audit manager commented:

> Yeah, it is funny, the people can be on the phone all the time, they can do WhatsApp all the time; *this* kind of information, they get it and then immediately redistribute it again. And actually they would need to do exactly that. I have an information, oh, it is relevant, ok, I redistribute it internally to the right place.

These are ideas that can also be found in the literature (e.g. Hsu & Lin, 2016; J.-W. Moon & Kim, 2001; Pöyry, Parvinen, & Malmivaara, 2013).

Figure 7.14: ORA features in the CA front-end system in the version prior to the redesign (left) versus the Material-Design-inspired version after the redesign (right).

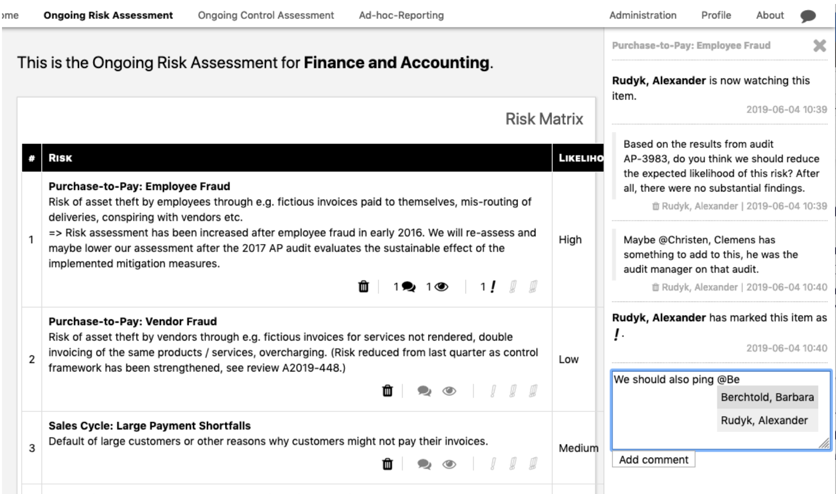


Gehrke and Wolf (2010) have evaluated a similar newsfeed in the context of a community for user-generated audit content.

This is why as part of a large release in the second half of the case study, the system has been completely redesigned (inspired by Google's Material Design; Google, 2019, see Figure 7.14 for a comparison) and new social features have been introduced. All interactions can be performed on any note, ORA risk item, OCA task, or audit form in the system (see Figure 7.15):

- Comments can be added to these elements, to discuss specific items among the auditors and with audit management. These comments can

Figure 7.15: Social interactions can be attached to any note, ORA risk item (pictured here), OCA task, or audit form. The interaction buttons below the risk open the interaction sidebar (on the right), where comments can be added. At-mentions can be entered using autocompletion (bottom right).



also be used for quality assurance discussions.

- Every user of the system can rate elements by importance on a scale from one to three exclamation marks. This can give writers of notes or risk items a “crowd-sourced” indication of how important others judge these inputs.

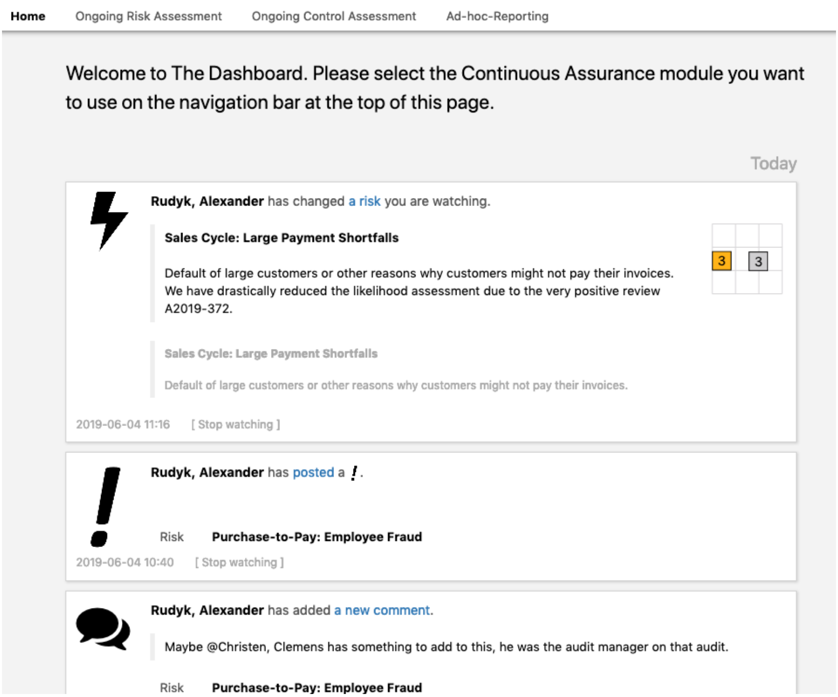
- Every user can “watch” any of these elements. New elements will automatically be watched by the user who created them. Any changes, comments, or other interactions with a watched element will be mentioned on the newsfeed of the watching user.

- In comments it is possible to “at-mention” a user by entering the at-symbol (“@”) followed by the name of the user. If a user is at-mentioned this way, the discussion will appear on that user’s newsfeed. This way, another auditor who might have valuable inputs can be drawn into a discussion on a specific element.

In addition to these interactions on individual elements, it is possible to watch entire keywords (or combinations of keywords) as well as entire risk matrices. This way, any new note or risk item or changes to existing risks in the risk matrix will trigger a notification in the watching user’s newsfeed.

The newsfeed is displayed prominently on the main entry page of the OCA front-end system, so that it is visible for every auditor whenever he or she accesses the system (see Figure 7.16). In addition, it is possible to subscribe to an RSS feed (e.g. in Microsoft Outlook) for new newsfeed entries. The aim of these social features is to motivate auditors to access and interact with the system and to increase communication about risks and developments within the organisation. As a side-effect, it can also improve quality assurance (user story 2.6, support quality assurance conversations) and by encouraging users to see ORA as a truly ongoing effort, it also aims to support user story 4.2 (support for agile auditing).

Figure 7.16: A user's newsfeed on the main page of the CA front-end system.



7.2.5 Built on Microsoft SharePoint

User stories 7.1 (does not require IT involvement) and 3.1 / 3.2 (data security, retention requirements) contain an inherent dilemma: if the audit function can install the CA front-end themselves, it will necessarily be outside of the firm-wide IT processes and governance which aim to ensure data security and adherence to retention requirements.

To solve this dilemma, the CA front-end system was developed on top of Microsoft SharePoint. In any organisation that already uses Microsoft SharePoint, it can be installed by the audit department themselves by simply copying the system code to a new SharePoint site. As it stores all its data in regular SharePoint lists and document libraries, access controls and retention settings from the organisation-wide SharePoint configuration apply. The system itself does not need to implement any user access control logic, thus avoiding the potential for mistakes and bugs. This also extends to system availability: the system itself only contains front-end code and does not use its own server infrastructure. This means that its availability is equal to the availability of the underlying SharePoint infrastructure and can leverage the redundancy and backup plans often already in place. Microsoft SharePoint runs "on-premise" as well as in cloud-based environments, making sure the system is compatible with a move towards cloud-based services.

This choice should also enable a more widespread use in a real-world setting. As Marks (2009b) notes, "justifying an acquisition for a product that will be used only by internal auditing can be tough for some audit shops [...]. CAEs are more likely to succeed by examining what is already available within their organization" (p. 37). Similarly, Hardy (2015) reports that decisions "were largely influenced and challenged by the types of business intelligence (eg. Oracle BI) and audit analytics tools (eg. ACL, IDEA) already used in the organization" (p. 4737). This is consistent with the survey responses on the importance of CA front-end system features, where the response "Built on existing IT platforms within your organisation" (EXISTING) was judged as "important" (ranked fourth out of nine proposed features). Microsoft SharePoint is a common enterprise platform, which has also been used by Microsoft's internal audit department for their CA solution (Ramamoorti et al., 2011, p. 48) and for research into online collaborative auditing (Eni, 2016).

For the technical implementation, the CA front-end system has been written in JavaScript building on the AngularJS 1.x framework orginally developed by Google[5]. While this framework has by now been superseded in popularity by its successor Angular[6] and Facebook's React[7], its wide usage particularly in industries important to internal auditing such as finance, insurance, and manufacturing (Allen, 2018) means that more IT departments should be comfortable with solutions built on AngularJS. The complete front-end consists of this AngularJS-based JavaScript code, plus various HTML templates and CSS stylesheets for the user interface design. Deployment tools have been developed that can merge the codefiles, directly deliver them to a SharePoint document library for development work and testing, and package them in a ZIP file for easy deployment to a dedicated SharePoint site. The front-end code interacts directly with the SharePoint REST API, so no specific server-side code had to be developed or deployed.

The choice to limit development to a client component without server modules does pose some practical challenges: restricting oneself to standard SharePoint list and libraries and the SharePoint application programming interface (API) means programming the system is far more cumbersome than it would be with its own back-end technology. It also limits what can be done, in particular regarding interactivity, as e.g. real-time push or email notifications are not possible without back-end code. All system logic runs in the Web browser on the client machine, which makes it difficult to employ e.g. machine learning algorithms if they cannot be offloaded to a back-end system. Nevertheless, building on Microsoft SharePoint seems to be a good choice for a tool that aims to enable collaboration on ORA and

[5] `https://angularjs.org/`

[6] `https://angular.io/`

[7] `https://reactjs.org/`

OCA processes, as SharePoint is primarily a collaboration platform.

7.3 Embedded in Overall Implementation Strategy

While this study focusses on the technical aspect of a CA front-end system, technology does not exist in a vacuum and a large body of research exists on the importance of looking at technology as part of wider socio-technological developments (Österle & Winter, 2003). This has been confirmed by the auditor interviews and the survey on CA adoption, which have highlighted that the most important factors influencing CA adoption are social, not technological, factors: re-engineering of audit processes and organisation, the right skills within the organisation, strong buy-in from stakeholders and robust change management.

Thus, this section will explain the overall implementation strategy that has been adopted by the case study partner for implementing CA and the CA front-end system developed in this work. The goal is to add sufficient context to be able to properly evaluate the case study results, not to provide a systematic evaluation of wider CA implementation strategies – for this, some research already exists (e.g. Kiesow et al., 2015) and further research can build on the work in this study (see section 9.3).

7.3.1 Re-Engineering of Audit Processes and Organisation

As discussed in section 4.1.1, CA can add more value if it is accompanied by a re-engineering of the audit organisation and the audit processes, accounting for the more dynamic and agile nature of analyzing risks and control effectiveness.

The case study partner has opted for an incremental approach to this, starting with only moderate process changes. During or before the case study, the following changes have been implemented:

1. The case study partner already has well-established, quarterly meetings within audit management to discuss the current risk analysis and changes in the risk environment that would warrant changes to the au-

dit plan. These quarterly meetings have been transformed into "ORA meetings", where the results from the (continuous) ORA are being presented by the auditors responsible for the nine audit areas of the audit universe. These results are being discussed, challenged, and subsequently consolidated on a firm-wide level.

2. With the introduction of the system, the ORA was explicitly turned into a continuous process. Prior to the new system, ORA was a quarterly process conducted prior to the risk analysis meetings discussed above and supported by forms which needed to be filled in on a quarterly basis. Now auditors are encouraged to record information they gather as soon as possible in the system for a continuous record of changes in risk assessments. As the quality assurance touchpoints remain the quarterly ORA meetings, however, this new expectation of continuous activity is not (yet) consistently met by all auditors (see section 7.1.1).

3. Prior to the case study, audit universe entity owners were responsible for the overall risk assessment of their audit universe entities, but separate auditors were looking at the data-driven ORA analyses which they also had to document separately. Now, these responsibilities have been consolidated with the audit universe entity owners, who can now record their qualitative analysis in the same system where they will also have access to and can interact with the data-driven analyses and visualisations.

4. OCA tasks are now being completed on a quarterly schedule, with a report (including findings) being produced by a designated auditor each quarter for the OCA tasks completed in the preceding period. This process change provides dedicated resources (planned just like regular audit projects) and a vehicle to communicate findings from and management's response to these OCA tasks.

During the case study, no organisational changes for CA have been implemented. This has in some areas lead to an experience that has also been mentioned by multiple of the interviewed organisations: without dedicated organisational resources, business auditors will treat CA as a “hobby” that will be worked on with lower priority than the regular audit projects. To account for this, beginning in mid-2019, after the completion of the case study, a new “Digital Audit” team has been formed which will combine dedicated business auditors and technical staff to move forward with CA and data analytics in the audit function.

7.3.2 Analytical Mindset and CA Skills

As discussed in section 4.2.1, the skills required to successfully implement CA was the factor mentioned most often by the interviewees regarding their CA efforts. This was supported by the survey results, in which the available skills are a significant driver of Effort Expectancy.

To address this challenge, the case study partner has initiated (at the same time but not as part of the case study) a training program for all auditors which covered three of the areas mentioned in section 4.2.1: data analysis know-how and an analytical mindset, business and industry know-how, and an understanding of the organisation-internal processes and systems. The fourth area, audit skills, has also before been mandatory for new auditors without sufficient audit experience and uses existing training programs from IIA Switzerland.

7.3.3 Digitalisation of the Organisation and CA

In section 4.2.2, a hypothesis has been developed that digitalisation of an organisation’s processes are both a prerequisite for effective CA (as only digital processes will provide the rich data trail CA depends on) as well as a challenge that can only be addressed by CA (as digital processes do away with the often paper-based audit trails classic sample testing depends on). This theory has been complicated by the results of the survey, which indicate that digitalised processes actually seem to make CA harder for the survey respondents (see discussion in section 5.5.1). Potential reasons could either be that digitalised organisations are in general more advanced, making further improvements more challenging (the “no low hanging fruits” theory), or a potential large number of “hits” these large data sources might create (the “overwhelming” theory).

At the case study partner, many digitalisation initiatives were ongoing during the course of the case study. As most of them did not finish by the end of the case study, it is difficult to identify their effect on the CA initiatives. The case study partner did complete a big digitalisation initiative for their investment advisory processes, however, and the effects in this area followed the “no low hanging fruits” theory: as many controls were automated and embedded within straight-through digital processes, the overall control framework improved. However, most existing continuous auditing analyses had to be turned off as they were no longer relevant or necessary.

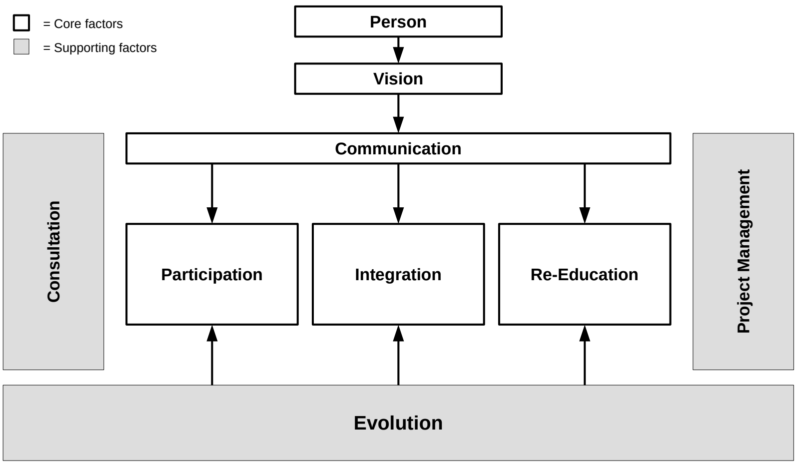
7.3.4 Change Management

Section 4.3.4 highlights the need for effective change management in rolling-out CA, the effect of which on the Social Influence antecedent has been confirmed by the survey results.

For the case study, established strategies from the change management literature have been evaluated and applied. Lauer (2014) builds on the change management model from Lewin, Cartwright, Lang, and Lohr (1963) to propose a set of success factors (see Figure 7.17) that enable successful change:

- A *vision* has been established with the CAE, who was involved in the early communications around the project, showing the auditors that he supports and drives the move towards CA.
- *Participation* of auditors was realized by establishing the case study partner’s approach to CA through a working group that included auditors from all audit areas and different hierarchical areas (this happened prior to the case study). After the roll-out of the system, auditors were

Figure 7.17: Change management sucess factors and their interactions (English translation from Lauer, 2014, p. 82).



encouraged to provide feedback and suggest changes and improvements to the system, which was supported by a prominent “feedback” button that allowed users to directly provide feedback from within the system.

- *Integration* was not a major factor in this change management process, as no organisational change was initiated during the case study period (see section 7.3.1). It will, however, be a necessary component for the re-organisation that created the new Digital Audit team but occured after the case study end date.

- *Education* about the new system and the accompanying processes was achieved through on-site trainings of all involved auditors (for the initial roll-out and the roll-out of the redesign and social features in the second half of the case study). For the OCA functionality, the auditors involved in OCA activities where trained separately. Training materials were prepared that detailed the functionality of the system. All newjoiners in the audit department get a week of onboarding training which also includes sessions on CA.

At the conclusion of the case study, all the interim feedback was analyzed and combined with a final round of interviews to identify the impact of the developed front-end system on CA adoption and to establish how the different initial design decisions were judged by the front-end system's user base. This plus comparing the final system to the initial user stories served as the basis for its summative evaluation.

Table 7.1: Topics of the feedback received using the feedback tool integrated into the system.

1. An e-mail notification with changes in the system would be helpful (1x)
2. Integration of a "risk map" that would highlight gaps in the audit coverage across the audit universe (1x)
3. Search function across the audit universe (5x; this functionality was in fact available but not visible enough)
4. Full-text search should highlight the search term where it was found (1x; implemented during the study)
5. Risk items in the risk matrices should support formatting (1x; not implemented as a design choice in order to reduce complexity)
6. Audit forms should close automatically after being saved (1x; implemented during the study)
7. Audit form date and author should be displayed in the OCA tasks tables (1x; implemented during the study as mouseover due to space constraints)
8. "New note" button is not visible enough (1x, after the redesign; work-in-progress)
9. It should be possible to include tables when adding notes (1x; work-in-progress)
10. Bug reports (3x)
11. General praise for the system (1x)
12. Specific feedback on individual content items (4x)

Chapter 8

Summative System Evaluation from Case Study

As discussed in section 3.2.2, a systematic evaluation of the designed artefact is a necessary step in DSR, covering the “Rigour Cycle” discussed by Hevner (2007). This project follows a “Human Risk & Effectiveness” evaluation strategy, as proposed by Venable et al. (2016). During the system design and implementation, this strategy was realised with ongoing evaluation as part of the agile system design, based on user observations and intermediary discussions with the case study partner (see section 7.1). At the conclusion of the case study, both a naturalistic, summative evaluation and an artificial, summative evaluation of the final artefact have been conducted:

- A naturalistic evaluation looks at the artefact “in its real environment, typically within an organisation”, embracing “all of the complexities of human practice in real organisations” (Venable et al., 2016, p. 81). For this, the usage patterns with the final artefact have been observed among the about 50 auditors of our case study partner which were using the artefact as part of their work (see section 8.1). Final interviews have been conducted with audit management and select auditors, with a focus on their experiences and on how the new system has influenced their continuous use decisions, their efficiency and effectiveness, and their acceptance of continuous auditing methods (see section 8.2).

- An artificial evaluation may be “empirical or non-empirical (e.g., logical/rhetorical)” (Venable et al., 2016, p. 80). For this study, the artificial evaluation chosen will be a comparison (see section 8.3) of the final design product, the implemented artefact, against the initial design goals, which are presented in Chapter 6 in the form of user stories with acceptance criteria. Differences may indicate a failure in the design or implementation process (implementation of not needed features or lack of implementation of required functionality) or they may indicate changes in the understanding of what the users need as part of the design and implementation process (a process which is supported by the agile development methodology). Note that changes in the understanding of what the users need might have implications on the theories that underpinned the original user stories (see section 8.4.3).

8.1 Real-World Usage Data

During the case study period of approximately one year, from May 2018 through June 2019, 1'636 notes have been created by 50 unique auditors in the ORA section of the system[1]. Eight "heavy user" auditors are responsible for a bit more than 50% of all notes, however 36 auditors have authored at least 10 notes, indicating regular usage (see Figure 8.1).

The distribution of authored notes over time (see Figure 8.2) shows what has also come up repeatedly during the interviews conducted (see section 8.2): a relevant number of auditors primarily added notes prior to the quarterly "ORA meetings", which the case study partner held to discuss the summary findings from last quarter's ORA work. In general, the number of authored notes per week shows a (relatively small) linear upward trend. Unfortunately there is not yet enough data available to identify whether this is a general trend or is caused by the re-design of the system and interaction feature roll-out in May 2019 (see section 7.2.4).

Of the 1'636 notes, only 86 notes were created on individual data points within the system's data visualisations and timelines. Note, however, that data visualisations had been defined for only 12 of the total 63 auditable entities within the system. On the auditable entities with data visualisations, 86 (19%) out of 461 notes were created on specific data points.

[1] All figures quoted exclude activity in the system by the researcher. Also note that due to employee turnover, those 50 auditors have not all worked at the case study partner at the same time.

Figure 8.1: Auditors that have used the system by number of notes authored during the case study period. Each bar represents one auditor, ordered by the most to the least active in the system.

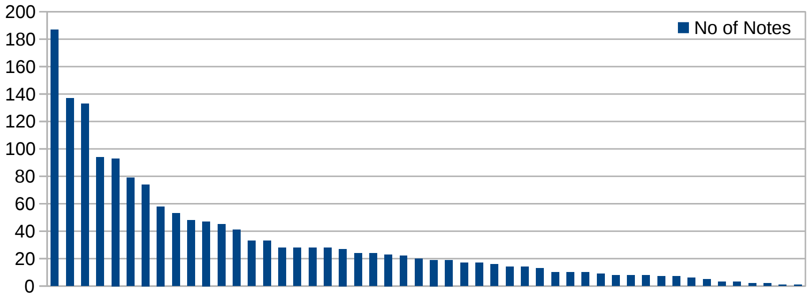
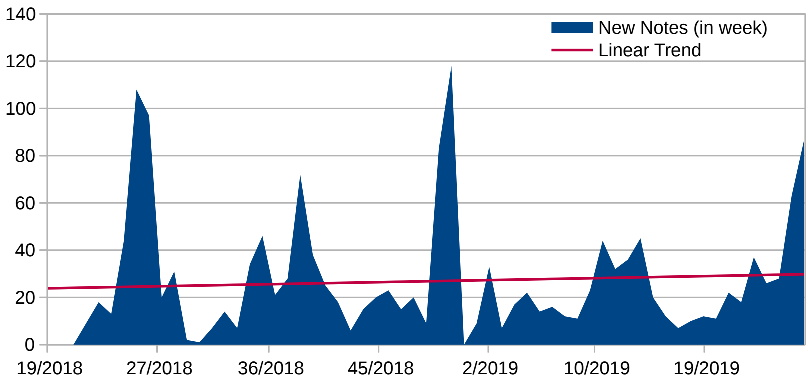


Figure 8.2: Number of new notes created per week, with linear trend line. Note that note creation spikes prior to and during quarter end dates, after which the case study partner held quarterly "ORA meetings" to discuss current developments.



Unfortunately, visits to the different dashboard pages were only logged very late into the case study, after the feature had been implemented and consent had been obtained from the system users. Thus, the number of visits are only available for a two-month period at the end of the case study, from May 6th to July 5th. During that period, 4474 visits were recorded in total (see Figure 8.3). The days with little to no usage correspond to weekends and public holidays (the auditors can access the system remotely, however, which is why there is some observable weekend activity). Two spikes can be observed: one spike occured on May 9th, which was the day after the new version of the system which included the re-design and interaction features (see section 7.2.4) was released and presented to the auditors. The second spike can be observed at the very end of the observation period, July 4th and 5th. These days correspond to the period immediately prior to the quarterly “ORA meeting”, at which the case study partner discusses the results from the ORA and whether these should lead to any changes to the audit plan. The 14-day moving average indicates a steady increase in the usage of the system during the period. Due to the small time window and the effect of the ORA meeting it is unclear, however, whether this constitutes a permanent increase in usage due to the new features released at the beginning of May or is just a temporary phenomenon.

Figure 8.4 shows the distribution of total visits to the system during that period by auditor, with each bar representing one auditor. While there clearly are some heavy users, overall system usage is distributed across a wide range of auditors. Different usage patterns correspond to different individual working patterns but also to different roles: some auditors have to analyze multiple auditable entities or are responsible for the “business areas” which are higher up in the audit universe hierarchy and/or need to conduct one or more OCA tasks, while others are only responsible for a single or no auditable entities and no OCA tasks, decreasing their need to use the system.

After the update on May 8th, 2019, the system users could add “inter-

Figure 8.3: Number of visits to the system over time for the period from May 6th to July 5th, 2019.

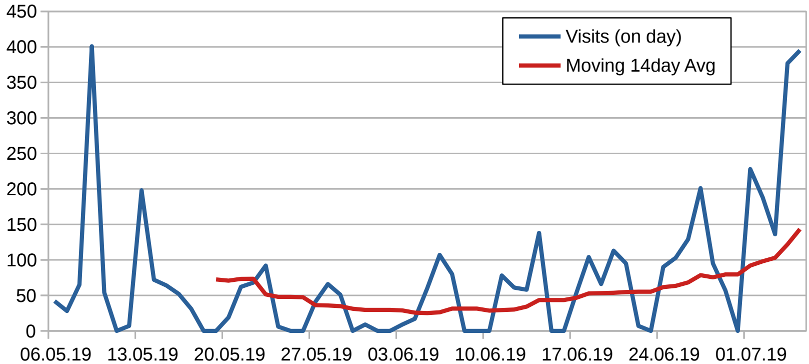
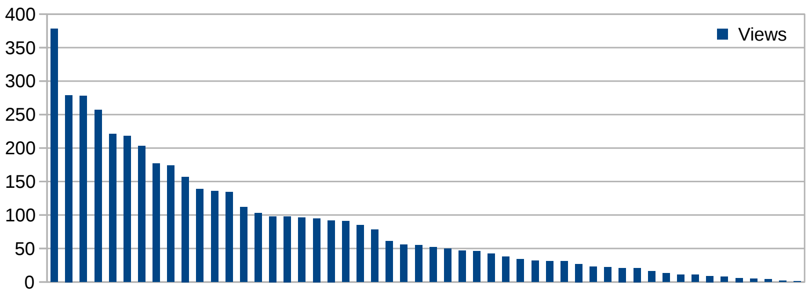


Figure 8.4: Distribution of total number of visits to the system from May 6th to July 5th, 2019, per auditor. Each bar depicts the total page visits during that period for one individual auditor, with the auditors using the system most frequently being shown first.



actions" on elements such as notes, OCA tasks, audit forms, or risk items and could add subscriptions for specific keywords or risk matrices. From then until July 5th, 427 interactions have been added in total. However, almost all of them have been triggered by the system as a creator of a new element in the system would automatically watch that element. Only about 20 interactions were explicitly triggered by the corresponding user.

8.2 Post-Implementation Interviews

For the conclusion of the case study, semi-structured interviews with nine auditors at the case study partner have been conducted, covering the whole management team (the CAE plus four Audit Area Heads), the new Head of Digital Audit, the Head of Management Support and two auditors who were highly involved in ORA and OCA preparation and completion. The interviews were structured along the hypotheses to be tested (also see section 8.4.1) and along continuous use theory, validating whether the interviewees' expectations were met, whether they plan to continue to use CA and/or the implemented front-end system and how this and the acceptance of CA has changed following the implementation of the CA front-end system.

Overall, all nine interviewees judged the implementation of the CA front-end system a success, with differing reasonings (see section 8.2.3). All interviewees confirmed that their expectations were met or exceeded and that they want to continue (and in most cases expand) the use of CA in their internal audit activity. Regarding the design choices made, interviewees were generally more favorable towards the ORA components than towards the OCA implementation (see section 8.2.1). The social interaction features which were added based on user feedback (see section 7.2.4) did not seem to have the anticipated effect, with some respondents arguing for further usability improvements.

8.2.1 Design Choices

The Dashboard was designed and implemented based on certain design choices as detailed in section 7.2. In general, the final interviews indicated that the auditors were content with the choices made, in particular with regards to the ORA module and the choice of building an end user application based on Microsoft SharePoint. For the OCA module and the system's UI/UX, some auditors called for additional improvements. Some wishes discussed in the interviews also pointed to the limits of the chosen implementation strategy: data drill-downs and on-demand analytics would require implementation or inclusion of a full analytics engine instead of loading static CSV files with analytics completed outside of the system. And a more push notification-based approach would require a server component that could send out customized notifications through different channels.

Table 8.1 summarizes the various pros and cons mentioned by the interviewees for each design choice, which are discussed in detail below.

Table 8.1: Summary of the pros and cons of the different design choices made according to the case study interviewees.

Design Choice	Pros	Cons
Data Sources The Dashboard flexibly loads standard CSV files generated by existing analytics instead of implementing its own ETL processes and/or requiring its own data standards.	(+) Enabled integration of existing analytics	(-) Does not enable drill-downs to raw original data (-) Does not enable (re-)defining analytics on demand by the user
Ongoing Risk Assessments The Dashboard implements ORA as specified by Ames et al. (2015b) in a dedicated module. It combines recording of qualitative information ("notes") with annotated data visualisations and links both to risk matrices for qualitative risk aggregation.	(+) Having everything (quantitative + qualitative) in one place (+) Having old data easily available (+) Accessible to all auditors, they can collaborate (+) Qualitative risk aggregation (+) Is being used as it does more than just presenting information (+) Interactive, zoomable visualisations (+) Data annotations on visualisations (+) Qualitative aggregation is right approach (for now)	(-) Lack of workflow support for process & QA (-) Lack of data drill-downs on visualisations (-) Long-term a quantitative aggregation might be preferable (-) Charts without interpretation (thresholds, limits) might lead to information overload (-) Friction to add notes is still too high for some (better desktop integration necessary) (-) Some argue for more structure, metadata on notes

Table 8.1: Summary of the pros and cons of the different design choices made according to the case study interviewees.

Design Choice	Pros	Cons
Ongoing Control Assessments The Dashboard implements OCA as specified by Ames et al. (2015b) in a dedicated module. OCA tasks can be assigned to auditors for completion and the work performed and any conclusions reached can be recorded for each identified exception. Performed QA can be recorded and all results can be exported.	(+) All in one place, more visible (+) Feedback loop resurfaces audit conclusions from prior tasks	(-) Alarm floods still an issue, lead to monotone work (-) Not integrated with AMS, duplication of documentation effort
Interaction Features and App-Inspired Design Based on initial user feedback, the Dashboard implements interaction features where users can “watch”, “highlight” and comment on ORA notes and risks and OCA tasks. Updates are pushed to a newsfeed on the homepage. The design has been based on Google’s Material Design for a refreshed, more “app-like” experience.	(+) New design is being appreciated as improved (+) Interaction features might be more appreciated by younger auditors	(-) Engagement with the system was not improved by new interaction features (-) Interaction features might put off less social-media-affine auditors (-) Further usability improvements feasible

Table 8.1: Summary of the pros and cons of the different design choices made according to the case study interviewees.

Design Choice	Pros	Cons
Built on Microsoft SharePoint The Dashboard is built as a pure browser-based front-end application which can be installed on any standard Microsoft SharePoint server. It does not have its own server components. This means it can be installed by the internal audit activity without IT involvement while still benefiting from SharePoint's enterprise security (access controls, backups etc.).	(+) Enabled the project to produce results in a short period of time (+) Enables easier, more timely improvements and experimentation (+) Data security is ensured by Microsoft SharePoint	(-) Limits ability to implement drill-downs and on-demand analytics (-) Limits ability for push features such as email notifications (-) Implementation as end user application means the internal audit activity needs the expertise to maintain the system

Data Sources

The possibility to load analytics results in CSV format into the system meant that the existing analytics developed by the case study partner could easily be included in the ORA and OCA modules. Thus, while it enabled the overall project, this design choice was a prerequisite behind-the-scenes and not visible functionality, and was thus not mentioned by the interviewees.

A problem with this approach was mentioned by three interviewees, however, which argued for a "drill-down" functionality and more interactivity that would allow auditors to use the CA front-end to drill down from the aggregated statistics presented as part of the ORA to individual data items:

> "Of course it is nice if one can access the original data, there it should be possible to do a drill-down. I think, if we... that's certainly the biggest weakness of the dashboard, that it is more or less a static view, that does not allow a drill-down to the data. Because it is not based on a BI platform." (Interviewee 2, translated from German)

> "This would also be nice, if one could easily aggregate specific things and then also move from the aggregation down again to the individual trades and then also see them, the whole process chain..." (Interviewee 3, translated from German)

And, related to this, the possibility to directly define new analyses and aggregations in the system:

> "I believe it would probably have been better [...] to have a real BI tool, a flexible, interactive solution, where one can easily add things and remove them and create its own charts et cetera. I believe with that there would be real excitement for these analyses." (Interviewee 4, translated from German)

Such a drill-down and dynamic analytics functionality would require access to the raw data, however, and would thus need data interfaces and analytics that go beyond the static CSV imports currently implemented, duplicating functionality of existing analytics tools. Alternatives to this are explored in section 8.2.3.

Ongoing Risk Assessments

The interviewees' comments on the ORA module were primarily positive, with some arguing for additional functionality but no one arguing for a return to the prior situation. In particular, efficiency gains due to the new system (see also section 8.2.3) and having everything in one place instead of scattered through multiple documents and files are seen as benefits:

> "More efficient, I would say. [...] Connecting the risks, that is also good. And what I find very good above all is that old items are in one place. If now, for example, someone is new in the team, they can read through the older items or we can also look at other teams, what has been entered there. That is good. From this point of view, more efficient, yes." (Interviewee 3, translated from German)

> "[...] Ongoing Risk Assessment is the topic that it now makes really massively easier. The structure for working is now of course ten times easier than before. There I use... earlier, prior to you doing that, I needed surely half a day or a day until I had aggregated everything, that was incredible. This eases a lot for me. That is a great thing. And it has also proven itself." (Interviewee 7, translated from German)

One interviewee stressed that what distinguishes the implemented front-end system the most from regular BI tools is its focus on the overall process and not just on presenting information to the user. By implementing the CA process within the system, it forces the user to engage with the data:

> "What certainly stands out is that the Dashboard has a real process view. And this is unique in this form in the organisation.

> At least I do not know of any other dashboard that offers something like this. Of course it is heavily customized for the use case we have, but all the other vessels that we use to bring data to the managers or the employees are only static, colorful, graphically enhanced data graveyards. So to speak data graveyard 2.0, and one can then look at those, but does not have too. And most of the people pick the latter. [...] Maybe there are a few that can get excited about this, but if there is not somehow a motivator to really engage with this one doesn't do it. And this is exactly the gap that is filled by this process view that you have implemented. One uses it necessarily as a work tool. And due to this it is really being done. So this is the unique selling proposition." (Interviewee 2, translated from German)

The focus on interactive, zoomable charts and other visualisations was positively recognized by six interviewees[2]:

> "The visualisations? Yes. Yes, those I find great. With the zooming, where you can zoom in and out, where you can show or hide individual data... [...] The visualisations, yes, those I find top." (Interviewee 1, translated from German)

> "I mean, they work very well, actually. One can also zoom in and out. [...] We can also set benchmarks, analyse the items and evaluate them. They are also relatively flexible." (Interviewee 4, translated from German)

Related to this, the possibility to create notes and annotations directly on each data element were explicitly highlighted by two interviewees:

[2]Note that the incremental roll-out of CA at the case study partner meant that some audit areas did not yet have any data visualisations on their auditable entity dashboards, thus not all interviewees were already exposed to these visualisations.

> “I mean, what has definitely saved a certain administrative effort is the possibility to capture notes that are then basically kept forever. Because this saves us from an examination what has happened in prior quarters and what one has somewhere in Excel or somewhere without any links.” (Interviewee 4, translated from German)

> “In particular this feature to add these data annotations that are then persisted. This is definitely valuable. It also meets the demand to document one’s analysis of the available information in one form or another. The evidence, so to speak, I have seen it, I have acknowledged it. And this I find extremely valuable and it also corresponds to the requirements.” (Interviewee 2, translated from German)

Two interviewees, however, mentioned that one risks information overload by just presenting a lot of data visualisations for each auditable entity. One interviewee noted that one should leverage technology to highlight only anomalous data points or data points exceeding certain thresholds to avoid getting lost in a “forest of charts” and to move from the currently implemented pull to a push approach:

> “I see the risk in that, well, if you replace the data graveyard with a forest of charts, than you have the same problem in the end. Probably... the path forward would be more to really move to an indicator-based form. Where not only the trend line is relevant, but where one also needs to think about thresholds and target bands and similar things. And this means to have this discussion a priori and not a posteriori. And we haven’t yet achieved this change of mindset. But there is no way around it. Because the more data you have, the more you have to aggregate it, and then the automaton comes into play which can tell you, ‘hey, the threshold has been breached three times, I will send

> you an email'. And then you get everything via push, not pull." (Interviewee 2, translated from German)

This question is also adressed in section 8.4.1, where the need for audit re-engineering is discussed. This is probably related to the concern voiced by some auditors that some analyses are too detailed and not on the right level of aggregation:

> "And then, when I told them that, they say: 'Well, but this is too detailed for me. Can't we aggregate this to a higher level? [...] I'm not interested in this.' I believe we still have some need there." (Interviewee 7, translated from German)

This is not strictly speaking directly an issue of the CA front-end system, which is agnostic to the analyses being presented. However, it is possible that it would be easier for auditors to design more high-level aggregations if they would know that it were possible to drill-down to lower levels as necessary, which could be an enhancement of the CA front-end system as discussed in section 8.2.1.

The CA front-end system implements a qualitative approach to risk analysis and aggregation: auditors collect information and conclusions from various sources – including the data visualised within the system – as notes and use impact flags and summaries to aggregate these notes towards higher-level risk items which are placed on impact-likelihood risk matrices. The interviewed auditors generally argued that this qualitative approach was the right approach, at least at the moment, with seven interviewees supporting this approach:

> "I believe this is the right approach [...] Some say it needs to remain a qualitative thing in the end and it needs a judgement and you have – as support, as service – a certain data monitoring, I have other sources of information, but all of this I then still need to acknowledge. And there the expertise of the expert comes into

play. And me, I am also of this opinion. I do believe that this needs to be the way forward. Today we are not yet ready, I believe – and I am also not sure if one will ever be ready – to be able to make really valid assertions based purely on quantitative data aggregation." (Interviewee 1, translated from German)

"Then you would have maybe 100 indicators, and then you would apply them to all areas... I do have the feeling that it was the right path at the moment to use qualitative and human professional-judgement-based aggregation and not everything only with quantitative figures. [...] One gets an information, but this information doesn't really say anything. And this is something I want to avoid. That's why I prefer to have a human go through this and explain what this now means for us. And then you really need to think. We now also have interesting discussions from quarter to quarter." (Interviewee 5, translated from German)

However, some auditors argued that when data quality and KRI maturity improve in the future, a quantitative approach might become feasible and superior:

"Maybe this will change one day, when one further advances technologically there. But currently I think that the qualitative approach with the augmentation of data is still the more practical path. Currently." (Interviewee 8, translated from German)

"The [qualitative risk aggregation] is definitely the easier approach. [For a quanitative risk aggregation] one would also need to ask whether we need to do this alone. Or if this would not rather be a task for some kind of combined governance, risk, compliance function. [...] It then becomes more of a medium or long-term initiative." (Interviewee 9, translated from German)

For the qualitative risk aggregation, the interviewees appreciated the support the CA front-end system provides to aggregate information from individual notes to risk items on the risk matrices by a) connecting them using the "impacts" functionality and b) the summary notes which are automatically shown both on the auditable entity level and on the superordinate audit areas:

> "This in particular helps me of course to easily get an overview. And to see from these different [auditable entities]... also that the people have the possibility to mark something as 'this is particularly important, please note this when you do your summary'. And then these items are forced upwards to me. They make a summary over their [auditable entity], that I can then see immediately and have available." (Interviewee 1, translated from German)

> "I have to fight my way through less. I can really trust a bit what they have already highlighted." (Interviewee 6, translated from German)

However, what is lacking in the system is a way to support aggregating risks from lower-level risk matrices to higher-level risk matrices, which at the case study partner is needed for aggregating risk items on the audit area level to the overall organisation:

> "We use the Dashboard to obtain at the end the top risks on the organisational level. And these top risks we have then always included in the reports with a graphic. But, if one is honest, this is a gimmick. [...] [Audit management] moves all, not only their own but all risks a bit [...] and thus it is no longer, so to say, scientifically deduced but in the end it is just manual input that plays into this a lot. [...] Until the audit-area-level the way we do it works well. There it makes sense for me. And in the end

> these [organisational level] top risks are being added on top. And there, this transition is not sufficiently clean to me, it is just a lot of judgement." (Interviewee 8, translated from German)

> "What we would need to think about is the step from the audit areas up to the organisational view. Can we do this... at the moment this does not follow a structured process on how to further aggregate these risks. The path from the risks we have on the organisational level to the risks in the audit areas is not transparent at the moment. Can we do something also on the technical side to maybe support this even better?" (Interviewee 1, translated from German)

A lot of research already exists on this topic (e.g. Abbate, Gourier, & Farkas, 2009; Chavez-Demoulin, Embrechts, & Nešlehová, 2006; Giacometti, Rachev, Chernobai, & Bertocchi, 2008) which could be applied to this potential future development step for the CA front-end system.

Four interviewees highlighted the benefits of now having everything related to ORA – notes, data analyses, and risk matrices – in one place instead of the information being dispersed over various Word, Excel, and PowerPoint files and of being able to collaborate in one place:

> "Just simply by really having a tool that everybody uses together, where the information is in one place and where you also see what the other one has... thus, this collaboration, actually, I find really valuable." (Interviewee 1, translated from German)

> "It's also more transparent really, what the people are writing, because you have the information in one place. [...] Yes, it is a communication platform in that sense. Where you can have a discussion about or can also tell people, hey, this has happened in the world." (Interviewee 6, translated from German)

This was repeatedly stressed as a big benefit, also in combination with the increased access for all auditors to this information. The single point of access for all auditors across all ORA information was seen as positively increasing transparency and traceability of the ORA process:

> "If I imagine how this was before, with permanent files and a lot of paper and ad-hoc-requests, one would certainly never have the transparency across the topics in their full breadth. I mean this has surely also for the [audit management team] an enormous added value." (Interviewee 2, translated from German)

> "You know this is the information that is being referenced. The traceability is really much better. You do not have to enquire about it as often." (Interviewee 6, translated from German)

> "You have the complete overview. And you can exchange information across audit areas. Everyone can look at it. And I believe that this is moving one forward." (Interviewee 5, translated from German)

The implemented ORA module by design does not enforce a lot of structure: in particular, there is no workflow where users would have to confirm that they have performed their work or quality assurance. Four interviewees have asked for better workflow support:

> "The QA process, this is a topic one should look at again. How exactly could one implement or document a QA process. [...] For the data monitoring it is always difficult for me to know what is the current status. What have we already looked at and what have we not looked at yet. Would there be a possibility... I don't know, quarterly... I mean, my people perform the monitoring quarterly, and if there is something interesting they just document it on the data elements, they comment on the anomalies. But a documentation, where I then see that data monitoring

for the quarter has been performed, and overall, a summary, a conclusion, 'no material results, this is something exciting I have seen', this I don't have anywhere. This would help me in my role to faster see... to draw a summary, a conclusion." (Interviewee 1, translated from German)

"I believe that the process behind it, somehow a systematic processing of all sources, and then collecting this in one place, this is, well, for the success of the ORA also very important. And this is maybe something where one could think about whether to add a workflow for the ORA process. You know, like, these are the sources, that one could maybe automatically... well, it works like this, [...] over email every [auditable entity] owner gets delivered his or her items and then they have to process them. And of course one could also do this in the Dashboard. I find this to be very important." (Interviewee 3, translated from German)

"That one would somewhere at the top have a complete overview. Even if it is small. Where he then sees: where am I within the process. And where he also sees what will happen afterwards with the information, more or less. Simply... even when it is also a bit graphical. Where he sees, ah, here I am right now. And maybe they could even click into it and see directly what has happened with it. [...] I think, like a timeline or process-wise, that he easily sees, here I am right now. I believe this could really help to internalize it a bit." (Interviewee 6, translated from German)

"'What exactly do I have to do here?' They are somehow missing how it moves on from there... [...] Somehow like a user manual." (Interviewee 7, translated from German)

Related to this, it was a conscious design choice (see section 7.2.2) to keep notes as simple as possible, and they are implemented as simple open text fields without any metadata fields to be filled in (except for the keywords functionality). However, three interviewees have asked for more structure in the ORA documentation, meaning templates or structured metadata for the notes and content to be added by the auditors:

> "And then if one writes somewhere one has some... a digitalisation risk or something. Then it would be interesting to find out whether one has such a risk also in other areas. And you could use text mining for this. And for this it would be nicer if you could already say you find certain keywords in the risk section. To have a certain guidance there about what to record. [...] Today in the end it is only text that is being written down. And not the structured content that we would actually already know from our audit reporting." (Interviewee 6, translated from German)

> "After we have dropped this, the people have been a bit lost. And then they didn't really know anymore, well, what shall we write down here. I think, maybe it would help the people if we would have that again. A bit of structure. It would then also maybe be a bit more consistent for the complete overview." (Interviewee 8, translated from German)

> "Well, for me it would probably be better if one would always also have to enter as metadata – this is maybe a specific improvement – which meeting minutes, which sources, which date. This is just an entry one has to make. And only afterwards comes the actual information. And then one can sort based on this information. But I know very well that people don't like to work like this. Because if you have to enter information and in addition to this ten or twelve metadata fields, the people don't like that." (Interviewee 5, translated from German)

In addition to this, various other enhancements have been proposed for the note-taking functionality: One interviewee mentioned that he isn't adding notes right away because he doesn't want others to see his in-progress thoughts and all notes are instantly public within the audit department. He would thus benefit from a 'private' status for notes, which would hide the note from everyone else until it has sufficiently matured. Multiple interviewees have mentioned that some auditors are still gathering notes in their own tools (e.g. Word documents, Microsoft OneNote) and are only copying them to the system when asked to do so. The reason for this seems to be that these tools are always open while opening the Dashboard to add new information increases friction. A possible solution would be to implement a note clipping tool as provided by Microsoft OneNote[3], which however would increase IT complexity by requiring a software to be installed locally on the auditors' systems. Some interviewees (and also intermediate feedback) have requested more options to filter and sort notes. At the moment, notes are always sorted chronologically descending by last modification date. Filtering is possible full-text and based on keywords and note status, as these are the only fields available – additional filtering capabilities would thus also require additional metadata.

However, as has been acknowledged in the last quote, all such demands need to be balanced against the increase of complexity and friction they impose (especially mandatory new metadata fields will increase the friction to add new content). At least the demand for a documented workflow support is, however, also supported by the emphasis the IIA Standards place on ongoing, documented in-process quality assurance (IIA Standard 1300, IIA, 2017a, and related guidance).

Ongoing Control Assessments

While the interviewees all agreed that the CA front-end system added value for ORA, the OCA module received both less attention in general and also

[3]See `https://huit.re/tcbRH_p6` under "Create a Quick Note when OneNote isn't running".

less excitement when explicitly asked about. Most users did not see a large improvement over the previous Microsoft Excel sheets.

This was probably also due to the fact that one of the main proposed benefits of the OCA module, the feedback loop that allows the system to learn and auditors to immediately see past audit results on re-appearing data elements, was not yet visible for most users as only three OCA iterations were completed during the case study, leading to few re-appearing data elements. In fact, one auditor who already did observe re-appearing data elements was much more positive about the OCA module:

> “Where it has exceeded [expectations] is surely in the Ongoing Control Assessment, simply because it has the functionality [...] that one has a backwards check with certain items. And that you also have this within the same runs, if there have already been cases.” (Interviewee 4, translated from German)

Some interviewees have noted that OCA as a process is not something the auditors like to do, that in its current implementation it is painful and monotone work as it means mechanically evaluating a large number of (mostly false) hits:

> “I mean if I look at certain [OCA tasks] that are defined today[...] With the amount of false positives it is of course, at least in my perception... for certain business auditors it is actually a punishment if they have to go in and process the individual hits. This is so to speak Audit 1.0 dressed up as 4.0. Instead of dossiers I go through a list of hits and of course for the creative aspiration one has as an auditor... you don’t get much of that.” (Interviewee 2, translated from German)

This ties in directly with the negative effects of “alarm floods” already observed in the literature (see section 4.2.3). Based on the interviews and other observations, it is the researcher’s understanding, however, that this perception varies greatly between different audit areas and OCA tasks. Some OCA tasks are well-defined and yield few or no false positives, while others require further work in better specifying their goals and the underlying ruleset. The CA front-end system has implemented two approaches to help with this: firstly, the results for past OCA runs can be analyzed and used to manually identify rulesets in need of improvement. Secondly, the CA front-end system implements a machine learning component that can learn to identify false positives from past OCA results. However, neither of these were actually applied during the case study due to its limited duration and the necessary amount of past training data to be gathered. Thus, it remains unclear (and an area of future research) whether the CA front-end system could actually help mitigate these concerns if given sufficient time.

Some interviewees mentioned that they deem ORA more valuable than OCA in the CA context, again mentioning that the OCA tasks as currently implemented are not as automated as one would like:

> "From my point of view the value added of the Ongoing Risk Assessment is larger than of the Ongoing Control Assessment, I believe. The Control Assessment[...], it is surely in a gray area reagrding what is our task and what is the second line. [...] Frequently in practice it is not that ongoing... you develop it, and then you do it once, and then you bring up a finding... and the latest after two or three times, if you come every time and tell them, well, we have seen this again and again... At some point either the business sees it as well and says 'thank you, we do something', then you can switch it off again. Then you don't need to continue it ongoing. Or the [organisation] says, 'yes, nice that you come to us every quarter with that, but I am not interested in it'. And nothing happens. And then you also need to ask yourself, what do you do with that? Do you continue every quarter, and every quarter I come with my findings and no one is interested...

> [...]
>
> Except where the controls work well. [...] But there as well you need to ask yourself at some point, if you have monitored it for two years and you always have, every quarter works well, then you also have to ask yourself... Well, if you have done it cleverly and really data-based and it doesn't generate any [manual] effort for you, and you just get every quarter assurance again, yes, the control still works, there are no hits. Yes, this would actually be... this is where it would need to boil down to. This would be a good thing." (Interviewee 1, translated from German)

All interviewees spent far more time discussing the ORA component than the OCA component, again suggesting that they attribute more significance to the former than to the latter in their internal audit activity. One possible explanation for this is that OCA has not yet reached full maturity at the case study partner, a topic that is also explored in section 8.4.1 and supported by the quote above.

One commonly mentioned downside of the OCA module in the CA front-end system is that it does not tie in with the audit management system (AMS) in use at the case study partner[4]. As the internal audit activities uses the AMS to document all audit work, this means that OCA results need to be manually exported from the front-end system and then imported into the AMS, resulting in additional, avoidable work to be performed. This has been partially mitigated by providing an export function from the CA front-end, but it is still annoying for the auditors:

> "If we run the Ongoing Control Assessment in there, then we still need to improve. Because this is a bit[...] The problem is actually, the link into [TeamMate] is missing. [...] This is something where one has to say, yes, one would need to have that. Because like this we are doing the same as before, only that we

[4]TeamMate from Wolters Kluwer, `http://www.teammatesolutions.com/`.

> somehow download it from the Dashboard, copy it into [TeamMate] and then... thus we are actually less efficient than before in this thing. And this would need to improve.” (Interviewee 3, translated from German)

Any future CA front-end should thus either be fully integrated into an AMS or should connect to a separate AMS using appropriate APIs.

Interaction Features and App-Inspired Design
None of the interviewed auditors had the impression that the new interaction features and app-inspired design released in May 2019 had a large impact on system usage, neither for themselves nor for their team members or colleagues.

Some attributed this to the short time period (about two months) between the release of these features and the interviews. Some interviewees also weren’t fully aware of the new functionality, which indicates that the training for it might have been insufficient.

Others pointed out that especially for the less digital-native auditors the interaction features might actually be an unwanted distraction and that it might become more appreciated over time as the internal audit activity employs more and more auditors from a younger generation:

> “Maybe when it was introduced, that some have found that, ‘oh, do we also need to go there thumbs up, like on Facebook, and what else not’, but on the other hand... all the young people, they document their lifes in Facebook and on WhatsApp and whereever else. Hence I think this is more a question of the generation. That one works like this here, too, is thus actually a logical consequence. That one introduces that here as well. I think, this is probably more an affront to the long-established auditors here. It makes it maybe more complicated at first sight for those who are not used to working with these tools from a young age.” (Interviewee 8, translated from German)

While the new design was seen as positive, one interviewee argued that it did not fully achieve the expected increase in usability:

> “[The redesign] did help. But I believe one could still design it more attractively. It is still a bit tabular. You know... step by step you click yourself through[...] No, it’s somehow so... the old file explorer world[...] maybe move a bit away from the folders or these structures where you navigate through like a folder. But yes, it is difficult. Maybe one would need to have a direct graphical access.
>
> [...]
>
> With the GUI, with the user experience... it is still a bit rough.” (Interviewee 6, translated from German)

These observations are supported by the quantitative data from section 8.1, which show that only about 20 interactions have been explicitly added by the auditors during the two-month window at the end of the case study.

As part of future research it seems necessary to continue observing the usage of these new interaction features over a longer time period and other internal audit activities prior to drawing a definite conclusion on their effects or the absence thereof.

Built on Microsoft SharePoint

All interviewees agreed that it was the right choice to implement the CA front-end system as an end user application that could be installed and maintainted by the internal audit activity themselves on the organisation-wide SharePoint platform without needing to involve the IT department for changes. There was broad agreement that this approach was necessary to get the CA implementation off the ground:

> “I believe if we had started a huge IT project, then we would probably still be in the concept phase today. Then we wouldn’t have anything yet. It needs people that can do this and move

this forward hands-on. And just doing it. And this worked very well for us. I do not believe that we would already have something to show if one would have made a huge project out of it." (Interviewee 1, translated from German)

"It is easier. You are faster. You are – plain and simple – faster; you get results faster than if you would have to go through the whole process. Then you would probably only get started now." (Interviewee 6, translated from German)

One interviewee explicitly noticed that the uniqueness of the solution meant that there was no existing commercial software that could easily be purchased and deployed:

"If you are completely new in an area... if you have a completely new idea in an area, then you cannot expect that the market already provides a mature software. So you would limit yourself. And that's why I say it makes sense to start with a prototype, to show what is possible, and then to improve on that. [...] Audit should improve itself. [...] Well, also the providers will improve themselves of course. But the software providers also improve themselves because there are good internal audit activities from which the providers can learn." (Interviewee 5, translated from German)

The use of Microsoft SharePoint also meant that the system nevertheless fits into the bank's IT landscape and is future-proof in that the data can be easily extracted and transferred to different solutions in the future:

"Yes, it is relatively flexible. We have the data, they can be transferred into other vessels, I assume that. We have used a technology that the [organisation] intends to be used, it is nothing exotic. SharePoint is, yes, browser-based, it is accessible for

> everyone, the acess rights work relatively easily, the communication... yes, I think one has used the tool... the strengths of the tool optimally for our intentions." (Interviewee 8, translated from German)

Some auditors also voiced concerns about the sensitive data stored in the system, where the reliance on Microsoft SharePoint's security apparatus could also provide reassurance.

However, the interviews also highlighted some downsides of this chosen approach. A concern voiced multiple times was how one could go on maintaining and improving the system outside of the IT department after the conclusion of this case study:

> "It is a unique instrument, specifically oriented towards this single process. And this process it supports well. And the problem is the question of, yes, how is this going to be maintained if one does not base it on a standard solution. How can one continue to develop it, this is certainly the big challenge." (Interviewee 2, translated from German)

This is, of course, a common issue with end user applications (Alavi & Weiss, 1985; Mirani & King, 1994). It is somewhat mitigated in this case as the system is provided as an open source solution that everyone can work together to improve and keep alive, but this, of course, still necessitates sufficient technical know-how inside the internal audit activity or the transfer of the application to the IT function.

Other downsides are technical limitations of the decision to use Microsoft SharePoint as back-end component and only develop a browser-based front-end component without server component: it means, for example, that it is not possible to send customized email notifications to individual users, a feature that was requested often and by many auditors, during and after the case study. As the web browser cannot directly communicate with an email server, this would necessitate a server-based API, going against this design choice.

Also, because the system is based on Microsoft SharePoint it cannot fully integrate neither with an existing AMS such as TeamMate nor with BI and data visualisation platforms such as Tableau. It was a frequently mentioned opinion that this should be the final destination, as it would allow to use the best of all worlds (electronic working paper and planning tools from the AMS, the CA-specific functionality of the Dashboard and the advanced visualisation and drill-down capabilities of a full BI platform):

> "What I am missing, actually, is that it is not connected to TeamMate. And it is also not... I mean, the progress of the audit projects themselves, where we are working on, which we also partially report into the ORA, this is also missing. For this we have our audit management information system. And I could imagine for the future that one connects all of these together." (Interviewee 5, translated from German)

> "If one could integrate it into an audit suite, this would be more interesting I believe. More interesting... you would have everything in one place then. And I think you would have possibilities such as... if someone starts his TeamMate, at the beginning there appears something, hey, this and this has happened with the information you have entered, or something like that. You know: now the auditor is in audit mode. He wants to get to work in there. And now there appears a message. Where you can directly speak to him and get him involved in the process again." (Interviewee 6, translated from German)

> "I would marry it together. Thus I would both... or rather the data part in a BI tool or in a much more interactive tool... I believe this is also a core part of it and that needs to be as flexible as possible. But for the rest I would say that [the Dashboard] is

> actually a good instrument. Hence I would do this on the basis of the Dashboard." (Interviewee 4, translated from German)

The Dashboard provides some options to include e.g. Tableau visualisations into the ORA dashboards, but this means that you lose the data annotation functionality for these visualisations – those would need further development work, going beyond a SharePoint front-end component. It appears that these needs would be an opportunity for AMS vendors to introduce CA-specific functionality and interfaces to advanced BI tools into their systems, possibly building on the work presented in this study.

8.2.2 Acceptance of CA

When asked about whether the CA front-end system has changed the acceptance of CA, responses were mixed depending on the stakeholders. Most interviewees saw little to no impact on the auditees, mainly as the system was not known to them or used together with them:

> "[The system did not yet have an impact on CA acceptance with the auditees] as one does not use it. One does not take it along, one doesn't show it." (Interviewee 6, translated from German)

> "Well, actually... I come with a chart or something like that from time to time. But they do not know that this comes from the Dashboard. This is just... I could have also done that in Microsoft Excel or something else. I believe they don't know that we are using this." (Interviewee 3, translated from German)

In areas where it was used to communicate results to the auditees, interviewees saw a positive impact, less from the CA front-end system itself and more from the results of the underlying data analyses:

> "The data part, that I would say, that one we have also shown to some. And, yes, there in one or the other area their acceptance

has increased regarding this." (Interviewee 4, translated from German)

> "Yes, in certain areas they are surprised what we have, what kind of information we have." (Interviewee 5, translated from German)

One interviewee, however, also noted that acceptance from auditees could actually decrease if the data analyses give them the feeling that they are under constant surveillance:

> "And I believe in one or two cases there was criticism, because [there] reservations existed about the question of employee or data protection. If one directly sees... or a bit a surveillance state... if one sees directly which [employee] has which amount of specific customers in his portfolio and these things." (Interviewee 4, translated from German)

This reinforces the importance one should place on data protection issues and auditee onboarding when designing CA measures.

For the audit committee and other higher-level stakeholders, the interviewees are more positive about the effect on CA acceptance. This is related to the internal audit activity having provided multiple demonstrations of the tool to these stakeholders. Four interviewees believe that the CA front-end system has increased CA acceptance, albeit passive acceptance:

> "Without a doubt, it improves [CA acceptance]. Because it is a good sales tool. There one can really proof that we are engaging with the data, that we are doing something useful with the information. And that we use all this to really provide optimal assurance. So, yes, absolutely." (Interviewee 2, translated from German)

> "I do have that feeling, yes. Positive. [...] It is a tool where we can always say, yes, we have a sytematic approach, we do this regularly. And it is not just something that they need to believe us for, that we sit together and discuss something. But one can record something, one can show it, too. And every time they look into it, they are excited." (Interviewee 5, translated from German)

> "They like it, they understand what it is. They see that one takes up information from a lower and broad level, documents it, aggregates it and then can basically make a statement. And that it is important that this also comes from a vessel that is accepted. Continuous Auditing is actually from the IIA, and this is surely also important for them, that one does not emerge with something self-created or self-developed – regarding the methodology – but that one can say, yes, this is a globally accepted best practice standard which we are following and supporting with this tool." (Interviewee 8, translated from German)

For the auditors themselves, six interviewees have stated that the CA front-end system did have a positive impact on acceptance of CA. The main reason stated was that the new system made CA more visible and tangible and signaled that the internal audit activity is really committed to this new methodology:

> "It is more tangible now. One knows where it is. One finds it. It is, well, visible. Especially... I believe for the data monitoring, the Ongoing Risk Assessment, especially there the aceptance has increased, because this is now in one place, where the people know where they can retrieve that information." (Interviewee 1, translated from German)

> "It specifies a pratical application of the path to take... shows it, makes it personally perceptible... or one also notices, one

> personally adds an item in the system and this then gets pushed upwards. I believe this is very important, that one does not only tell the people what they should be doing but also provides them with a practical solution, this also increases the credibility." (Interviewee 4, translated from German)

> "Yes, one thing is the presence of it. That it is listed there, that it is brought together in one place. And this also means that... yes, we are not only talking about Continuous Auditing but we are also doing it. We are implementing it, we provide the tools for it. And I simply believe this also sends a signal." (Interviewee 3, translated from German)

> "And I believe it was important that we have brought in this tool. There the people really see that, yes, it is more than nice idle talk and one can really work with it. And I believe the people, as far as I have noticed it, appreciate that. And given that it was certainly supporting for acceptance." (Interviewee 8, translated from German)

One interviewee was more sceptical in general, while one interviewee was positive in general but sceptical regarding the OCA, whose monotone nature and the necessary duplication of efforts might actually decrease acceptance of CA (see above):

> "No, I believe [acceptance for CA] has stayed the same. It has stayed the same, but generally I believe everybody is happy that one no longer does it in Microsoft Word." (Interviewee 6, translated from German)

> "I mean, given that my gut feeling is that going through the [OCA tasks] is a punishment, I have the impression that this is generally not increasing acceptance. Just a priori, and this has

> nothing to do with the Dashboard. If I have to tick-off a list every month, this is not that thrilling, of course. If the alternative is, hey, I can audit whatever I want." (Interviewee 2, translated from German)

This might point to a need for further process re-engineering, also see section 8.4.1.

8.2.3 Continuous Use Intentions and Project Success

The semi-structured interviews covered the constructs from Bhattacherjee (2001)'s continuance theory (see section 3.1) to gain at least some qualitative insights into the impact of a CA front-end system on CA continuance. The choice of a continuance model instead of TAM or UTAUT follows the discussion in section 5.4, where the survey results did not provide support for the predicitive power of in particular UTAUT regarding CA adoption in Switzerland.

The perceived usefulness construct has been split into a discussion of efficiency gains and effectiveness gains in the interview questions. This follows the scale items used by Bhattacherjee (2001) (adapted from Davis et al., 1989) for this construct, which also ask separately about " productivity" (efficiency) and effectiveness. Interviewees were very positive about efficiency gains from the new CA front-end system – with a focus on the ORA module and none or more sceptical mentions of the OCA part – while effectiveness gains were mostly denied:

> "And especially at the end of the quarter, to summarize all this and to consolidate it and draw a summary has become much more comfortable and efficient than if I compare it with the prior situation, where we still filled in various forms[...] And now we really have this in one tool and you can somehow retrace it. That makes it certainly more efficient." (Interviewee 1, translated from German)

> "But especially the level of the team heads, they of course see what kind of savings they have there. Earlier they had to record it there and then for the monitoring they had to do it again separately and he wanted it like that and so on... and now it is in one place and one can condense it and draw an extract. The team heads are those who appreciate it the most. And it also offers them the most at the moment." (Interviewee 9, translated from German)

> "Well, especially the ORA we have already done like that before. This means, the process, the workflow was the same, it is only just that we have documented it differently. There is an efficiency gain but no effectiveness gain." (Interviewee 3, translated from German)

Given that a front-end system focusses on the presentation layer and is thus not changing the overall substance but only how it is presented to and processed by the auditors, it is not surprising that its main benefits would lie in efficiency gains. Note that this might change if future enhancements such as machine learning and the OCA feedback loop could really be rolled out effectively.

Regarding expectation confirmation, most interviewees found their expectations to be met (four interviewees) or exceeded (three interviewees; the remaining two did not answer that question). Together with the perceived usefulness, continuance theory would predict that users are satisfied and thus intent to continue using the information system. This prediction is born out by the interviews, where all interviewees indicate that they want to continue or increase efforts both on the CA front-end system and – more importantly – on CA in general:

> "Yes, expand... fill it with more content and use it. I don't believe... Missing functionalities are not yet known to me. No, it

> is more now to really use it, use it and fill the gaps." (Interviewee 9, translated from German)

> "I wouldn't know where there is an alternative. And that's why I would say we continue with what we have. As I have said before, an externally purchased software will not be doing this just like that." (Interviewee 5, translated from German)

> "Expanding it would be the goal. Especially on the data side. [...] Because at the moment we are operating very selectively, data monitoring-wise, and I am convinced that if one sets this up intelligently and with clever indicators this could simply be another important source of information that could bring us a lot." (Interviewee 1, translated from German)

The only caveat is that some interviewees would prefer if the CA front-end system could be replaced with a solution fully integrated into the AMS and/or advanced BI and visualisation tools (see section 8.2.1). However, given that such a switch should keep and improve on the unique features of the CA front-end system, this does not indicate that users want to stop using them.

As an overarching question, the interviewees were asked whether they judge the implementation of the new tool to be a success. All interviewees confirmed that they see the implementation as a success, quoting reasons such as overall user acceptance and a successful roll-out, the advantage of having all of CA in one place for everyone, and that it shows what is possible to stakeholders inside and outside of audit:

> "Because... you have ORA, you have the control assessments, you have the complete overview. And you can exchange information across audit areas. Everyone can look in. And this, I think, this moves one forward." (Interviewee 5, translated from German)

> "Well, it works. Primarily it works, it has been communicated well, you have trained it well, shown it to the people. It is being lived. It is really being employed. They use it actively." (Interviewee 1, translated from German)

> "I would say, surely the important first realisation for people that don't work digitally at all or that deal with this very little to simply show them which possibilities exist. Also how relatively easy one can do certain things." (Interviewee 4, translated from German)

8.3 Final System Design Versus Original Goals

Table 8.2 compares the system design choices with the user stories and their acceptance criteria. It lists both where user stories have not or only partially been met by the system and also where explicit design choices have gone beyond the original user stories. Note that any differences can have two reasons: They could either be evidence of a failure in the design process (a mismatch of product versus design). Or they could point to changes in the understanding and prioritisation of user needs, the inclusion of which is a core feature of the agile design process. User stories are relatively high-level descriptions of user needs, and how they are met in practice is being established during the design process. This – an enhanced understanding of user needs arising due to and during the implementation of the artefact – is how DSR can inform the underlying kernel theories (see section 8.4.3).

When looking at unmet needs, the following key areas and necessary actions can be summarized from the table:

1. **ORA workflow.** The ORA process should be supported by a full end-to-end workflow, that starts with ingesting qualitative and quantitative source information, assigning these sources to the responsible auditors, tracking their progress in analyzing these sources and ends with quality assurance on the resulting risk analysis. This also includes in-line help

in the system to guide auditors within the process and to provide feedback to them on how their contributions have fed into the internal audit activity's overall risk assessment.

2. **Qualitative risk aggregation.** The qualitative risk aggregation within the ORA should not only be supported from notes to notes and notes to risk matrices but also from lower-level risk matrices to higher-level risk matrices.

3. **Push notifications.** Users want to receive push notifications outside of the system (either in the AMS they use daily or via email or mobile push).

4. **Drill-downs and self-service analyses.** Users want to be able to drill-down into the source data behind the data visualisations in the system. They want to be able to interactively modify the underlying analyses.

Note that as these needs are derived from the originally defined user stories, they will not usually yield new user stories but will often be clarifications and amendments to existing user stories.

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
1.1 ORA on the audit universe As audit universe entity owner, I want to perform the ORA structured along the audit universe entities, so that I can discharge my duties as per IIA Standard 2010 and ensure complete audit coverage.	The audit universe can be flexibly configured and changed	**Ongoing Risk Assessments** The audit universe is fully configurable as a tree-based hierarchy. Tree elements can be limited by start and end dates to cover changes to the audit universe over time.	**Met**
	ORA functionality is structured according to the audit universe	**Ongoing Risk Assessments** ORA dashboards exist for each audit universe entity and only for each audit universe entity. The ORA functionality is thus fully structured by the audit universe and items can be aggregated upwards along the tree.	**Met**
	No specific type of audit universe entities is enforced	**Ongoing Risk Assessments** The audit universe tree as well as the terminology used in the system does not restrict audit universe elements to a specific type (e.g. organisational units or business processes).	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
1.2 Review management's risk monitoring As audit universe entity owner, I want to receive and evaluate management's risk monitoring in the ORA system, so that I can review and use it without having to switch systems.	Qualitative 1/2LoD reports can be stored and pushed into the system	**Ongoing Risk Assessments** All notes in the system can contain attachments such as 1/2LoD reports. As these notes are based on SharePoint lists, any system that can write to SharePoint using its open APIs can also push entries into the system. *However, auditors have mentioned that they would like more explicit workflow mechanisms to push new 1/2LoD reports to the auditors, get notified about them and be able to document whether they have looked at them.*	**Partially met**
	Quantitative 1/2LoD risk monitoring data can be visualised	**Ongoing Risk Assessments** 1/2LoD risk monitoring data can be imported as standard CSV files and external systems can push these files through SharePoint's open APIs. Different visualisations can then be configured based on this imported data.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	1/2LoD risk monitoring can be assessed and commented on	**Ongoing Risk Assessments** Notes can be attached both to qualitative 1/2LoD reports (as they are linked as attachments to notes) as well as to quantitative data elements visualised within the system. These notes can be used to summarize important findings from these reports and/or data elements.	**Met**
1.3 Capture interviews, surveys, meetings, and workshops As audit universe entity owner, I want to store interview notes, survey results, meeting memos and other qualitative inputs for my ORA in the system, so that I do not have to context switch when working with them.	Qualitative notes can be stored in the system	**Ongoing Risk Assessments** Notes can be stored and tagged with keywords within all ORA dashboards.	**Met**
	Arbitrary files can be stored in a structured form	**Ongoing Risk Assessments** Arbitrary files can be attached to notes, which are themselves structured using the ORA audit universe tree structure and/or additional keywords.	**Met**
	Files and notes are filed in a structure following the ORA process	**Ongoing Risk Assessments** Notes follow a risk aggregation logic, with “detail” notes for detailed notekeeping and “summary” notes for aggregation to the next higher level. “Draft” and “final” status levels allow notes to progress over time.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
1.4 Data-driven ORA with trends, comparisons, outliers As audit universe entity owner, I want to work with and interactively visualise quantitative data in my ORA, so that I can quickly identify trends and outliers and perform comparisons.	Data can be loaded and interactively visualised	**Data Sources** Arbitrary data can be loaded as standardized CSV files and subsequently visualised using various implemented visualisations on the configurable ORA dashboards for each audit universe entity.	**Met**
	Available visualisations allow to identify trends and outliers	**Ongoing Risk Assessments** In particular time series, bar charts, portfolio charts and bubble charts allow to identify trends over time and outliers in categories. Tables can be displayed with sparklines, which are specifically designed for quickly identifying trends.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	Data visualisations are integrated into the ORA process	**Ongoing Risk Assessments** Data visualisations allow for notes to be added on individual data elements. These notes are the same notes as in the qualitative area and thus fully integrated into the ORA process: they can be attached as detail notes per auditable entity or as summary notes and can be linked to risk items using the impact functionality. *However, auditors have mentioned the need for a stronger workflow support, particularly for the data visualisations, to clarify whether new data has arrived and whether it has been processed by the designated auditor.*	**Partially met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
1.5 Assessing emerging enterprise risks As audit management, I want to gather and aggregate all the individual inputs from the audit universe entity level, so that I can get a big picture view and identify emerging enterprise-wide risks.	Risk inputs flow bottom-up along the audit universe hierarchy	**Ongoing Risk Assessments** Detailed notes can be linked bottom-up to higher-level risk items using the impact functionality, which can be used to indicate which risk items are impacted by a given note. Also, summary notes exist to aggregate information along the audit universe tree. *However, auditors have noted that no functionality exists to support the aggregation of lower-level risk matrices to higher-level risk matrices.*	**Partially met**
	Qualitative assessment tools enable a systematic discussion of risks	**Ongoing Risk Assessments** Risk matrices allow risks to be described and mapped (qualitatively) onto an impact-likelihood matrix, thus systematically ordering risks on these two dimensions. The dimensions are configurable, so also other risk matrix terminologies can be supported.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	Inputs from different sources (qualitative, quantitative) can be merged	**Ongoing Risk Assessments** Notes added on quantitative data visualisations (data annotations) are treated like any other (qualitative) note added in the system and are integrated through common keywords on an audit universe entity or higher level.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
1.6 Document risk assessment As audit universe entity owner, I want to document all the work performed for the risk assessment in a way that adheres to data retention requirements, so that I can document conformance to the ORA process and IIA Standard 2010.	Arbitrary work performed and thoughts need to be captured	**Ongoing Risk Assessments** Notes are a flexible instrument on an audit universe entity level that can be used to capture diverse content. Keywords (and filtering notes by keyword and keyword-specific note areas) enable grouping of notes e.g. to specifically document work performed.	**Met**
	An audit trail needs to exist for changes and removals	**Built on Microsoft SharePoint** All SharePoint lists the system uses are configured with versioning enabled, which means the history of all changes is being stored. Removals use SharePoint's "recycle" feature which moves removed data to the recycling bin instead of deleting it immediately. *However, these audit trails are not exposed to the Dashboard user interface and can be overriden by tech-savvy users. They do thus not provide a perfect audit trail. Real audit trails have to be enabled server-side, e.g. by enabling comprehensive logging on the SharePoint server.*	**Partially met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	Document retention and removal requirements need to be followed	**Built on Microsoft SharePoint** The system only uses regular SharePoint lists. SharePoint, being an enterprise-ready document management system, can be used to configure organisation-wide retention policies which would then also be applicable to the SharePoint lists used by the system.	**Met**
1.7 ORA available for engagement planning As auditor, I want to access relevant ORA results and the thought process behind them, so that I can use this information for planning my engagements conforming to IIA Standard 2200.	Access rights enable access to relevant ORA results for auditors	**Built on Microsoft SharePoint** Access rights to the system data are fully controlled by Microsoft SharePoint, enabling internal audit activities to use SharePoint groups and access rights control to specify who gets access to which parts of the system.	**Met**
	The thought process behind risk assessments stays visible	**Ongoing Risk Assessments** All notes, impacts, and past risk matrix entries remain in the system and allow users to look at past insights and thought processes.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
2.1 Examining transactional data, configurations for OCA As an auditor, I want to access OCAs assigned to me and load and examine transactional and configuration data, so that I can evaluate controls against a baseline condition and obtain more timely assurance on key controls.	Open OCA tasks can be assigned to auditors and displayed	**Ongoing Control Assessments** OCA tasks can be pushed directly to The Dashboard using SharePoint's APIs. They are subsequently displayed to the relevant auditors in the system's OCA module.	**Met**
	OCA tasks include transactional and configuration data	**Ongoing Control Assessments** The CA front-end system is agnostic to the type of analytics results that are being processed in it. It does not include any pre-made analytics. It can thus be used to work on analytics results covering both transactional and configuration data.	**Met**
	Auditors can perform and document an evaluation of this data	**Ongoing Control Assessments** OCA task results can be documented on a per-exception level. Auditors can document both a simple, configurable result status (e.g. "OK", "NOK", "false positive") or they can use customizable audit forms to document detailed work performed and results.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
2.2 Display work program and procedures As an auditor, I want to access the work program and procedures behind a given OCA, so that I know what I am supposed to do and what to look out for.	OCA tasks are stored together with their work program	**Ongoing Control Assessments** Each OCA task comes with a configurable description field detailing what kind of analytics has been run and the audit procedures to be performed.	**Met**
	The OCA work program is displayed to the auditor accessing it	**Ongoing Control Assessments** The OCA task description with the audit procedures to be performed is available with the OCA task (“i” icon).	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
2.3 Documenting work performed As an auditor, I want to document the work I have performed and the conclusions I have drawn within the OCA data set, so that I can document conformance to the IIA Standards.	Work performed can be documented within OCA procedure	**Ongoing Control Assessments** OCA task results can be documented on a per-exception level. Auditors can document both a simple, configurable result status (e.g. "OK", "NOK", "false positive") or they can use customizable audit forms to document detailed work performed and results.	**Met**
	Conclusions can be documented within OCA procedure	**Ongoing Control Assessments** The system currently only accepts results documentation on a per-exception level; it is not possible to record overall conclusions for a given OCA task. This is due to the case study partner still using their AMS for documenting OCA conclusions, so it was not necessary (and would have been a duplication) to add conclusions on the OCA task level.	**Unmet**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
2.4 Cross-reference past OCA results As an auditor, I want to get access to past OCA results concerning the same data elements (transactions, configurations etc.) when conducting an OCA, so that I can take these past findings into account when planning and performing my work.	Past OCA results are displayed if they concern the same data object	**Ongoing Control Assessments** Audit forms – which document audit results on past exceptions – are linked through common identifiers (e.g. a client or employee ID, a country code or an organisational unit identifier) between OCA tasks. If a data object with the same identifier appears in a future OCA task, the auditor will see a greyed-out audit form, can click on it and retrieve the past audit work performed and results on that object.	**Met**
	Auditors can access details of past OCA results for the same object		**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
2.5 Support quality assurance workflow As audit management, I want to conduct my quality assurance within the CA front-end system including documenting approvals and sign-offs, so that I can document conformance to IIA Standard 2340 and all internal QAIP measures.	Quality assurance workflows exist within the system	**Ongoing Control Assessments** OCA tasks as well as individual audit forms use a workflow in which auditors can mark the object as complete and a second auditor can mark the object as reviewed, documenting QA performed. The workflow supports both a four-eye principle in which a different auditor needs to review the work performed by his or her colleague as well as a management approval in which a manager needs to review the work performed by his or her staff member.	**Met**
	Sign-offs, approvals can be documented on OCA tasks, workpapers		**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
2.6 Support quality assurance conversations As audit management, I want to be able to engage with and discuss review points with my auditors on the OCA platform, so that I do not have to switch context for my ongoing communication as per IIA Standard 2340.	Electronic discussions are possible on OCA tasks, workpapers	**Interaction Features and App-Inspired Design** Comments can be added on an audit form and OCA task-level, which can be used to discuss the audit work performed and conclusions reached.	**Met**
	Discussions are kept separate from audit findings	**Interaction Features and App-Inspired Design** Discussions are documented in a separate SharePoint list. They are also not exported when the full OCA task is exported for archiving.	**Met**
	Auditors get notified about new review discussions	**Interaction Features and App-Inspired Design** Auditors get notified about new comments on audit forms or OCA tasks they are watching (which by default include those which they have created or reviewed) in their global newsfeed on the homepage. *However, auditors have indicated that they would prefer a push notification outside of the CA front-end system, e.g. via email or within the AMS.*	**Partially met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
3.1 Data security As audit management, I want to control access to the OCA and ORA platform and prevent any unauthorized access to the data, so that I can ensure the confidentiality of our work and adherence to IIA Standard 2330.	Access can be controlled for ORA and OCA tasks	**Built on Microsoft SharePoint** Access rights are controlled by Microsoft SharePoint, which in general allows very granular access controls on lists and list items, which would allow access rights to be set individually per ORA element and OCA tasks. *However, the CA front-end system does not yet implement an administration interface for such granular access rights, thus they would need to be set and maintained externally via the SharePoint GUI or API.*	**Partially met**
	No unauthorized access to the platform is possible	**Built on Microsoft SharePoint** Access rights are controlled by Microsoft SharePoint, an established enterprise platform.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
3.2 Retention requirements As audit management, I want my CA front-end system to adhere to the organisation-wide data retention requirements, so that I ensure adherance to IIA Standard 2330.A2.	Data stored in the system is stored and deleted	**Built on Microsoft SharePoint** The system uses regular SharePoint lists and document libraries. Hence, any retention and deletion policies specified on Microsoft SharePoint globally would also apply to the SharePoint data for the CA front-end system.	**Met**
	Data retention requirements follow organisation-wide policies		**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
4.1 Structured focus on risks As audit management, I want to capture risks in the ORA in a structured form organised along the audit universe, so that I can aggregate the risks throughout the organisation and know where to focus my audit resources.	ORA structure follows a (configurable) audit universe	**Ongoing Risk Assessments** ORA dashboards exist for each (configurable) audit universe entity and only for each audit universe entity. The ORA functionality is thus fully structured by the audit universe and items can be aggregated upwards along the tree.	**Met**
	ORA allows capturing risks in a structured form	**Ongoing Risk Assessments** Risk matrices allow risks to be described and mapped (qualitatively) onto an impact-likelihood matrix, thus systematically ordering risks on these two dimensions. The dimensions are configurable, so also other risk matrix terminologies can be supported.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	ORA supports aggregating risk information	**Ongoing Risk Assessments** Detailed notes can be linked bottom-up to higher-level risk items using the impact functionality, which can be used to indicate which risk items are impacted by a given note. Also, summary notes exist to aggregate information along the audit universe tree. *However, auditors have noted that no functionality exists to support the aggregation of lower-level risk matrices to higher-level risk matrices.*	**Partially met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
4.2 Support for agile auditing As audit management, I want to update and converse about risks in both ORA and OCA channels all the time, so that agile auditing practices can be supported outside of fixed planning periods.	Risk assessments can be updated and documented continously	**Ongoing Risk Assessments** The ORA dashboards do not enforce any timings or rhythm on new information to be added. Data can be added and updated continuously and risk matrices can be "frozen" freely at user-determined points in time to record past risk states.	**Met**
	Dynamic conversations on risk and control are possible	**Interaction Features and App-Inspired Design** Comments can be added on notes, risk items, OCA tasks and audit forms within the system, enabling a discussion on these items to take place. Auditors are notified in their newsfeed of new comments on items they are watching or that they have created. Auditors can be "at-mentioned" to draw them into an ongoing discussion.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	The system must not enforce fixed long-term planning periods	**Ongoing Risk Assessments** The ORA dashboards do not enforce any timings or rhythm on new information to be added. Risk matrices can be "frozen" freely at user-determined points in time to record past risk states and plan based on those frozen states.	**Met**
4.3 Quantitative and qualitative data As audit universe entity owner, I want to use, capture, and mix both quantitative and qualitative data for my risk assessment, so that I can use the right type of data for the right audit area.	Quantitative data can be loaded and displayed	**Data Sources** The system supports loading standard CSV files which can then be used as OCA tasks or for data visualiations in the ORA.	**Met**
	Qualitative data can be captured and displayed	**Ongoing Risk Assessments** The auditors can add notes with arbitrary attachments to capture any qualitative data that they come across. As notes are stored in standard SharePoint lists, notes can also be added programmatically using the SharePoint APIs.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	Quantitative and qualitative data can be mixed	**Ongoing Risk Assessments** ORA dashboards can contain any combination of notes and data visualisations, tightly integrating quantitative and qualitative data. Notes added on date elements of quantitative data are kept together with notes on qualitative insights.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
4.4 Guide auditors along CA processes As auditor, I want structured guidance along the new CA processes of ORA and OCA, so that I am both forced to and supported in adopting my way of working to the new ORA and OCA world.	Separate processes for ORA and OCA exist	**Ongoing Risk Assessments, Ongoing Control Assessments** The auditor can choose between ORA and OCA from the main navigation bar, launching separate but integrated modules which follow separate processes.	Met
	Where needed, the system shows the auditor what to do	*During the case study the need for an in-line tutorial or help function within the system was evaluated, but the auditors stated that they felt comfortable about how to use the system without additional guidance, so in the end no in-line help was implemented. In the final interviews, however, some audit managers argued for better process guidance especially in the ORA area.* The system does allow for configurable help screens to be displayed to the auditors within the ORA dashboards and for each OCA tasks, which can be used to document organisation-specific guidance on the CA process and on specific analytics and audit procedures or evaluations to be performed.	Unmet

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
	The system documentation describes ORA and OCA processes	**Ongoing Risk Assessments, Ongoing Control Assessments** A high-level documentation was created specific to the case study partner which ties into the CA processes as implemented at the case study partner.	**Met**
5.1 Possible to start small As audit management, I want to be able to start small with data analyses only in specific areas, so that I do not have to spend a lot of resources before I have anything to show for it.	ORA is useful even if quantitative data only exists in some areas	**Ongoing Risk Assessments** By integrating qualitative notes and quantitative data visualisations in common dashboards, dashboards can be rolled out with purely qualitative notes until additional quantitative analytics results become available. This step-by-step approach has been validated in the case study, where quantitative data was available for only a minority of audit universe entities.	**Met**
	OCAs can be rolled-out independently for each analysis	**Ongoing Control Assessments** Each OCA task encapsulates its own description, audit procedure, and data (exceptions hit). The system displays all OCA tasks pushed to the relevant SharePoint list and is thus agnostic to any changes in the available OCA tasks.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
5.2 Visualisation of complex data As Audit Committee member, audit management and/or auditor, we want to see large data sets in a visual form, so that we can better spot trends, emerging risks and unusual patterns or changes.	Common visualisations of data can be used	**Ongoing Risk Assessments** The system implements common visualisations such as time series, bar charts, area charts, portfolio charts, bubble charts, and tables with sparklines.	**Met**
	Visualisations can be manipulated to support identifying anomalies	**Ongoing Risk Assessments** It is possible to zoom into visualisations and to highlight or exclude individual groups of analysis. This allows the auditor to visually pin down individual anomalies. *However, auditors would like additional drill-down functionality to evaluate the data elements underpinning any visualisation within the system.*	**Partially met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
6.1 Easy-to-use without documentation As auditor, I want to be able to understand and use the system right away without having to consult documentation, so that I do not have to spend a lot of time learning how the system works.	Users can discover main features without reading any documentation	**Interaction Features and App-Inspired Design** Interviews with auditors at the case study partner have confirmed that they were able to navigate the system without referencing the (only high-level) documentation provided and after attending only a single training session.	**Met**
	System uses common, known UI/UX patterns where possible	**Interaction Features and App-Inspired Design** The system is web-based and thus uses design elements users know from other web-based applications. Its design is inspired by Google's Material Design, which is also used for the Android UI and Google's own web applications, which are probably known to most users.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
6.2 Configurable without programming As audit management, I want to be able to configure the system without needing technical or programming skills, so that I do not have to hire staff with special skills to support this system.	System configuration is possible without programming skills	**Data Sources** Data sources, the audit universe entities, and the dashboards for each audit universe entity (including the data visualisation and the notes sections) can be configured using the "Administration" interface available in the CA front-end system.	**Met**
	System adopts to different audit functions with configuration alone	*As the given study only covers a single case study partner, it is untested whether the system will also adopt to other internal audit functions and their needs. Future research can use the open source codebase to implement the system at other organisations and report on this area.*	(Untested)
7.1 Does not require IT involvement As audit management, I want to be able to install the system myself, so that I do not depend on our slow IT department to get us set-up.	Installation without IT involvement possible	**Built on Microsoft SharePoint** The system can be installed by any user who has full access rights on a single SharePoint site, without the need for administrative access to Microsoft SharePoint. This was shown at the case study partner, where the system was implemented and maintained as an end user application.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
7.2 Leverages existing analytics As audit management, I want to be able to integrate results from our existing corporate analytics platforms, so that I conform to our IT architecture and do not duplicate organisation-wide systems already in place.	Not limited to specific source systems	**Data Sources** The system loads standard CSV files, which can be generated by practically all existing analytics systems (including R, Python, SAS, ACL, IDEA, SAP).	**Met**
	Leverages existing analytics solutions instead of duplicating them	**Data Sources** The system does not implement any analytics capabilities. All analytics results need to be produced outside of the system and can then be loaded from standard CSV files.	**Met**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
(Additional design choices beyond initial user stories)		**Ongoing Risk Assessments** *A repeat request by auditors was to be able to store information in the ORA section on the auditable entities which is not strictly risk- and "news"-focussed (as the notes as implemented are sorted by newest first and disappear from view as they age). Two approaches have been implemented: a "repository of topics" where ideas for future audits are stored and which remain in there until they are being marked as Completed. And a more complex, process-based object explorer, where (sub-)processes can be linked to arbitrary objects such as past audit reports, management actions or risk scenarios and controls from the organisation-wide operational risk repository.*	**Extra feature**
		Ongoing Risk Assessments *Notes in the ORA can be formatted using rich-text and can include inline pictures and images (via copy-and-paste). This feature was frequently mentioned by auditors as being very important to their daily work.*	**Extra feature**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
		Ongoing Risk Assessments *It is possible to search over all notes in the system across all audit universe entities using a combination of full-text search and/or keywords attached to the notes. This feature was hidden in the beginning and was one of the most requested features at that time.*	**Extra feature**
		Ongoing Control Assessments *Audit forms in the OCA tasks are now auto-saving after multiple auditors have complained about lost data as they did not save their work. Auditors request a similar feature for ORA notes, where this has not yet been implemented.*	**Extra feature**

Table 8.2: Comparison of the original user stories and their acceptance criteria to the final design choices implemented in the CA front-end system.

User Story	Acceptance Criteria	Design Choice: Explanation and Discussion	Status
		Interaction Features and App-Inspired Design *Auditors can show the risk matrices in the ORA in a conference room projection environment, displaying the risk matrix and the accompanying descriptions on one screen. This supports discussion of risk analysis results in workshops within internal audit and with stakeholders.*	**Extra feature**
		Interaction Features and App-Inspired Design *Auditors can subscribe to arbitrary keywords, auditable entities and/or risk areas and get notified of new or modified notes or risks in these areas in their newsfeed. This was a highly requested feature; most auditors would prefer email notifications but due to technical restrictions only the system-internal newsfeed and a way to subscribe to it via standard RSS is provided.*	**Extra feature**

Many auditors have argued for integrating the CA front-end functionality into a full AMS as a long-term strategy. Prior to this full integration, it does not make sense to capture overall conclusions for OCA tasks (an unmet user story in Table 8.2), as this would duplicate mandatory information in the AMS. Accordingly – with hindsight – this user story is not needed for a separate CA front-end. Also, while full audit trails were part of the initial user stories, they were never implemented because the versioning in Microsoft SharePoint was deemed "good enough" and also as the yearly risk analysis and planning documents were still kept within the AMS, hence providing an additional audit trail outside of the CA front-end system. This also leads to a reduction in the user stories until the CA front-end system becomes fully merged with or replaces the existing AMS.

When looking at design decisions yielding additional features not captured by the original user stories, key areas are:

1. **Knowledge repository.** Once users have access to a system that structures content along the audit universe entities, they want to be able to use this system to access more than just "current affairs". The system thus needs to be able to capture permanent information on audit universe entities and to be able to link audit universe entities with information objects from the AMS (such as audit reports issued and management actions agreed) and/or other governance, risk, and compliance (GRC) systems in the organisation.

2. **Rich-text formatting and inline images.** Users expect notes to provide rich-text formatting options comparable to Microsoft Word and in particular including the ability to in-line pictures and tables.

3. **Auto-save.** Any user-entered information needs to be auto-saving to avoid data loss due to system malfunction or user error.

4. **Use of ORA results in workshops.** Users want to be able to use and discuss the ORA results in workshops within internal audit and

with stakeholders. Thus, the system should make it easier to use ORA in a workshop setting, including a user interface tailored to conference room projection.

5. **Arbitrary subscriptions.** Users want to be able to subscribe to any content area in the system, i.e. notes, risks or OCA tasks for any audit universe entity or user-defined keyword. Subscriptions should notify users about changes or new content in the areas they have subscribed to (see “push notifications” above for suitable means of delivering these notifications).

These areas were *not* covered by the initial user stories and they thus point to user requirements that have only been revealed during the agile development process. Section 8.4.2 looks into these new user requirements in particular to derive the final post-implementation user stories.

8.3.1 Survey Results on CA Front-End Features

The results of the survey among Swiss internal auditors on the importance they assign to different CA front-end system features (see section 5.6.2) show that auditors judge most features as “important”, only a workflow support for CA and the ability to use the tool also for the first and second LoD are seen as less important. If we compare the survey results (features ordered in decreasing importance according to the survey respondents) with the final system implementation, we observe the following coverage or gaps:

1. **BALANCE – Right balance between capabilities and complexity (3.158)**[5]
   Although this balance is mentioned frequently in the literature and in the initial interviews, it is very hard to objectively determine whether the right balance has been met. The CA front-end as implemented falls

[5]The number in parantheses indicates the mean value from the survey, see Table 5.18, with a scale from 0 = “not important” to 4 = “ very important”.

rather on the side of fewer capabilities and correspondingly lower complexity, as can be evidenced by the interviewees' responses: They cover many additional feature requests (some of which would clearly increase complexity, such as more metadata and filtering on ORA notes) but all interviewees confirmed that the system is easy-to-use and thus not too complex. *It seems thus reasonable to slightly increase the capabilities of the system to better match the right balance, which will be taken up with the additional user stories in section 8.4.2.*

2. **VISUALISATION – Visualisation of large data sets (3.121)**
This is a central pillar of the CA front-end's ORA module.

3. **SELFSERVE – Self-service analytics for users without programming skills to analyze data (3.102)**
Due to the design decision to use Microsoft SharePoint as underlying technology and to not include its own analytics capabilities, the CA front-end does not currently support any self-service analytics. *This is something also brought up by some interviewees who have asked for more interactive visualisations and analyses including drill-downs. Some have suggested to achieve this by integrating existing solutions such as Tableau into the CA front-end. An alternative would be to build the CA front-end on such solutions instead of Microsoft SharePoint.*

4. **EXISTING – Built on existing IT platforms within your organisation (2.966)**
By building on Microsoft SharePoint, a very common enterprise platform, this goal has been met by the CA front-end.

5. **HITS – Support processing large number of potential exceptions from imprecise analytics (2.931)**
In general, the OCA module supports and has been tested with large numbers of potential exceptions. It supports filtering and sorting

exceptions and OCA tasks can also be exported to and results re-imported from Microsoft Excel to deal with large exception lists. *However, interviewees have noted that working with especially large lists of hits is much easier directly within Microsoft Excel than using the OCA module. The OCA module includes various features that aim at dealing with large numbers of exceptions, such as a machine learning component and the feedback loop from past runs, but these could not yet be deployed at the case study partner and their benefits could thus not be analyzed.*

6. **CAPTURE – Ability to capture audit work performed and conclusions directly within the system (2.895)**
   These are key functionalities of both the ORA module (with the ability to record notes about qualitative information as well as on quantitative data points) and the OCA module (with the ability to attach user-definable "audit forms" to each data point of a given OCA analytics run).

7. **INTEGRATED – Integrated platform for all CA processes (2.857)**
   This is a primary goal for the CA front-end system, to cover CA processes along both ORA and OCA. *However, interviewees have pointed out that it is not enough to integrate all CA processes: as long as CA and regular audits co-exist, the system also needs to integrate with the AMS for the regular audits, to be able to include audit results in the ORA and conversely ORA and OCA results for regular audit preparation.*

8. **WORKFLOW – Workflow support for CA work, including quality assurance processes (2.618)**[6]
   The OCA module includes, in line with IIA Standards, support for a

[6]WORKFLOW and LODS were judged to be significantly less important than the highest-ranked feature BALANCE.

QA workflow. For the ORA, a more agile approach without a predetermined workflow has been chosen however, in line with the low priority assigned to this feature by the survey respondents. *Interviewed audit management have, however, repeatedly stated that they miss better workflow support for the ORA. It thus seems that there is a difference between the survey respondents and audit management at our case study partner.*

9. **LODS – Can be accessed by first or second line of defence staff (2.000)**
   The CA front-end system is agnostic to how access rights are being configured, but it does not support (in line with the low prioritisation of this feature) special views tailored to first or second LoD members' needs. At the case study partner, the system is only used by internal auditors and in workshops managed by internal auditors, so this need did not arise there, either.

Except for WORKFLOW, the interviews have in general supported the survey results on feature prioritisation: Ease-of-use, or the right balance between features and capabilities, was often stressed by interviewees, as was the advantage (and the "wow" effect) of effective data visualisations. The lack of self-serve analytics in the current CA front-end implementation was bemoaned by multiple interviewees, also supporting the importance of this feature request. No interviewee has suggested that the system should be rolled-out for the first or second LoD, also supporting the low importance the survey respondents assigned to the LODS feature. Only for WORKFLOW did survey results and interviewees provide different evaluations: while survey respondents judged this feature significantly less important than BALANCE, interviewees in particular on the audit management level whished for better ORA workflow support in the system. It is unclear whether this is due to the fact that many survey respondents will have answered in the abstract (without having personal experience with an existing CA system) while the interviewees could answer based on their day-to-day experience or whether this is due to peculiarities of the case study partner, e.g. that this internal audit activity is extraordinarly workflow-driven. It remains an interesting future research topic how *a)* auditors at other organisations would judge this feature once they have gained some practical experience with a CA system and *b)* auditors at the case study partner would judge the system after an ORA workflow has been implemented. This question also relates to the "appropriate use" of the system, as a more restrictive system is one (but only one) way to potentially increase appropriate use (Dowling, 2009).

8.4 Overall Summative Evaluation

Overall, the naturalistic, summative evaluation based on the interviews at our case study partner indicates that the CA front-end system was implemented successfully and lead to an increased acceptance of CA among the auditors at the internal audit activity. This was primarily achieved by increasing the visibility of ORA and OCA in the internal audit activity and thus turning CA from an abstract theory into something real that is supported by audit management with appropriate tools. Acceptance of CA also benefitted from the system providing tangible benefits in the form of efficiency gains in particular for the auditors' periodic risk analysis process (now merged into the ORA). According to the interviewees at the case study partner, some gaps remain regarding the value added of the OCA module as well as the workflow support for ORAs.

The artificial, summative evaluation – comparing the final system design to the initial user stories – reveals that unexpected development has occured with regards to making the ORA dashboards also available as long-term knowledge repositories, that the users want to be able to subscribe to and search for content outside of their immediate area and that a modern information system needs to support advanced formatting, inline pictures and media, and auto-saving of content. As the auditors still use their existing AMS to document parts of their OCA work, less functionality was implemented in this area in the CA front-end system than initially anticipated. Some initial user stories need to be clarified, as they had been implemented on first impression, but subsequent user feedback showed that this implementation did not cover everything users deemed important for these user stories. This covers areas such as ORA workflow support, qualitative risk aggregation between risk matrices, push notifications, and data drill-downs.

Together, the naturalistic and artifical evaluation yield updated user stories that cover both gaps and reductions identified during the development process and as part of the discussion with the case study partner (see section 8.4.2). They also indicate whether the initial hypotheses, based on the survey results, are supported by the case study (see section 8.4.1). As the initial user stories and hypotheses were derived from initial theory, any changes to them indicated by the experiences from the case study can also suggest the need for changes to the underlying theory (see section 8.4.3).

8.4.1 Validation of Initial Hypotheses

The CA front-end system user stories (see Chapter 6) were built using IIA guidance and theory underpinning the concept of CA as well as the results from the survey conducted among Swiss internal auditors (see Chapter 5). However, the survey results were not fully conclusive as while the hypotheses used to design the CA front-end system were significant, these only covered the relationship of the detailed concepts to the UTAUT antecedents of Performance Expectancy, Effort Expectancy, and Social Influence. As the UTAUT relationships were not found to be explaining a large amount of variance in the survey regarding acceptance of CA, it remained unclear whether the significant impact on the UTAUT antecedents would actually also translate into increased CA acceptance. That is why it makes sense to evaluate the impact of these potential drivers of CA acceptance now also based on the case study results: How do discussions with the interviewees and findings from the development process support the impact of these constructs on CA adoption?

Re-Engineering (H1a)
The hypothesis that a systematic re-engineering of audit processes has a positive impact on CA acceptance (via Performance Expectancy) was supported at the case study partner by comparing areas where more re-engineering has already occured with areas where not much re-engineering had been done as part of the CA front-end system roll-out. In general, most auditors argued that only relatively little has changed process-wise due to the roll-out of the system. The largest process changes were recognized in the ORA area:

> "Well, earlier we had there such a quarterly thing, which was a bit formal. A piece of paper. We don't have to do that anymore. This means we have a clear simplification there. [...] I am happy that we don't have that anymore." (Interviewee 5, translated from German)

This area, where processes have changed and adopted to the new system by e.g. replacing manual forms and separate documentation, the auditors were also the most positive about the effects of the CA front-end system and the success of CA (see section 8.2.1).

In contrast, auditors were less impressed in areas where processes were not changed at all (or not enough) and thus inefficiences and inconsistencies remained. One such area is the OCA and also the yearly risk assessment, where processes have not been sufficiently re-engineered, such that data now needs to be documented both in the CA front-end system and the existing AMS, leading to scorned discontinuities and duplication of effort:

> "If we run the Ongoing Control Assessment in there, then we still need to improve. Because this is a bit[...] The problem is actually, the link into [TeamMate] is missing. [...] This is something where one has to say, yes, one would need to have that. Because like this we are doing the same as before, only that we somehow download it from the Dashboard, copy it into [TeamMate] and then... thus we are actually less efficient than before

> in this thing. And this would need to improve."[7] (Interviewee 3, translated from German)

> "And then we actually have all this within TeamRisk, also still separate. This we would need to match somehow eventually. I know, we haven't done that now on purpose, but this were of course helpful, that we would have it in one place, logically. Not these separate rails. This would be nice." (Interviewee 7, translated from German)

> "By documenting the risk assessment, the yearly one, still in TeamRisk, there is still somehow a break. It would of course be nice if the whole risk assessment also for the whole year could be developed in the same way. And to document it like that, in one place. Then it would maybe be even more consistent and the people, now, when they again have to type it into TeamRisk within the old structure, they maybe fall a bit back into this mode. One just has two systems." (Interviewee 8, translated from German)

For the OCA, where auditors' acceptance was in general lower than for ORA, interviewees also noted that for OCAs to be successful, it is not enough to just turn existing audit procedures into quarterly exercises within the OCA process. Instead, they need to be based on a very stringent risk assessment and process and controls analysis to identify the highest risk areas and they need to be automated to a high degree to make running them indefinitely feasible and avoiding repetitive, annoying work for the auditors (for the latter also see quotes in section 8.2.1):

> "And that is why it is an intermediate step. Because there is the question, well, if this is really such a mechanical, mindless work... why isn't this part also automated? And I think there

[7] Quote reproduced from section 8.2.1 for easier reference.

> is a lot of potential for further developments." (Interviewee 2, translated from German)

> "Probably do less OCA tasks, but instead do better ones. Go there and really capture the process, step by step, and then really focus on the effective key controls. And then analyze those." (Interviewee 2, translated from German)

> "And approach this a bit more targeted, risk-oriented than in the past, where we really just... well, opportunistically is probably the right word." (Interviewee 9, translated from German)

To achieve a gradual introduction of quantitative data into the ORA, the quantitative data requested by the auditable entity owners was embedded into the ORA dashboards in a visual form but otherwise as-is, leaving it up to the auditors which trends or portfolio positions they felt necessary to further look into or not. This as well was now identified by some interviewees as not going far enough in terms of process re-engineering, arguing for investing more work into defining limits, triggers and thresholds to move to a push-based ORA, where the system already pre-filters what is relevant in terms of risk impact:

> "I see the risk in that, well, if you replace the data graveyard with a forest of charts, than you have the same problem in the end. Probably... the path forward would be more to really move to an indicator-based form. Where not only the trend line is relevant, but where one also needs to think about thresholds and target bands and similar things. And this means to have this discussion a priori and not a posteriori. And we haven't yet achieved this change of mindset. But there is no way around it. Because the more data you have, the more you have to aggregate it, and then the automaton comes into play which can tell you, 'hey, the threshold has been breached three times, I will send

> you an email'. And then you get everything via push, not pull."[8] (Interviewee 2, translated from German)

All in all, the impact of the CA front-end system on CA acceptance is seen as clearly more positive at our case study partner in areas where re-engineering has taken place than in areas where old processes were not fully replaced and remain stitched to the new CA world, supporting this hypothesis. In the beginning, many argued for a very gradual implementation of CA, but in the final interviews, multiple interviewees argued for a bigger, more impactful re-engineering of audit processes.

Visible Benefits (H1c)
The hypothesis that visible benefits of CA early on in the development process have a positive impact on CA acceptance (via Performance Expectancy) could not be comprehensively evaluated as part of the case study. Initial experiments with CA at the case study partner predated this research initiative, so the earliest benefits were outside of the case study horizon. Also, while at some organisations the internal audit activity needs to "market" its CA efforts also to senior management in order to ensure sufficient funding, at the case study partner this was not the case due to the strong level of independence of its internal audit activity. Hence, there was no focus on "quick wins" and the system was not used with most senior management stakeholders.

Where the system was used, reception was positive and often lead to an increase in (passive) acceptance for CA, providing at least some support for the hypothesis and no contradicting evidence:

> "I think [our stakeholders] were all always really impressed to also see how substantially [the internal audit function] looks at the audited entities. They weren't aware what we are doing there. By showing something like that one of course opens a door somewhat." (Interviewee 2, translated from German)

[8]Quote reproduced from section 8.2.1 for easier reference.

> "Some have been amazed[...]. And the people have even been told internally there that if they have any questions regarding data, they could also approach [the internal audit function], 'they have a relatively large overview'." (Interviewee 4, translated from German)

This hypothesis also implies that any implementation of CA should be step-by-step, so that results can be presented early and not only after a (potentially multi-year) implementation period. This agile approach has been used in the case study and was widely appreciated by the interviewees:

> "From my point of view, I am convinced this is the right approach, also a bit trial and error, a bit of experimentation, learning, how one could do it... and then put together the best of what has been proven." (Interviewee 1, translated from German)

> "I believe this is the right [approach]. Because one first has to observe, do a pilot project, or just do a prototype, in order to firstly gather experiences and not do the same mistakes with everything at the same time. And secondly to see whether it yields something. And this is why I believe this is right like that." (Interviewee 3, translated from German)

> "I am a big friend of such prototype-based approaches. Because in the past I have experienced often... all these big monsters, they perish before they have even been rolled-out. In the beginning a lot of paper gets written and in the end the amount of money has no relationship to the paper. And this fails miserably. Or one rolls out something gigantic, and then it isn't practical, because one just didn't know how this would develop. I do think that such prototype-based approaches are a good thing. And it is also within the zeitgeist. It is more agile." (Interviewee 2, translated from German)

Availability of Skills (H2a)

The hypothesis that the availability of the right skills is a major driver of CA acceptance (via Effort Expectancy), as adopting CA is not feasible without the right auditor skillset, was a major theme in the interviews conducted as part of this study, both inside and outside of the case study partner.

The interviews during and after the case study have highlighted that the required skills cannot be substituted by a CA front-end system. What is missing is not primarily expertise in using computers in general or analytics system specifically. While a CA front-end system can help auditors in analysing data by providing self-service capabilities and thus eliminating the need for advanced programming skills, most interviewees noted that they are already not looking for coding skills in auditors but instead are searching for an analytical, curious mindset. It is more about being able to organise, connect, and properly judge the information received than it is about procuring the information in the first place. And, as one interviewee has remarked, they do not expect these skills to be replaced by a computer anytime soon:

> "The algorithms, one needs to train them somehow. And the effort needed to do this... In theory it is feasible, I mean, certain sentiment analyses or something like that, those one could do. But then one has to draw the right conclusions from it. And this inference part of generating knowledge is not [that easy]. And there, I believe, the market is also not yet ready. These are primarily empty promises. Basically, extracting information from texts, yes, that is possible... text classification and something like that. Also translation, of course. These are all utility functions. But the actual knowledge generation will remain in human hands for a long time to come." (Interviewee 2, translated from German)

It is also not the goal to replace these inference skills by auditors with computers:

> "I have hired the auditor for him to think. I also pay him for introducing his inputs, for analyzing the data and to reach a reasonable judgement at the end." (Interviewee 6, translated from German)

Thus, this case study which has focussed on the specific aspects of a CA front-end system will not be able to evaluate this particular hypothesis, which is unfortunate given that this seems to be one of the key questions when one wants to increase adoption of CA and other digital auditing initiatives. This will be discussed further in section 9.3.

Effective Corporate IT (H2b)
The hypothesis that an effective corporate IT function will enable CA and thus increase CA acceptance (via Effort Expectancy) is supported in the case study both by how avoiding IT involvement can increase CA adoption as well as by how additional data sources and analytics capabilities can motivate auditors and enable future CA implementations.

In areas or organisations where corporate IT projects require long planning periods and significant investments and are not well aligned with the development cycles of CA in most internal audit departments, implementing CA as end user applications in the domain of the internal audit activity can speed up development and thus help make CA projects feasible (also regarding the visible benefits early on, discussed above). This was the approach chosen for this case study and all interviewees agreed that this was the right approach (see section 8.2.1).

Note that this does not necessarily amount to a lack of confidence in the IT function. In many cases, this approach just recognizes that corporate IT processes are set-up to account for the significant risks that changes will impact the availability, integrity, or security of operative, core IT systems, failures of which will lead to significant losses (in remediation costs and/or lost revenue) to the organisation. Compared to these systems, a CA front-end system has far lower risks regarding availability and integrity, as the independence of the internal audit activity means that those systems will necessarily stand apart from and will thus not impact any operative business processes, and can thus be set-up and operate in a leaner way. Regarding security, no compromises are possible as audit systems will often hold particularly sensitive corporate information, but this risk can be addressed by delegating data storage and access control to an existing, well-controlled corporate IT platform (such as Microsoft SharePoint in this case study, but also an established database system with granular access controls could take on such a role).

Implementing CA as end user application supports both cases from the literature who have also found this to be a successful approach (e.g. Hardy & Laslett, 2015) as well as sucess stories from the initial interviews, where one interviewee e.g. also confirmed that “I find, the independence that we have, the freedom that we have to do this, is great. [...] Within ten minutes I can provide a new version. And this makes us very free” (see section 4.2.2). Interestingly, by moving forward like this, it can also show the IT function what is possible and lead to new impulses for the IT infrastructure of the organisation:

> “I have used it to show the colleagues in the [business intelligence] project, what business intelligence could really mean. And not just colored charts with colorful buttons. [...] And basically set this up as requirements for the procurement function.” (Interviewee 2, translated from German)

> “If you have quickly made a prototype somewhere[...] and then you give it to the [organisation] for the programming, then it will develop into something good. But [...] you can try different variations and you do not already have to anticipate the final result.” (Interviewee 5, translated from German)

Nevertheless, this does not mean that CA can work without an effective corporate IT function. As Hardy and Laslett (2015) have also pointed out, even if the CA systems are operated within the internal audit activity, audit will still rely on the corporate IT to get high-quality data and analyses out of the corporate IT systems. This has been mirrored by the experience in our case study:

> "And this probably also means that one obtains data from certain systems which does not yet exist." (Interviewee 2, translated from German)

Our case study has also shown how a proactive IT function, that makes powerful tools available, can develop excitement for data analytics and CA. After the organisation started a project to roll-out the BI visualisation platform Tableau for data exploration and showcased it to potential users, multiple interviewees started to suddenly show real excitement for the new possibilities and how they might spark enthusiasm among the auditors:

> "What of course would be even more awesome, if one could do something a bit generic à la Tableau. But this is of course a totally different league." (Interviewee 3, translated from German)

> "And they are at the moment evaluating whether they buy Tableau. More in the sense of a BI tool. And I believe, this would be[...] I could already have a look in there, and probably this is almost the better approach to get the people a bit onto this topic." (Interviewee 4, translated from German)

Thus, while implementing CA as end user application can mitigate the impact of the corporate IT function on CA success somewhat, a really effective corporate IT will provide data sources and tools that can increase CA acceptance through enthusiasm about the new capabilities.

Board (H3a)

At the case study partner, the audit committee did not demand or push the internal audit activity to adopt CA. They appreciated the work invested by the internal audit activity into CA as an increase in assurance provided to them, providing passive encouragement. Thus, the move towards CA was not driven by the demands of the oversight body and consequently it was not possible to observe the effect such a push by the oversight body would have had on CA adoption.

Management Support (H3b)

Due to the regulatory environment and the historic role of the internal audit activity at the case study partner, it has a very strong independence from operative management. Thus, senior management support in this case study was probably less important than it might be at other organisations, where internal audit has a dual reporting relationship and/or a bigger need to prove its business value not only to the oversight bodies but also to management.

Change Management (H3d)

The implementation of CA at the case study partner was accompanied by change management prior to and during the case study. Many parts of proper change management, such as consultation of the affected auditors and the implementation of a working group to evaluate the right approach for CA at the organisation, predated the beginning of the case study and their effect could thus not be properly evaluated. During the case study, change management was supported by ongoing training and implementation of a strong feedback mechanism where auditors could provide feedback on the implemented tool and such feedback was taken seriously for future design iterations. After the conclusion of the case study, the internal audit activity developed a comprehensive training program for all auditors to give them the opportunity to increase their business process and technical knowledge, another important part for such a transformation process. However, as the implementation happened after the case study, also this part was not evaluated in this study. Thus, while the importance placed on comprehensive change management at the case study partner suggests that it was at least believed that change management is an important factor for successful CA adoption, its actual effects are less clear and the case study can provide only little evidence for this specific hypothesis.

Other hypotheses, not confirmed in the survey results

During the case study, also some hypotheses which were not confirmed in the survey results[9] resurfaced in the interviews.

The hypothesis that an effective coordination and positioning of CA within the 3LoDs (H1b) would increase CA acceptance (via Performance Expectancy) was mentioned as an opportunity for future improvements by multiple interviewees, in particular regarding a common risk taxonomy and definitions:

> "We have to think about, yes, the risk category... can we do this a bit more structured, also around the risk categories in which the [organisation] is thinking. This would be a concern of mine, that we think about, how we can do this in the future. That not everybody is just defining his risk categories as he pleases." (Interviewee 1, translated from German)

> "But it is important that the whole [organisation] talks about the same risks, the same understanding, the same definitions. And we should also use those." (Interviewee 7, translated from German)

> "It would raise the question if we have to build this as [internal audit] alone. If this would not be rather a task for a somehow combined GRC function.
>
> [...]

[9]Note that this only means that no significant relationship was identified, which – especially given the relatively small sample size – does not indicate that no relationship exists. It is thus not a contradiction if evidence for hypotheses is found in the case study for which no significant relationship was found in the survey results.

> Maybe the only negative is that we have to do it stand-alone [without involvement from the other control functions]." (Interviewee 9, translated from German)

The quotes above suggest a shift in the discussion around the 3LoD model in the context of CA: in past literature (e.g. de Aquino et al., 2013) the main risk was seen in internal audit potentially taking over operational duties of the second LoD by monitoring operational processes as part of OCA, i.e. the challenge was one of how to achieve a clear delineation and avoid a blurring of the lines. However, a clear delineation of the 3LoD did not exhibit a significant effect in the quantitative survey results and in the case study discussions the main challenge discussed was how to leave the different silos behind and how to cooperate better among the 3LoDs. This shift mirrors the IIA's proposal on the future of the 3LoDs (John et al., 2019), which also highlights a move from isolation of the individual functions towards closer collaboration.

As the case study provided evidence that an effective CA front-end system can change attitudes regarding CA (see section 8.2.2) and that this also relies on effectively re-engineered CA processes (see above), the case study also seems to support that efficient CA processes and systems (H2c, H2d) can have a positive impact on CA acceptance.

Combined view on hypotheses

Table 8.3 and Figure 8.5 provide an overview over the tested hypotheses and both the quantitative survey results as well as the indications obtained from the qualitative case study. Figure 8.5 also indicates the relationships confirmed by Gonzalez et al. (2012). The strongest confirmation for a hypothesis is obtained when both the qualitative results and the case study findings support it; these cases are depicted by the boldest arrows. If a hypothesis is supported just by either the survey or the case study, the relationship is depicted as less strong. The figure cannot depict all the nuances of the qualitative findings: The relationship between Digitalisation (H2b2) and Effort Expectancy was significant, but in the opposite direction than originally hypothesized. This opposite relationship was partially supported by the case study (see table). In the case study, a positive effect of an effective CA system (H2c) on intention to use CA was mentioned by multiple interviewees, but the effect was not explained via Effort Expectancy, which is why there is no evidence depicted in the figure.

Note that just as a lack of significance in the quantitative survey analysis does *not* indicate that the given effect does not exist, similarly a lack of evidence in the qualitative case study does *not* contradict the hypothesis, it just means that it could not be substantiated. This could be due to the effect not being present, but it can also be due to some hypotheses not being extensively discussed as part of the case study. Some effects by definition cannot be observed in a single case study, as they rely on differences between different organisations.

Table 8.3: Quantitative and qualitative results on adapted hypotheses. Significance levels from PLS-SEM bootstrapping on survey results (see table 5.16): * = 10%, ** = 5%, *** = 1% level. Hypotheses printed in bold have support from the quantitative survey and/or the qualitative results.

Hypothesis	Survey Coeff.	Qualitative results
Re-engineer (H1a) → Performance	**0.252** **	**Supported.** Properly re-engineered areas (in particular the ORA) were overall seen as successful. Most auditor criticism focussed on areas which were *not* properly re-engineered. This confirms the survey results.

Table 8.3: Quantitative and qualitative results on adapted hypotheses. P-values are from PLS-SEM bootstrapping on surve results (see table 5.16). Significance levels: * = 10%, ** = 5%, *** = 1% level. Hypotheses printed in bold have support from the quantitative survey and/or the qualitative results.

Hypothesis	Survey Coeff.	Qualitative results
Delineate 3LoDs (H1b) → Performance	0.003	**Partially supported.** This construct was reduced in scope during the survey analysis. In the case study, there was less of a focus on delineation of duties and more on coordination, sharing of information and shared taxonomies among the 3LoDs; a goal that was expressed by multiple interviewees.
Visible (H1c) → Performance	**0.414*****	**Partially supported.** Some parts of the CA implementation at the case study partner predated the case study itself, so it was not possible to evaluate the effect of "wins" very early on. Also, the system was not used extensively with senior stakeholders. Interviewees pointed out that, where they were shown the system, stakeholders were impressed with it (and the depth of the content within). The step-by-step implementation strategy was widely seen as successful and superior to the alternatives.
Robust ITGC (H1d) → Performance	0.044	**No evidence.** This topic was not explicitly addressed with the case study interviewees but also has not been mentioned by interviewees on their own. It is unclear whether this is because the need for robust ITGC is obvious and just assumed or whether it is really not seen as an important topic for CA.

Table 8.3: Quantitative and qualitative results on adapted hypotheses. P-values are from PLS-SEM bootstrapping on surve results (see table 5.16). Significance levels: * = 10%, ** = 5%, *** = 1% level. Hypotheses printed in bold have support from the quantitative survey and/or the qualitative results.

Hypothesis	Survey Coeff.	Qualitative results
Need (H1e) → Performance	0.094	**No evidence.** At the case study partner, the implementation of CA was not driven by an urgent need caused for example by a lack of ressources. Increasing efficiency and (in particular) effectiveness were drivers of CA adoption, but seen as an opportunity and not a need. Interviewees mentioned multiple times that their CA efforts were driven by their own desire to improve and not by (external) pressure.
Skills (H2a) → Effort	**0.541*** **	**Supported.** The required skills for CA and data analysis were always a major topic during the interviews. Audit management is not looking for coders or IT experts but for auditors with an analytical, creative mindest and an ability to distinguish between relevant information and noise.
Corp IT (H2b) → Effort	**0.276*** **	**Indirectly supported.** In the case study, the front-end system was implemented as an end user application to avoid corporate IT. This was seen by interviewees as the right approach for achieving results, indirectly supporting the hypothesis.

Table 8.3: Quantitative and qualitative results on adapted hypotheses. P-values are from PLS-SEM bootstrapping on surve results (see table 5.16). Significance levels: * = 10%, ** = 5%, *** = 1% level. Hypotheses printed in bold have support from the quantitative survey and/or the qualitative results.

Hypothesis	Survey Coeff.	Qualitative results
Digitalisation (H2b2) → Effort	**-0.251*** **	**Opposite effect.** The survey shows an effect in the opposite direction of the original hypothesis (i.e. a higher level of digitalisation makes CA more difficult). During the case study, this direction was supported by the example of an area where the case study partner has recently made a big investment in re-engineered digital processes and this lead to "low hanging fruits" OCA analyses to lose value, making a meaningful CA impact more challenging.
CA System (H2c) → Effort	0.010	**Different effect.** The users appreciated the process simplifications due to the system (see below). The system itself was seen as increasing CA adoption, but not primarily through effort reduction but through an increase in performance (→ Performance) and due to it signalling management commitment for CA (→ Social).
CA Processes (H2d) → Effort	0.090	**Supported.** While the survey showed no significant effect, the interviewees did repeatedly stress how the improved processes as part of the front-end system roll-out increased their efficiency.

Table 8.3: Quantitative and qualitative results on adapted hypotheses. P-values are from PLS-SEM bootstrapping on surve results (see table 5.16). Significance levels: * = 10%, ** = 5%, *** = 1% level. Hypotheses printed in bold have support from the quantitative survey and/or the qualitative results.

Hypothesis	Survey Coeff.	Qualitative results
Training (H3d2) → Effort	**-0.197****	**Little evidence.** The front-end system was introduced using multiple training sessions which were appreciated by some interviewees, but as part of a single case study it was not possible to isolate the effect of these training sessions. Inverse relationship not confirmed in case study.
Board (H3a) → Social	**0.178****	**Little evidence.** The intervieweees at the case study partner noted that their board and audit committee appreciate their work on CA but are not demanding it and are not the driving force behind its implementation.
Mgmt Support (H3b) → Social	**0.531*****	**No evidence.** Due to the strong independence of the internal audit activity at the case study partner, the impact of the organization's management on the implementation of CA is probably lower than at other organizations.
Change Mgmt (H3d) → Social	**0.239*****	**Little evidence.** Change management practices have been taken into account while the front-end system was rolled out, but as part of a single case study it was not possible to isolate the effect of the change management process.

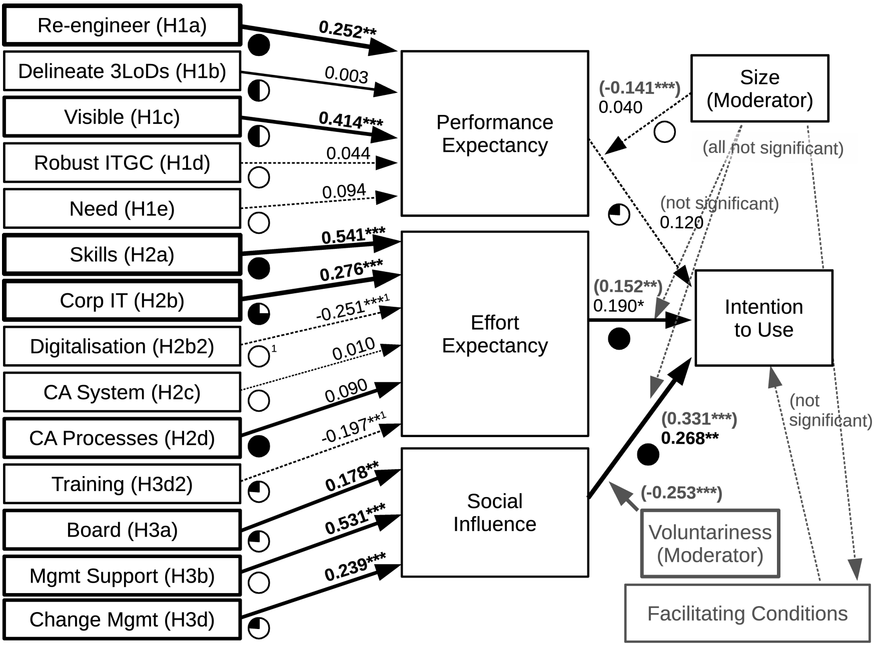
Table 8.3: Quantitative and qualitative results on adapted hypotheses. P-values are from PLS-SEM bootstrapping on surve results (see table 5.16). Significance levels: * = 10%, ** = 5%, *** = 1% level. Hypotheses printed in bold have support from the quantitative survey and/or the qualitative results.

Hypothesis	Survey Co-eff.	Qualitative results
Performance → Intention	0.120	**Little evidence.** In the abstract, the interviewees want to increase future use of CA in order to provide better assurance. However, this was not (yet) based on specific areas where CA increased performance and effectiveness.
Effort → Intention	0.190*	**Supported.** That the new CA methodology and system makes their lives easier and reduces duplication of efforts was a main driver in the interviews about why they want to increase the use of CA.
Social → Intention	**0.268****	**Supported.** A future increase in the use of CA was often seen by interviewees as without alternative, as it is what will be expected from a modern audit activity in the future.
Size Proxy → Intention	0.048	**No evidence.** It is not possible to test the effect of the size of the internal audit activity in a single case study.
Size on Perf → Intention	0.040	**No evidence.** It is not possible to test the effect of the size of the internal audit activity in a single case study.

8.4.2 Refined User Stories

Based on the development process and the final interviews as part of the case study, the initial user stories developed from the theory and the survey findings (see Chapter 6) can be refined and amended, leading to a final set of user stories that can serve as template for future CA front-end system

Figure 8.5: Combined quantitative and qualitative results on adapted hypotheses. Numbers given are survey results coefficients. Significance levels: * = 10%, ** = 5%, *** = 1% level. Pie charts indicate strength of qualitative results (full pie = qualitative evidence for hypothesis, empty pie = no qualitative evidence). Strength of arrow indicates combined hypotheses confirmation (strongest arrows indicate hypotheses confirmed both by survey results and case study). Parts in grey show results from Gonzalez et al. (2012).



1) Significant relationship in the opposite direction than hypothesized

designs and implementations.

Based on the findings in this chapter, the following amendments to the initial user stories can be proposed (changes are given with additions underlined and removals striked-through):

1.2 Review management's risk monitoring

As audit universe entity owner, I want to receive and evaluate management's risk monitoring in the ORA system, so that I can review and use it without having to switch systems. I want to receive push notifications about new information and be able to mark information as processed.

Acceptance Criteria

- ☐ Qualitative 1/2LoD reports can be stored and pushed into the system
- ☐ Quantitative 1/2LoD risk monitoring data can be visualised
- ☐ Users can receive push notifications about new reports or data
- ☐ Qualitative and quantitative data can be marked as "done"
- ☐ 1/2LoD risk monitoring can be assessed and commented on

1.4 Data-driven ORA with trends, comparisons, outliers

As audit universe entity owner, I want to work with and interactively visualise quantitative data in my ORA, so that I can quickly identify trends and outliers and perform comparisons. I want to mark which visualisations I have already analyzed.

Acceptance Criteria

- ☐ Data can be loaded and interactively visualised
- ☐ Available visualisations allow to identify trends and outliers

- ☐ Data visualisations are integrated into the ORA process
- ☐ The user can mark elements of visualisations as “done”

1.5 Assessing emerging enterprise risks

As audit management, I want to gather and aggregate all the individual inputs from the audit universe entity level, so that I can get a big picture view and identify emerging enterprise-wide risks.

Acceptance Criteria

- ☐ Risk inputs flow bottom-up along the audit universe hierarchy
- ☐ Qualitative assessment tools enable a systematic discussion of risks
- ☐ Inputs from different sources (qualitative, quantitative) can be merged
- ☐ Lower-level risk items can be aggregated to higher-level items

1.6 Document risk assessment

As audit universe entity owner, I want to document all the work performed for the risk assessment in a way that adheres to data retention requirements, so that I can document conformance to the ORA process and IIA Standard 2010.

Acceptance Criteria

- ☐ Arbitrary work performed and thoughts need to be captured
- ☐ ~~An audit trail needs to exist for changes and removals~~
- ☐ Assessments which serve as planning inputs are archived inside or outside the system
- ☐ Document retention and removal requirements need to be followed

2.3 Documenting work performed

As an auditor, I want to document the work I have performed and the conclusions I have drawn within the OCA data set, so that I can document conformance to the IIA Standards.

Acceptance Criteria

- ☐ Work performed can be documented within OCA procedure
- ☐ ~~Conclusions can be documented within OCA procedure~~
- ☐ OCA procedure documentation can be exported to the AMS

2.6 Support quality assurance conversations

As audit management, I want to be able to engage with and discuss review points with my auditors on the OCA platform, so that I do not have to switch context for my ongoing communication as per IIA Standard 2340.

Acceptance Criteria

- ☐ Electronic discussions are possible on OCA tasks, workpapers
- ☐ Discussions are kept separate from audit findings (IIA, 2016f)
- ☐ Auditors get notified about new review discussions via email or other external notification

4.1 Structured focus on risks

As audit management, I want to capture risks in the ORA in a structured form organised along the audit universe, so that I can aggregate the risks throughout the organisation and know where to focus my audit resources.

Acceptance Criteria

- ☐ ORA structure follows a (configurable) audit universe
- ☐ ORA allows capturing risks in a structured form
- ☐ ORA supports aggregating risk information from notes to risk items
- ☐ ORA supports aggregating lower-level risk items to higher-level items

5.2 Visualisation of complex data

As Audit Committee member, audit management and/or auditor, we want to see large data sets in a visual form, so that we can better spot trends, emerging risks and unusual patterns or changes. Drill-downs should allow us to easily move down to the source of aggregate data and to recombine or slice the source data in new ways.

Acceptance Criteria

- ☐ Common visualisations of data can be used
- ☐ Visualisations can be manipulated to support identifying anomalies
- ☐ Drill-downs allow to move from aggregated to source data
- ☐ Data can be recombined or sliced interactively by the user

In addition, the following new user stories can be proposed:

8.1 Knowledge repository

As audit universe entity owner, I want to be able to store additional, permanent knowledge about my audit universe entity. In particular, I want to keep track of pending items that might be relevant for future audits and I want to be able to link existing objects from our organisa-

tion's AMS and/or GRC systems (such as audit reports and findings, risk scenarios and mitigating measures) to the structural elements of my audit universe entity.

Acceptance Criteria

- ☐ Pending items can be stored for each audit universe entity
- ☐ Pending items remain visible until they are marked as "done"
- ☐ Sub-elements can be configured for each audit universe entity
- ☐ AMS and/or GRC objects can be linked to these sub-elements

8.2 Advanced authoring capabilities

As an auditor, when I create or edit information in the system, I want to be able to use rich-text formatting capabilities and want to be able to add inline images and tables to my text. Also, I need to be sure that everything I enter is saved immediately and will not get lost when I (expectedly or unexpectedly) exit the system.

Acceptance Criteria

- ☐ Information in the system can be edited using a rich-text editor
- ☐ Information in the system can contain inline images and tables
- ☐ New or changed information is saved continuously without user input

8.3 Usable in Workshop Settings

As an auditor, I want to be able to use the system in workshops, showing, discussing, and directly updating our ORA risk analysis and OCA results with workshop participants. For this, I also want to be able to project the system on big screens in conference rooms.

Acceptance Criteria

- ☐ User interface supports big screen projections
- ☐ Coherent entities can be displayed on a single screen to enable discussion

8.4 Subscriptions and push notifications

As an auditor, I want to be able to subscribe to arbitrary content from the system, such as to specific audit universe entities and/or keywords. I want to get notified by push notification in- and outside of the system whenever new or changed content exists for the elements I have subscribed to.

Acceptance Criteria

- ☐ Users can subscribe to audit universe entities and/or keywords
- ☐ Users get notified about new or changed entries for these
- ☐ Notifications appear inside and outside of the system (e.g. via email)

These user stories account for the feedback received during the development process and in the final case study interviews. Hence, they go beyond the current state of the CA front-end system implementation (e.g. regarding risk aggregation between risk items, drill-downs and self-serve analytics, and external push notifications) but rather document what a final CA front-end system should encompass based on this specific case. Thus, some of the user stories might contradict itself when evaluating them in the context of this specific CA front-end system - for example, the wish for push notifications outside of the system which isn't feasible with the Microsoft SharePoint-based design. However, future systems might be based on different technologies and thus overcome these restrictions.

The amended user stories can inform both theory, by increasing the knowledge base on what users expect from CA, and practice, by providing a practical template for e.g. commercial AMS vendors on how to improve CA front-end capabilities in their existing or planned software solutions.

8.4.3 Impact on Theory

In general, the case study showed that Ames et al. (2015b)'s definition of CA and the separation of ORA and OCA is a sound theoretical basis for practical CA. The auditors were able to understand the benefits of CA and how it applies to their organisation. In particular Ames et al. (2015b)'s approach to the 3LoDs, with continuous auditing as a permissible and wanted stepping stone to full continuous monitoring and testing of continuous monitoring for CA, was helpful to resolve the inherent (at least technological) overlap between OCA and continuous monitoring (see section 2.5) that hindered earlier attempts at continuous auditing.

Ames et al. (2015b) focus on the use of "technology-based audit techniques" and in particular on data analyses in their guidance. While this makes sense for OCA, where the case study has shown that only stringent automation avoids auditor fatigue (see section 8.2.1), the case study showed that ORA works well even without available quantitative data analytics (only 12 of the total 63 auditable entities in the ORA were supported with quantitative data feeds). This is only alluded to by Ames et al. (2015b, p. 5) when they state that ORA "should include a review of the results of management's monitoring efforts", but highlighting a qualitative approach to ORA more could help smaller audit teams without the resources to build out large data streams and analytics to get started with value-added ORA.

In general, there is relatively little guidance available for a qualitative ORA process and the risk assessment process of audit overall. IIA Standard 2010.A1 merely prescribes that the "internal audit activity's plan of engagements must be based on a documented risk assessment, undertaken at least annually" and that "the input of senior management and the board must be considered in this process" (IIA, 2017a), without detailing this risk assessment process. The corresponding Implementation Guide (IIA, 2016a) clarifies the inputs into this process, that it needs to cover internal and external risks, needs to be documented and is the responsibility of the CAE. However, the implementation guide seems to start with the idea of a relatively infrequent, yearly process, and is not tailored to more frequent or ongoing planning cycles. It also does not recognize that in larger audit activities many auditors will be involved in a comprehensive risk analysis and planning, going far beyond the CAE alone. This leads to questions about coordination and quality assurance that remain unanswered. Last but not least it does not provide any guidance on risk aggregation neither among risk categories within one audit universe entity nor from lower-level audit universe entities to higher-level constructs. It only states that risks are "measured in terms of impact and likelihood".

D. Moon (2014) presents approaches for a very quantitative continuous risk analysis, assigning and aggregating key risk indicators (KRIs) to risks within the audit universe and prioritising audit procedures based on assigned risks' KRI values. His study presents a theoretical approach and illustrates it with one example KRI (Twitter sentiment). The interviewed audit management at the case study partner partially acknowledged that this could be an approach in the future and might be possible now in certain isolated areas, but they were unanimous in their assessment that such a fully quantitative approach would not be feasible today if it should cover the entire audit universe. Some also cautioned that this might lead to blind spots if one only relies on quantitative data. This means that theory such as D. Moon (2014), with a focus on a fully quantitative risk assessment far out in the future, leave a gap for more theory on how qualitative and quantitative approaches can be combined in the (messy; Hardy, 2014) present.

As some interviewees have mentioned, the case study partner has now launched a working group to overhaul its overall risk assessment and risk-oriented planning approach, in part motivated by the roll-out of the new

ORA in the CA front-end system. This working group has (by studying relevant literature and visiting other internal audit departments in Switzerland) also realized that there is little guidance for and standardisation among internal auditors regarding their risk assessments and overall audit planning. As this means that every internal audit activity needs to re-invent these processes from scratch, additional guidance in this area could both lead to efficiency gains by avoiding duplication of efforts and move internal audit as a profession forward.

Contrary to this, OCA processes are better understood. For one, a lot of early continuous auditing literature has covered continuous auditing more in the sense of OCA and thus really provided theory on how to perform OCAs. Also, OCAs are basically regular audit procedures (only with a higher frequency thanks to automation) and thus mostly follow the established IIA standards and guidance on conducting an audit engagement.

Mainardi (2011) also understands continuous auditing primarily as OCAs. He argues that continuous auditing does not necessarily have to be analytics-driven and automated but simply means to perform audit procedures on key controls repeatedly and with a higher frequency than usual (e.g. quarterly or monthly). The feedback from the case study interviewees partially contradicts this view: while it works in theory, not sufficiently automated OCA tasks lead to repetitive, low value-added work and thus frustration for the auditors (see section 8.2.1). In an only partially automated OCA task, either a control works well, in which case practically all cases to be analyzed will be false positives and frustrate the auditors, or a control does not work well, in which case each OCA run will just confirm known weaknesses and frustrate auditees with repetitive audit findings.

The case study applied an incremental approach to CA, following suggestions by Baksa and Turoff (2011, pp. 248–249) and Medinets et al. (2015, p. 149). The final interviews support this literature as most interviewees agreed that this incremental approach was the best (or only) way forward. By developing a CA front-end which can apply ORA also to audit universe entities without any data analytics, the case study also showed that such an incremental approach can be supported by appropriate tooling.

As almost all CA projects in practice do not aim to completely replace regular audits but usually complement regular audit projects with ORA and OCA, this also needs to be reflected in the IT architecture for CA. In particular, this means that any CA front-end system needs to be integrated with (or built into) the AMS in use for planning and performance of the regular audit projects. This should be recognized by proposed architectures such as by Baksa and Turoff (2011) or Kiesow et al. (2014), which integrate CA with data sources but not the AMS.

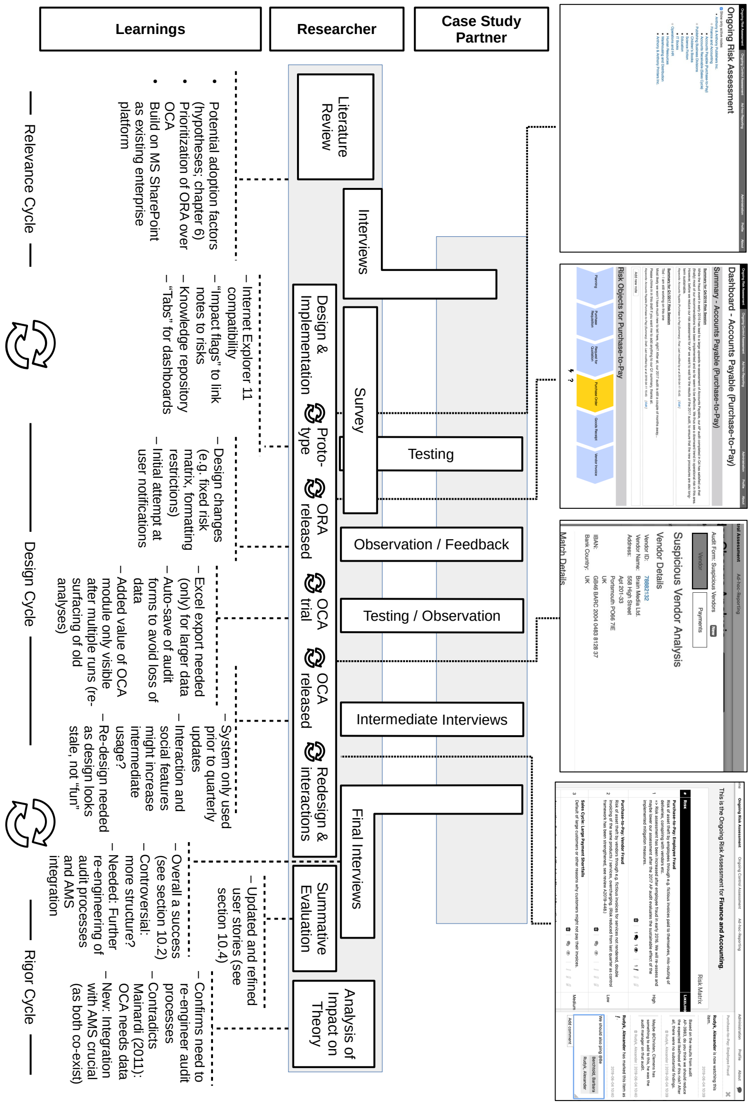
In general, during the case study the IIA Standards and implementation guidance were not experienced as barriers to CA. In fact, the opposite was the case and as can be observed in Chapter 6 a lot of IIA material was used to construct the user stories for the CA front-end system. This was also confirmed by the interviewees, who often expressed puzzlement when asked whether the IIA Standards in their opinion stand in the way of CA. This contradicts especially earlier theory, where regulatory guidance was often mentioned as a barrier (e.g. Vasarhelyi, Alles, & Williams, 2010). However, it has to be noted that *a)* these studies mostly related to external auditing, where standards are less flexible than in internal auditing, and *b)* it seems possible that the IIA Standards will get into the way when the goal is to completely replace traditional auditing with CA instead of complementing it (e.g. a completely "push"-based audit activity will probably find it difficult to adhere to IIA Standard 2020 which requires for the audit plan to be reviewed and approved by "senior management and the board").

The survey results point to Performance Expectancy, Effort Expectancy, and Social Influence being more driven by organisational, environmental, and social factors (such as process re-engineering, the availability of the right skills, proper change management) than by the particular tools being used. In general, the case study supports this observation that a CA front-end tool can only play a small part in the move towards CA. The interviews do suggest that the CA front-end can have some positive effect on CA acceptance among auditors, however. They point to potential indirect effects of an effective CA toolchain, which might not have been captured by the survey: Investment into a good CA front-end system can show to auditors management buy-in and thus support change management and the perception of Social Influence. And dynamic data visualisations can impress stakeholders, yielding the early visible benefits which the survey did find to exhibit a significant relationship on Performance Expectancy.

8.5 Summary of Design Iterations

As discussed in section 3.2.2, DSR uses design iterations to improve on theory-based system design – the results of which can in turn inform theory. Figure 8.6 provides an overview of the different iterations in this case study and how they mapped to the DSR cycles proposed by Hevner (2007). While the bottom part shows the insights gained from the different steps in the case study, the top part shows how in parallel the actually implemented software application artefact has developed and changed its form. The middle part highlights the importance of close collaboration between the researcher and the case study partner, as only through the various interactions new insights and design iterations could be obtained.

Figure 8.6: Completed design iterations as part of the case study. The timeline shows the development of the artefact (top), the actions and interactions of researcher and case study partner (middle), the learnings derived from these interactions (below the middle), and the mapping to Hevner (2007)'s DSR cycles (bottom).



Chapter 9

Conclusion and Outlook

This thesis investigated how the adoption of CA in internal audit practice can be increased and how this can be supported by a CA front-end system that provides auditors with an approachable interface to conduct their Ongoing Risk and Control Assessments.

9.1 Conclusion

Based on interviews with internal audit practitioners in Switzerland, potential factors that support CA adoption have been identified. Following Gonzalez et al. (2012), these factors have been structured following the UTAUT model of technology acceptance. The resulting hypothetical model has been tested in a survey among Swiss internal auditors. While an impact of some of the hypothesized factors on the UTAUT antecedents was supported by the survey results, the survey results did not support the explanatory power of UTAUT for CA adoption, contradicting the findings from Gonzalez et al. (2012). Based on the ubiquitousness and the more mature state of CA today, it might be more appropriate to use models on technology continuance such as Bhattacherjee (2001) or focus on user engagement when using CA systems (which goes beyond the concept of acceptance; Y. H. Kim, Kim, & Wachter, 2013).

User stories for a CA front-end system have been derived from CA theory and the survey results on which factors have a significant positive impact on Performance and Effort Expectancy and Social Influence for CA. Based on these initial user stories, a CA front-end system has been designed and implemented within the internal audit activity of a case study partner over a period of a bit more than a year. Results from that case study were used to refine the initial user stories and to validate the theory and survey results on CA adoption factors.

9.1.1 Factors Impacting CA Adoption

The first research subquestion asked "which factors have a significant impact on CA adoption in Swiss organisations, contingent on the organisational environment". The goal of this question was to identify factors that can be used to increase CA adoption within Swiss internal audit activities, in the current environment of ubiquitous digital transformation. The results of the survey among Swiss internal auditors indicate that UTAUT, a classical technology acceptance model which was successfully applied to the CA adoption context in the United States in 2012 (Gonzalez et al., 2012), can not explain CA adoption patterns in Switzerland today. Instead, models on technology continuance (Bhattacherjee, 2001) seemed to better reflect how CA is perceived by auditors during the subsequent case study.

The survey results did indicate that the perceived performance benefits of CA increase for auditors in internal audit activities where CA adoption was more fully supported by a re-engineering of audit processes and where CA was adopted in a way that yielded earlier, visible benefits to the stakeholders.

These findings from the survey have been confirmed by the results of the case study, where auditors were most critical about CA in areas where audit processes had not been sufficiently re-engineered and/or the benefits where not (yet) visible to them. This was also the feedback received from one of the initial interviewees at other organisations, who – when contacted towards the end of this study about their progress since the beginning – also mentioned that they have advanced a lot technologically but still need to move CA into the audit processes, which means that the "CAE needs to make some hard decisions for that". A barrier for this change is that CA can remove power from audit management, as they will have less freedom to decide what to audit and will instead have analytics and data tell them what their teams should look at.

The survey indicated that the perceived effort required for CA decreased for auditors in internal audit activities where staff with the right skills was available and which were supported by an effective, supportive corporate IT function. The CA front-end system at the case study partner was implemented as an end user application on the existing enterprise SharePoint infrastructure, thus avoiding the need for a large IT project and this way increasing corporate IT effectiveness. Near the end of the case study, the corporate IT function was proposing to roll-out Tableau, a modern, interactive analytics and visualisation platform, which lead to considerable interest in the new possibilities for CA among the auditors, further highlighting how an effective corporate IT can spark excitement for CA through the provisioning of effective tools and data sources.

Not surprisingly, the survey also confirmed that auditors will perceive more social support for adopting CA when their organisation's Board of Directors and its senior management show more support for CA. In addition, effective change management for adopting CA increased the perceived social support for adopting CA. The case study indicated that rolling out visible CA resources such as a new CA front-end system can aid in the change management process, as such a roll-out can be a way to show the commitment of audit management to the new way of doing things.

Successful CA will thus benefit from a strong commitment by audit management and from the realisation that implementing CA is not primarily a technology project: instead, implementing CA needs to be based on a targeted re-engineering of audit processes and requires hiring auditors with the right skill- and mindset. Interviewed internal audit managers highlighted that they are not primarily looking for programmers or IT specialists, but for auditors who can combine business and industry knowledge with an analytical mindset, helping them to ask questions and answering them through data. Performing audits on the full data instead of samples will often yield a variety of data quality and other issues, making it more important for auditors to be able to prioritize and separate high-risk issues from minor imperfections.

Adopting CA should be treated like any significant change process and follow established change management practices. Rolling-out modern tooling, such as advanced BI and visualisation tools and/or a CA front-end system (such as the one discussed in this study), as part of the CA adoption process can help build excitement and underline the commitment of audit management. Auditors will perceive more social influence to use CA if the Board and also the organisation's senior management support or even demand it. This can be supported by designing the CA implementation project in a step-by-step manner such that it becomes possible to show CA's benefits early-on in the process and not just after having spent considerable time and ressources. Here, too, the right front-end tools can help by presenting CA results in an appealing, modern way.

A counter-intuitive finding from the survey showed that for organisations whose auditors perceived their processes as more digitalised, these auditors also reported lower performance benefits from CA. The original assumption was that digitalised processes are a prerequisite for effective CA, as only digitalised processes yield the necessary data points for automated CA. However, based on the conducted interviews, it seems possible that this finding could be a result of reverse causality – auditors employing more effective CA have a better understanding of the organisation's processes and their limitations, and are thus more critical about the state of their digitalisation. Alternatively, the finding might support the hypothesis that at more digital organisations, where processes are already digitalised and thus less prone to human error, there are fewer low hanging fruits that could be harvested using even simple CA measures (such as identifying duplicate vendor payments in organisations where this is not yet controlled in-process by an IT-based application control), making it more difficult to show the added value of CA.

While the original research question also aimed at a differentiation of CA adoption factors by organisational environment, there were unfortunately not enough survey responses to conduct a full multi-group analysis. Based on the interviews and the overall response patterns, certain unsubstantiated observations can be made: Unsurprisingly, larger audit activities are more likely to already have adopted CA. This might change in the future, once CA tooling matures and can be rolled-out without advanced technical knowledge. The discussion on CA is particularly prevalent in the financial industry. Due to the regulatory environment, these organisations have proportionally much larger internal audit activities with often far broader mandates than e.g. in manufacturing companies. They are also data-driven businesses, with a lot of data being generated and also being exploited particularly in the 2LoD functions such as risk management. This also means that the discussion about how CA fits into the 3LoD model (see section 2.4) seems to be more prevalent in the financial industry: the 2LoD functions are bigger and more established there and the regulators will enforce a stricter separation between the LoDs. In other industries it seems more common that CA is marketed (and sometimes also paid for) by providing value-added and data analyses directly for the business (e.g. the accounting function or the procurement department).

9.1.2 Front-End System Design

The second research subquestion asked "how can a CA front-end system be designed to support CA adoption by organisations". This question was first approached theoretically by deriving user stories for such a CA front-end system from the theory on CA in the literature as well as from the survey results on CA adoption factors. These user stories were subsequently used to make design choices for a CA front-end system and to develop a working artefact which was put into use at a partner organisation's internal audit activity. Based on this case study and the feedback from the users, the system was amended over multiple iterations and data was gathered whether these user stories (and their underlying assumptions) properly captured user needs and helped to increase adoption of CA at the case study partner.

Based on CA theory, user stories were developed separately for ORA, OCA, and for overall audit documentation requirements. User stories for

ORA focus on an auditor-driven ORA organised around the audit universe of auditable entities. The CA front-end should support presenting to the user both qualitative and quantitative data as input for the ORA, which can include external information, reports from the first or second LoD, and/or quantitative data from other systems or data analytics. The CA front-end supports the user in identifying risks and in aggregating and documenting them along the audit universe hierarchy. The system captures auditor conclusions and trains of thought to properly document the ORA.

For OCA, the user needs to be able to examine transactional or configuration data, usually but not necessarily pre-processed by data analytics (outside of the system). Such data should be presented to the user together with the specific work program and the audit procedures for the given OCA task. The auditor who performs the OCA should be able to document the work performed and any conclusions reached and the manager or peer responsible for QA should be able to document the performed QA, following IIA Standards on audit fieldwork that will also apply to the OCA.

For data from both ORA and OCA, both the IIA Standards and the Code of Ethics require that auditors must ensure appropriate data security and data retention. Any CA front-end system must thus be able to accomodate organisation- and legal-environment-specific data security and retention policies.

Adding to these theory- and IIA Standards-based user stories, the survey results on CA adoption factors have been used for user stories development. As effective CA relies on process re-engineering, a CA front-end system should support re-engineered audit processes such as agile auditing and should support auditors in this change by closely guiding them along the re-engineered processes. To be able to show visible benefits early on, the CA front-end system should be designed in a way that makes it possible to start small, in a gradual way, without having to implement data analytics for all areas of the audit universe from day one. This requires a risk aggregation that also works if some auditable entities are not supported with quantitative data. Showing visible benefits can also be supported by powerful visualisations in the system, which can help to provide new insights into existing, complex data.

As the availability of skills is a key challenge in adopting CA, any CA front-end system should aim to be as easy-to-use and self-explainable as possible to avoid demanding even more knowledge build-up from the auditors. As the interviews have shown, audit managers do not aim to hire programmers or IT specialists but auditors with a technological mindset. This means that it needs to be possible to roll-out and configure any CA front-end system without programming know-how. In particular, the audit universe, the ORA dashboards and the OCA task interface needs to be configurable using an administrative GUI, without the need to modify program code or configuration files.

An effective corporate IT function makes it easier to implement CA in an organisation. However, this is an exogenous factor that cannot be changed by audit management. That is why ideally it should be possible to roll-out a CA front-end system without significant IT involvement, to make CA as feasible as possible regardless of an organisation's IT function. Related to this, it should be possible to leverage existing IT infrastructure within the organisation, in particular also existing data analytics output (from the business or the second LoD or from the audit activity itself).

Due to user feedback during the case study, it became clear that users do not only want to store current information, such as new developments and quantitative trends, in the ORA module for their audit universe entity, but they also want to use it as a broader knowledge repository, which links audit universe entities to items (such as risk scenarios, internal controls or action items for audit findings) from the organisation's AMS and/or GRC system. In addition, users want to be able to subscribe to new content in arbitrary areas of the system, such as new or changed risk items on audit area level or new notes for specific audit universe entities. New or changed entries in these subscribed areas should initiate a push notification e.g. via email.

With the exception of the email push notifications, solutions to these user stories were implemented during the case study. As part of the final, summative evaluation, additional needs were identified which yielded further user stories. Those, however, have not yet been implemented: Audit managers would appreciate an end-to-end workflow for the ORA, which would start with new information (qualitative or quantitative) coming in, being assigned to responsible auditors who have to evaluate it, documenting the work and (where necessary) QA performed and ending with a way for auditors to observe how their inputs are then aggregated upwards to the overall risk assessment of the internal audit activity. The idea is that this would both help audit management in understanding what has already been done and what still needs to be done and it would motivate auditors because they could see how their participation is being used and crucial for the overall process. Auditors working with quantitative data would benefit from the system providing drill-down and self-service analytics capabilities, which would allow them to disaggregate and investigate aggregate trends and ask questions based on their own hypotheses. This could also help in finding the right balance between high-level aggregation and detailed data, by providing a high aggregation by default and then allowing auditors to drill-down where necessary.

9.1.3 Increasing Adoption of CA in Organisations

This thesis started out with the overall research question on "how can adoption of CA in organisations be increased". As it turned out, UTAUT is no longer a good model to answer this question. Instead, alternatives such as technology continuance models might provide better results. Also, CA adoption is not primarily a technology discussion. It needs to be seen as an audit process re-engineering challenge and implemented employing appropriate change management and skills development. Proposed implementation strategies (Kiesow et al., 2015) can help with this.

An opportunity presents itself by the overall digital transformation being on everyone's mind: as the survey results show, auditors widely agree that they need to be a part of their organisation's digital transformation. Thus, by recognising that CA can be an audit methodology for digitally transformed audit activities and thus can play an important part in this necessary transformation (Bauch & Kriegelstein-Sternfeld, 2019), its adoption among internal auditors might increase.

While tooling on its own is not a solution, effective tools can nonetheless support CA adoption. A CA front-end system that guides auditors along the ORA and OCA processes can help auditors work efficiently in the new world. Interactive visualisations and analytics tools provide visible benefits to both auditors and stakeholders. And by providing effective tooling, audit management show that they are dedicated to adopting CA. CA systems that can be implemented and configured without deep IT know-how make CA accessible also for smaller audit departments without dedicated IT ressources and without the support of a highly effective corporate IT function, ideally decreasing costs by leveraging IT infrastructure that already exists within the organisation.

The case study showed that ideally, AMS vendors would start to include CA solutions, such as modules for ORA and OCA processes, in their systems. This way, regular audit work and CA work would be fully integrated, as (contrary to as predicted by some earlier literature) it is not the usual approach to completely eliminate regular audit work and replace it with CA, but the two usually co-exist. Any AMS should also integrate with (or include) modern BI and visualisation tools for working with quantitative data in addition to qualitative data. The user stories presented in Chapters 6 and 8 can serve as a template for such CA capabilities.

Internal audit activities might find it easier to apply ORA if the IIA would provide more specific guidance on how risk assessments should be setup, which scoring and risk aggregation methods have proven most effective, what amount of QA and documentation is to be expected for the ORA, and how qualitative and quantitative data can be merged. This observation is in line with the survey results on CPD options, where respondents noted a lack of CPD options provided by the professional bodies on CA (see section 5.6.3).

For OCA, contrary to some reports (Mainardi, 2011), a high degree of automation needs to be achieved for OCA to be really perceived as value-added by auditors and stakeholders alike. If each OCA run requires a lot of manual work and analysis of potential false positives, it will demotivate auditors given that it should not repeatedly yield significant findings.

While today many internal audit activities still rely on multi-year plans, covering areas to audit maybe only every couple of years, and on sample testing to identify anomalies, pressure is building to transform auditing using technology: as Susskind and Susskind (2015) point out, while auditing is important, it is also "big business", binding resources that could be used elsewhere (arguing for more efficiency). The "Big Four" external audit firms alone booked revenues of 148.3 billion USD in 2018, employing around a million people. The IIA has more than 185'000 members, most of which will work in internal auditing. And if things go wrong, the costs for society are significant, too: the accounting scandal at Enron alone wiped out around 60 billion USD of market value from its peak (Healy & Palepu, 2003; arguing for more effectiveness). The pressure to digitally transform their work is also catching up with internal audit. CA can be one approach to achieve this transformation. Thus, working on making CA more performant, easier to roll-out and apply, and more established among auditors and audit stakeholders is an important topic for the profession.

9.2 Discussion and Limitations

In 1999, CICA have stated that "independent auditors' ability to perform continuous audits is an attainable, if long-term, goal" (p. 3). By combining their and other researchers' original theoretical insights with today's tools and technologies, this study aims to move closer to this goal. A lot of progress has been made, but more work needs to be done. This thesis argued that a gap continues to exist between the large amount of theoretical research in this area and the not (yet) ubiquitous adoption in real-world audit practice and proposes research that aims to reduce it. As we move to a world in which big data will "reshape the way we live, work and think" (Mayer-Schönberger & Cukier, 2013, p. 189), closing this gap will become indispensable for the audit profession.

Susskind and Susskind (2015) argue that technology will dismantle the audit profession, "to be replaced by less expert people and high-performing systems" (p. 303). Contrary to this, the vision of this study is that auditors will work together with other assurance providers, leveraging intelligent technology to provide assurance more efficiently and more effectively than before. This follows the future imagined for internal auditing by Byrnes et al. (2014), and in fact this study wants to be one step towards bringing their "AART" system to life. It also aligns with John et al. (2019), who propose a revision of the strict 3LoD model, imagining a future where the internal audit activity uses "data and technology" to provide an assurance map of assurance activities and outcomes across all LoDs and relevant internal and external assurance providers. On the one hand, CA is one reason for this shift: as one interviewee at a Swiss internal audit activity admitted when discussing their progress over the study horizon, CA lead to blurring the boundaries between the 3LoDs. On the other hand, however, CA also provides a potential blueprint for this increased cooperation, as it allows to draw on data sourced from other assurance functions for both ORA and OCA.

This study frequently mentions the need for audit process re-engineering for successful CA. However, in the long-term CA itself may be seen only as a bridge towards the future of internal auditing: currently, CA contains both ORA and OCA, with the latter enabling assurance over control effectiveness in areas where controls are not (yet) fully automated and their ongoing effective performance is not ensured by automation (in combination with strong, automated ITGC). This will remain a necessity at least in the medium term: as long as data sources and algorithms do not yet allow a sufficiently precise separation of true from false positives in all areas of the audit universe, OCA will remain necessary. Moving data-driven testing from internal audit to the second LoD and finally to in-process controls in the first LoD requires an increasing level of precision in the analytics used as progressively less human filtering of the analytics results takes place. This is obvious where analytics are being used to prevent a crucial process from running, but also for example Gonzalez and Hoffman (2017) point out that using weak analytics for continuous fraud prevention in the first LoD can have adverse effects, as the realization that the system is not very effective "results in a greater perceived opportunity to commit fraud and more fraudulent behavior" (p. 31).

In the long-term, the role of OCA will diminish as more and more processes are standardized, digitalized, and equipped with automated in-process controls in the first or second LoD. Such a shift might be enabled by emerging technologies such as blockchains and Internet-of-Things, the former of which allows the immediate, irrevocable, and independently verifiable recording of transactions without the need for a trusted third party (Dai & Vasarhelyi, 2017; Meuldijk & Wattenhofer, 2017), while the latter will mean more and more sensor data coming available that can be used as evidence for physical transactions (e.g. warehouse movements, Krahel & Titera, 2015; Vasarhelyi, Kogan, & Tuttle, 2015, p. 393, note that "linkages of traditional extended data, as found in ERPs, to new sources of data may provide very strong confirmatory evidence for economic activity").

The role of ORA will remain stable or gain in importance, however: The identification of emerging risks – which, by definition, are not yet captured by existing controls – will only become more important as digitalisation increases the speed and magnitude not only of correct process execution but also of any process failures. Peemöller (2018) notes that even today internal audit's responsibilities shift towards "an early detection of risks" (p. 370, translated from German). Emerging risks imply that ORA will most likely retain a human element: Technology will support the auditor by efficiently retrieving and pre-sorting the enormous and growing amount of available information, but even the best artificial intelligence is restricted to observations within the data available to it – thus literally "thinking outside of the box" remains a human skill. Following this argument, the possibility to combine data-driven visualisations with qualitative observations in the proposed CA front-end system is not only an interim solution due to a current lack of data availability but will remain relevant for future emerging risks outside of the existing data universe. Being independent, ongoing assessors of risk aligns with the move proposed by John et al. (2019) for internal audit towards being trusted advisors and assurance mappers for the whole organisation: an assurance map relies on an accurate picture of risks to assess its completeness.

In the long-term, future auditors will thus perform an independent, ongoing assessment of risks, and use these results to identify emerging gaps in the assurance provided by the automated controls in the first and second LoDs. Internal audit will also use this broad understanding of the risks facing the organisation to evaluate the design of new controls. As long as risks don't change, ongoing control performance of existing controls will be assured through their automation in a robust IT environment, meaning that classic "control testing" will lose relevance. Finally, as risks and opportunities are two sides of the same coin, this risk awareness will also help auditors to strengthen their role as trusted advisors in the organisation.

Note that these ideas about the future can also have lessons for current audit work. New challengers are moving into more and more established industries and are trying to use digitalisation to their advantage. For example, in the banking industry "fintechs" such as TransferWise, Revolut, or N26 are pushing into areas currently dominated by the big banking institutions (Arslanian & Fischer, 2019). As they rely heavily on automated, digital processes, it might be reasonable to assume that they will be able to work with little or no internal auditing, as there is little room in digital processes for the common control failures that would warrant classic "control testing". However, this neglects the important role of internal audit in identifying changing risks and related gaps in control design, which, as discussed above, remain relevant even in a digitalised future. This observation has been confirmed by important control failures at fintechs such as Revolut, where anti-money laundering failures have been linked to regulatory probes and the resignation of the CFO (Cook, 2019), or N26, whose accounts have been misused by money mules (Schnor, 2018) and whose clients had to battle a wave of payment fraud leaving their acounts emptied out (Scherschel, 2019).

9.2.1 The Future of the Three Lines of Defence

The above assumes that, building on the groundwork laid by CA methodologies, an internal audit activity of the future will perform the following core functions:

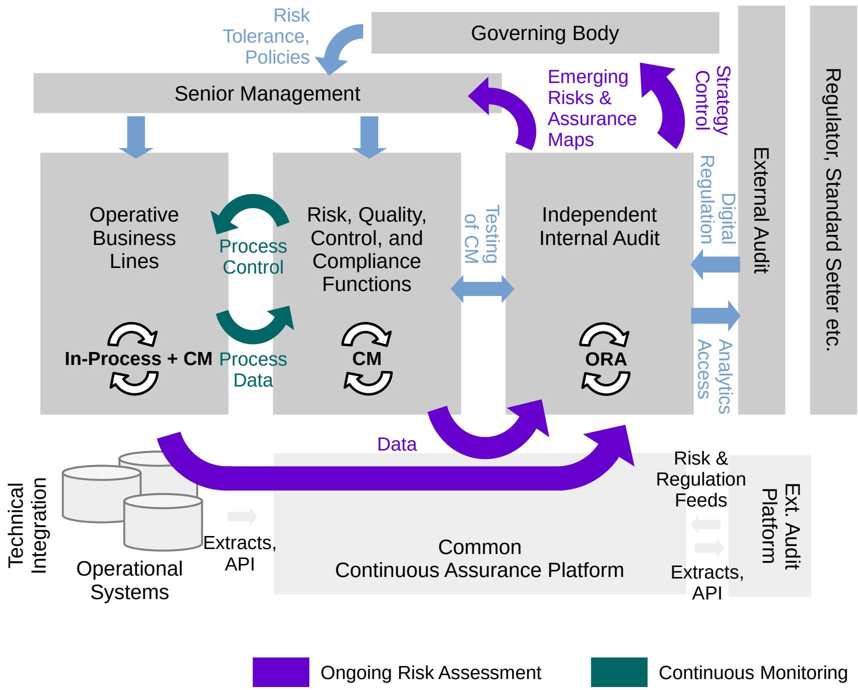
1. An independent, ongoing risk assessment, with a focus on emerging risks, leveraging and aggregating data provided by corporate IT systems, ubiquitous automated sensors, but also management discussions and other assurance providers in the organisation;

2. Assurance mapping, identifying gaps between the identified risks and the (mostly automated) in-process and CM controls (tested for effectiveness) within the organisation's business lines and other assurance providers;

3. Providing independent advice to the governing body of the organisation on emerging opportunities and threats and strategy execution.

These roles and responsibilities will answer some of the questions posed by John et al. (2019) regarding the future of the three lines of defence: They show how technology enables coordination and collaboration among the different functions. Internal audit accumulates assurance across the organisation; reducing reporting fatigue by integrating data and leverag-

Figure 9.1: Interaction-focussed, circular three lines of defence model. Colour-coded with the areas covered by ORA and CM methods.



ing interactive visualisations, hyperlinking in a web-based environment, and drill-downs to adapt reporting granularity to the individual stakeholders.

Figure 2.5 depicts the CA processes as circles that interact with each other to highlight the ongoing, coordinated nature of them. If this approach will form the basis of the future of the three lines of defence, it seems reasonable to draw the future of the 3LoDs also in a circular manner, highlighting coordination and data exchange between the different stakeholders. Figure 9.1 shows how such an interaction-focussed 3LoD model in light of the findings of this study and the proposed long-term evolution of CA could look like.

While the three lines of defence still exist as distinct entities in this view, the arrows between them show the "blurring of the lines" through intensified collaboration and data exchange, with the lines of defence profiting from each others' work: The operative business lines use and generate data in their processes. Where possible (and far more ubiquitous than today), automated in-process controls prevent process deviations and in turn generate additional data on control execution and results. Management functions use process data for their CM, identifying and rectifying process deviations as early as possible in the process. They can also leverage process control data prepared or aggregated by the 2LoD function for their CM.

2LoD functions such as risk, quality, control, and compliance functions use process data from the operative business lines to continuously monitor whether processes continue to be executed within acceptable risk and quality tolerance bands set by management (based on the overall risk tolerance set by the organisation's governing body). They identify and react on systematic deviations that need remediation or point to a lack of control effectiveness.

The internal audit function uses process data from the operative business as well as control data from the 2LoD functions to test the effectiveness of CM and to perform an independent ORA. The focus of the ORA will be on emerging risks, which are not yet recognized and thus not covered by the existing control framework. The ORA forms the foundation for internal audit's assurance mapping, providing governing bodies and management with an overview over risk-based assurance coverage across all LoDs. By highlighting to the governing body where the organisation's reality differs from its strategic ambition, internal audit acts as independent advisor in support of strategy control. The governing body and senior management will in turn use the risks identified and assurance maps provided by internal audit to set risk tolerance and define policies aimed at managing these risks to levels acceptable to the organisation, which in turn influences the control measures designed by the operative business lines and 2LoD functions, closing the loop.

External auditors are increasingly pushing for data feeds from their audit clients to be able to implement their own continuous auditing. Due to the increasing amount of data involved as well as an increased focus on data protection when sharing sensitive data with third parties, it seems likely that in the future external auditors will instead be able to execute their own anlytics within a controlled, trustworthy environment within the audit client's IT environment using standardized application programming interfaces (APIs). The external auditor will then only transfer relevant extracts to their own platform for further analysis and documentation of evidence. It has to be seen where these controlled analytics environments for the external auditor will be situated, but given the level of coordination and trusted relationships that often already exist between internal and external auditors, internal audit can be one possible conduit for the external auditor.

Collaboration is enabled through data flows between the various activities, but ideally also by sharing the technological basis: while CA will often be implemented outside of the operational systems due to risk and performance considerations, it makes sense to combine CM in the 2LoD and CA in a single, combined continuous assurance platform, which also enables the "common vocabulary" recommended by John et al. (2019, p. 11). This platform will in turn interface with external systems, both to enable continuous auditing at the external auditor and to leverage feeds of emerging risks and regulatory developments provided by external assurance and advisory providers.

By adopting CA and building up the necessary capabilities (in terms of data access, analytics capability, and the required skill- and mindset), internal audit can lay the groundwork for this new role of accumulator of assurance across the organisation. Internal audit would thus ensure to remain a key part in the feedback loop that enables the governing body and senior management to adopt the organisation's strategy in the face of changing and emerging risks and that allows them to rely on controlled strategy execution throughout the organisation.

9.2.2 Limitations

Adoption of CA is a multi-faceted subject. By evaluating CA adoption and its determinants in Swiss organisations, this study aimed to identify the major drivers and inhibitors of CA adoption. This knowledge was then put to use for designing and developing a front-end system for ORA and OCA aimed at improving CA adoption. Evaluating this CA front-end system in a real-world internal audit department yielded further insights into how to design this crucial but often overlooked part of overall CA.

This line of thinking follows Kuechler and Vaishnavi (2008, p. 499), who suggest that DSR as a methodology can help to gain new insights into the underlying kernel theories, possibly allowing to refine these theories in the process. In particular, this aims to provide a better understanding of why the existing theoretical contributions have not lead to more widespread real-world adoption (Byrnes, Ames, et al., 2012).

By providing a working CA front-end system implementation as SharePoint-based open-source software, this thesis added to the knowledge base by providing an enterprise-ready foundation for CA research that enables re-use and experimentation by future researchers.

Limitations of the work include that CA adoption factors were evaluated with a focus on Swiss organisations, which might limit the applicability of these results to countries with different cultural, legal or business environments. While the IIA Standards are global standards that govern internal audit activities across the world, differences in the role of internal audit across jurisdictions might impact the way CA needs to prove its value and how stakeholder perceptions influence CA adoption. In Switzerland in financial services, the internal audit activity typically reports to the board of directors as independent oversight body (FINMA, 2017). For example in Germany, however, the internal audit activity typically reports primarily to the “Vorstand”, which is the top executive management of the organisation, with only a secondary reporting relationship to the “Aufsichtsrat”, the supervisory board in Germany’s two-tier board system (DIIR Arbeitskreis

MaRisk, 2017).

The survey hypotheses were structured along the UTAUT model of technology acceptance, which, as the survey results have shown, only explains a small part of CA adoption. Thus, while the survey results did provide factors that can make CA be perceived as significantly more effective or easier to apply, it is not clear whether this will actually lead to increased CA adoption. As there were not enough survey responses for multi-group analyses, it remains unclear what these other factors could be that explain a larger part of CA adoption and it was not possible to quantitatively analyze differences on CA adoption factors among different organisational environments (such as industry).

The CA front-end system was only put to use and evaluated in a single case study, limiting the ability to generalize to other organisations. The case study was conducted in the financial services industry, in a medium-sized internal audit activity of about 50 auditors all located in one jurisdiction. Compared to the other organisations that were interviewed at the beginning of the study, the partner organisation was typical within the financial services industry and among the more advanced manufacturing companies in that a) a long history of data analysis in audit existed, b) the organisation has started to experiment with CA a few years ago, c) CA was seen as a necessary development of audit practice, but d) CA was not yet fully implemented and ingrained in the existing audit processes. For companies at this stage of development, findings from this case study can be transferable. For very small (e.g. less than 5 auditors) or very large and highly global audit departments, the results might be less applicable. As the CA front-end system is not a complete solution, but only a single piece of a bigger analytics environment, very small audit departments might find it difficult to implement the findings of this study due to their limited resources. For such departments it might make more sense to wait for solutions embedded into their existing AMS (see section 8.4.2) or the availability of CA as "audit-as-a-service" (Langhein & Thomas, 2018). Very large, globalized audit departments might already be in a different stage of development and will have different challenges (e.g. internationalization, cross-border data sharing, standardization of approaches and results) and also different resources (e.g. their own IT specialists).

Due to financial services regulation and the local culture, the partner internal audit activity was operating very independently from the business side of the organisation, answering only to the organisation's oversight body. At the same time, financial services institutions possess strong, established second LoD functions such as Risk Management and Compliance. These characteristics differ from some of the manufacturing companies interviewed at the beginning of the case study, where those functions were limited in scope and resources and where the internal audit activity often needs to show its value not exclusively to the oversight bodies but also to the organisation's senior management. In such a setting, the impact of senior management buy-in and the need to show benefits early on might be more pronounced than was observed in this case study. On the other hand, at companies where the control framework is less institutionalized, it might be easier to show value through more "low hanging fruits". Also, coordination with the second LoD functions might be less of a topic in organisations where these functions are less mature or do not exist at all.

Due to financial institutions being early adopters of technology in the 1970s and 1980s, many companies in this sector today have a fragmented, complex IT landscape with a lot of specialised applications for different parts of their business. At the same time, these systems deal with highly sensitive data about individuals and their financial situation, which are not only protected by data protection laws such as the GDPR but also by specialised laws such as banking secrecy in Switzerland[1]. Due to this combination, proper data sourcing at financial institutions is often more challenging than in e.g. manufacturing companies where most data may be contained in a single or a few ERP systems and covers accounting and manufacturing processes which

[1]BankG, art 47.

are less tied to identifiable individuals. The focus in the case study on a step-by-step approach which can grow as data availability grows may be less relevant for organisations that can easily source high-quality data for all or most areas of their audit universe.

With regards to a CA front-end system supporting an OCA, some features that were expected to make OCA more effective and increase acceptance among auditors could not be evaluated during the case study due to them requiring larger amounts of data to be gathered over longer time periods (e.g. machine learning and referencing past audit results).

However, providing the CA front-end system as open-source software will allow future researchers to enhance and build upon this work. They will be able to put it to use in other environments and also to modify parts of it in future studies to isolate individual aspects of CA and their effect on auditor effectiveness and efficiency.

By focussing on a CA front-end system in the design-oriented part, this study makes an assumption that such a system will play an important role in influencing CA adoption. However, topics such as the availability of skills, the need to re-engineer audit processes to fully benefit from CA, and a robust change management strategy have all been shown to be at least as relevant for CA adoption, and a large part of CA adoption variance remained unexplained in this study. Some of these areas are already well covered by existing work, but closing the skill gap in particular seems to be a topic warranting future research.

9.3 Outlook

As UTAUT is no longer a good explanatory model for CA adoption among internal auditors, at least not in Switzerland, future research might want to establish whether other models, such as technology continuance (Bhattacherjee, 2001) or hedonic-value-focussed models (e.g. Hsu & Lin, 2016) yield better explanatory power. Repeating the survey with a larger geographic scope (e.g. Western Europe) could yield sufficient data points for multi-group analyses to better investigate how the organisational environment and the current stage of CA adoption impact CA adoption factors (i.e. whether an auditor perceives CA adoption factors differently if CA is already a reality at his or her organisation).

The CA front-end system used in the case study has been provided as open source software[2] and can thus be used as a basis for future research on CA. Additional case studies should validate whether the results from the case study presented here also apply to other organisations from other industries, other countries, and/or a different size. In particular, a case study in a manufacturing company with a smaller regulatory burden might provide a different perspective on how to "sell" CA as an internal audit activity, as discussions with other Swiss companies have shown that in such environments it can be much more important to bring senior management on-board and market CA also as a tool for management. Also, companies with a more international footprint might bring new challenges to the table in adopting a single CA front-end, including cross-cultural challenges.

As open source software allows for modifications to be made, it can also be used to test other hypotheses on which aspects of a CA front-end system can optimize CA adoption. Gehrke and Wolf (2010) suggest sharing user-generated "auditlets" for continuous auditing among internal audit activities, an idea that becomes more feasible on a common system. Enhancing the CA front-end system with such pre-developed analytics components might also be an approach that could help make CA suitable for much smaller internal audit activities with only a few auditors – an area that so far has received very little research on CA (with the exception of Rikhardsson & Dull, 2016).

The current system design supports aggregating risks qualitatively from individual notes to risk items mapped on a likelihood-impact risk matrix. However, it does not yet provide support for sytematically aggregating lower-level risk items with their likelihood and impact to higher-level constructs, combining multiple risk items and quantitatively determining their combined

[2]See `https://www.the-dashboard.ch/`.

likelihood and impact from the lower-level values. Aggregating operational risks is an ongoing research area (see e.g. Abbate et al., 2009; Chavez-Demoulin et al., 2006; Giacometti et al., 2008) and combining approaches from there with the practical implementation in the CA front-end system could yield new insights in both areas. Such approaches could also explore alternatives to the established likelihood-impact matrix, which has drawbacks; for example Simon, Smith, and Zimbelman (2018) have found that it might make auditors less concerned about high-risk events.

The case study has shown that ideally CA front-end capabilities would be integrated with or merged into the existing AMS in place at many internal audit activities for audit management and regular audit documentation. Future research could build on the final user stories from this study to explore how such an integrated, CA-enabled AMS could look like, providing a blueprint for AMS vendors. This would update existing literature on CA system architectures, which have not yet discussed the necessary link to the AMS. If audit activities are to move to agile methods such as Scrum (Newmark et al., 2018), this would also require changes to the existing AMS and inclusion of ORA and OCA functionality.

Similarly, auditors expect drill-down and interactive analytics capabilities from a modern CA front-end. Instead of reinventing the wheel, it might make more sense for CA front-end systems (and/or AMS) to integrate directly with proven self-service BI solutions such as Tableau, Microsoft Power BI or Qlik. This would also be an avenue for future research, amending the understanding of ideal CA system architectures in light of these new capabilities.

The case study and discussions with other internal audit activities have shown that – contrary to established audit work and OCA, which can rely on the IIA guidance on regular audit fieldwork – there are few widely accepted best practices and methodologies on how to perform ORA and subsequent audit planning. Some audit activities use quantitative models, others use qualitative assessments; some audit activities have moved to quarterly planning, others use yearly plans with intra-year updates, others employ "tiger teams" to flexibly audit areas during the year. Additional theoretical research could produce more specific guidance on how audit activities should conduct their ORA, depending on their individual contexts.

A remaining challenge for many continuous auditing and CM implementations is the large number of alarms generated, which are often false alarms (see mentions throughout this study on "alarm floods"). If many false alarms are persistingly presented to the user, these implementations risk to suffer from "alert immunization" (Rikhardsson & Dull, 2016, p. 33). Among others, Perols and Murthy (2012) suggest that advanced analytics and machine learning could be used to reduce the number of false alerts.

In fact, initial research suggests that machine learning algorithms, in which a computer learns to separate real from false alarms, may in fact aid auditors to reduce false alarms (Brown-Liburd et al., 2015, p. 458; Issa, 2013; Jans & Hosseinpour, 2019; Li et al., 2016; Perols & Murthy, 2012). However, up to now many of these experiments suffer from a lack of real-world training data, as users' responses to continuous auditing or CM alerts are rarely captured in a systematic fashion. Based on the data gathered by the implemented CA front-end system, which captures ORA and OCA results on a data-point level, it should become feasible to train supervised learning algorithms to reduce the "alarm floods" plaguing CA users. Future research could use the CA front-end system to gather training data for their models, thus providing a specific application area of machine learning techniques in auditing. Note that preliminary code for in-line machine learning already exists in the open source code of the CA front-end system, but wasn't used in the case study due to a lack of training data (which needs to be gathered over longer time periods). Thus, analyzing their effects remains possible in follow-up research.

The CA front-end system is still in use at the case study partner, so it would be feasible to come back for a more long-term analysis – evaluating how usage patterns and acceptance have developed over time, looking at the effect of features which rely on a larger history of data (audit forms history and machine learning models for both OCA alarm reduction and ORA notes analysis), and/or evaluating new topics in auditing which could benefit from being implemented on an existing system. Such research could address the topic of “appropriate use”, i.e. whether systems are not only being used but are being used in the way they are intended to (Dowling, 2009), and investigate theories such as adaptive structuration theory (DeSanctis & Poole, 1994) on how new information technology leads to organizational, process, and behavioural changes over time.

One topic that seems to be particularly promising is the future of the audit report. It is still common that auditors only report the results of their work through the preparation of standalone audit reports after each audit engagement, which for longer engagements is not very timely and involves a lot of effort both for the writers and the readers as usually a lot of boilerplate will be replicated for each audit report. This also complicates CA work, as there is no obvious vehicle to report on CA results. Thus, new approaches are being discussed, such as interactive reports (where data analytics results that yielded audit findings are continuously updated, serving as an automated way to see whether a discussed problem still exists) and/or “audit feeds”, which present audit findings as they happen without having to wait for a final report being issued. Such approaches could easily be implemented on top of the CA front-end system presented here, and their impact could thus subsequently be evaluated in a real-world internal audit setting.

While the front-end is agnostic to the data sources used, the system design is still based on the idea of being used by an in-house internal audit activity and/or second LoD functions. If proposed changes in the audit supply chain such as audit-as-a-service (Langhein & Thomas, 2018) take hold, it would become necessary to re-evaluate the system design in light of such a revised process model.

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Appendix A

Survey Details

Table A.1: Seven-point Likert scale used in the survey in all three languages. Only the endpoints had textual labels in the interface.

Value	Sign	English	German	French
1	---	Strongly disagree	Lehne stark ab	Fortement en désaccord
2	--			
3	-			
4				
5	+			
6	++			
7	+++	Strongly agree	Stimme stark zu	Fortement d'accord

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
ADOPTION_ORA	Our internal audit activity is employing Ongoing Risk Assessments.	Unsere Interne Revision setzt laufende Risikobeurteilungen ein.	Notre audit interne utilise des évaluations continues des risques.
ADOPTION_OCA	Our internal audit activity is employing Ongoing Control Assessments.	Unsere Interne Revision setzt laufende Kontrollbeurteilungen ein.	Notre audit interne utilise des évaluations continues des contrôles.
ADOPTION_CM	Our organisation's first and second line of defense have comprehensive continuous monitoring in place.	Die erste und zweite Verteidigungslinie unserer Organisation betreibt ein umfassendes Continuous Monitoring.	La première et la deuxième ligne de maîtrise de notre organisation ont mis en place un contrôle en continu complet.
ADOPTION_CMTEST	Our internal audit activity is testing the effectiveness of management's continuous monitoring to provide Continuous Assurance.	Unsere Interne Revision beurteilt die Wirksamkeit des Continuous Monitorings durch das Management um Continuous Assurance zu bieten.	Notre audit interne effectue des tests sur le assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
CHANGE_CAPABLE	The change agility of our organization is strong.	Die Agilität unserer Organisation für Veränderungen ist hoch.	La capacité de changement de notre organisation est forte.
CHANGE_NEED	We need to participate in the digital transformation of our business.	Wir müssen an der Digitalen Transformation unseres Geschäfts teilnehmen.	Nous devons participer à la transformation numérique de notre entreprise.
CHANGE_CONVI	Our Chief Audit Executive (CAE) shows / I expect our Chief Audit Executive (CAE) would show personal conviction for adopting Continuous Assurance.	Unser Leiter der Internen Revision (CAE) zeigt eine persönliche Überzeugung für den Einsatz von Continuous Assurance. / Ich erwarte, dass unser Leiter der Internen Revision (CAE) eine persönliche Überzeugung für einen zukünftigen Einsatz von Continuous Assurance zeigen würde.	Notre responsable de l'audit interne soutient avec conviction la décision d'adopter l'assurance continue. / En cas d'adoption de l'assurance continue, je prévois que notre responsable de l'audit interne soutiendra avec conviction cette décision.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
CHANGE_VISION	Our adoption of Continuous Assurance is / I expect our adoption of Continuous Assurance would be driven by a clearly articulated vision for the future.	Unser Einsatz von Continuous Assurance wird durch eine klar formulierte Vision für die Zukunft getrieben. / Ich erwate, dass unser Einsatz von Continuous Assurance von einer klar formulierten Vision für die Zukunft getrieben würde.	Notre adoption de l'assurance continue est guidée par une vision clairement articulée. / En cas d'adoption de l'assurance continue, je prévois que nous aurons une vision pour l'assurance continue clairement formulée.
CHANGE_TRAINING	Our change towards Continuous Assurance was / I expect our change towards Continuous Assurance would be accompanied by training of relevant staff.	Unser Einsatz von Continuous Assurance wurde durch eine Schulung der betroffenen Mitarbeitenden begleitet. / Ich erwarte, dass unser Einsatz von Continuous Assurance durch eine Schulung der betroffenen Mitarbeitenden begleitet würde.	Notre changement vers l'assurance continue était / En cas d'adoption de l'assurance continue, je prévois que notre changement vers l'assurance continue sera accompagné par la formation du personnel concerné.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
RESOVERALL_SUFFICIENT	We have sufficient resources to perform all the audit work that is expected from us.	Wir haben ausreichende Ressourcen, um alle Revisionsarbeiten, die von uns erwartet werden, durchzuführen.	Nous disposons de ressources suffisantes pour effectuer tous les travaux d'audit qu'on attend de nous.
RESOVERALL_MANUAL	We have enough resources to rely on manual sample testing for achieving our audit coverage.	Wir haben genügend Ressourcen um unsere Auditabdeckung durch manuelle Stichprobenprüfungen zu erreichen.	Nous disposons de ressources suffisantes pour que les méthodes d'échantillonnage manuels suffisent à assurer une courverture de vérification adéquate.
RESOVERALL_MINDSET	Our internal auditors have a strong analytical mindset.	Unsere internen Revisoren haben eine stark analytische Denkweise.	Nos auditeurs internes ont un fort esprit analytique.
RESOURCES_SKILLSAUD	Our internal audit activity has the necessary skills to provide Continuous Assurance.	Unsere Interne Revision hat die notwendigen Fähigkeiten für Continuous Assurance.	Notre audit interne possède les savoir-faire nécessaires pour fournir l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
RESOURCES_SKILLSORG	Our organisation has the necessary skills to provide Continuous Assurance.	Unsere Organisation hat die notwendigen Fähigkeiten für Continuous Assurance.	Notre organisation possède les savoir-faire nécessaires pour fournir l'assurance continue.
RESOURCES_DIFFICFIND	It is difficult to find people with the skills to provide Continuous Assurance.	Es ist schwierig, Mitarbeitende mit den Fähigkeiten für Continuous Assurance zu finden.	Il est difficile de trouver des gens qui possèdent les savoir-faire pour fournir l'assurance continue.
RESOURCES_DEVELOP	It is difficult to develop the skills to provide Continuous Assurance.	Es ist schwierig, die Fähigkeiten für Continuous Assurance zu entwickeln.	Il est difficile de développer les savoir-faire pour fournir l'assurance continue.
RESOURCES_CPD	Available continuous development options (e.g. from IIA Switzerland) are sufficient to provide Continuous Assurance.	Die existierenden Weiterbildungsangebote (bspw. von IIA Switzerland) sind ausreichend für Continuous Assurance.	Les possibilités de formation professionnelle continue disponibles (par exemple de l'ASAI) sont suffisantes pour fournir l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
RESOURCES_OUTSOURCE	We have outsourced / We would outsource Continuous Assurance.	Wir haben Continuous Assurance outgesourced. / Wir würden Continuous Assurance outsourcen.	Nous avons externalisé / Nous prevoyons d'externaliser l'assurance continue.
THREELODS_DELINEATE	In our organisation, the responsibilities between the first, second and third line of defence are clearly delineated.	In unserer Organisation sind die Aufgaben der ersten, zweiten und dritten Verteidigungslinie klar aufgeteilt.	Dans notre organisation, les responsabilités entre la première, la deuxième et la troisième ligne de maîtrise sont clairement délimitées.
THREELODS_COORD	We systematically coordinate our work with the second line of defence.	Wir koordinieren unsere Arbeit systematisch mit der zweiten Verteidigungslinie.	Nous coordonnons systématiquement notre travail avec la deuxième ligne de maîtrise.
THREELODS_CLEAR	We have a clear understanding of how Continuous Assurance should fit in the three lines of defence model as used in our organisation.	Wir haben ein klares Verständnis dafür, wie Continuous Assurance in das Drei-Linien-Modell unserer Organisation passen sollte.	Nous avons une compréhension claire de la façon dont l'assurance continue devrait s'inscrire dans les trois lignes de maîtrise dans notre organisation.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
STAKEHOLDERS_CAE	Our senior audit management is promoting Continuous Assurance.	Unsere Auditleitung fördert Continuous Assurance.	Notre gestion de l'audit interne encourage l'assurance continue.
STAKEHOLDERS_BOARD	Our audit committee (or the board) are promoting Continuous Assurance.	Unser Audit Committee (oder Verwaltungsrat) fördert Continuous Assurance.	Notre comité d'audit (ou notre Conseil) encourage l'assurance continue.
STAKEHOLDERS_MGMT	Our senior management is promoting Continuous Assurance.	Unsere Geschäftsleitung fördert Continuous Assurance.	Notre direction générale encourage l'assurance continue.
STAKEHOLDERS_MGMT2	Our senior management supports Continuous Assurance.	Unsere Geschäftsleitung unterstützt Continuous Assurance.	Notre direction générale soutient l'assurance continue.
STAKEHOLDERS_EXTAUD	Our external auditor is promoting Continuous Assurance.	Unsere externe Revisionsstelle fördert Continuous Assurance.	Notre auditeur externe encourage l'assurance continue.
STAKEHOLDERS_REGULATOR	Regulators in our industry are promoting Continuous Assurance.	Regulatoren in unserer Industrie fördern Continuous Assurance.	Les régulateurs de notre industrie encouragent l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
STAKEHOLDERS_IIA	The IIA / SVIR is promoting Continuous Assurance.	Der IIA / SVIR fördern Continuous Assurance.	L'IIA / l'ASAI encourage l'assurance continue.
REENGINEER_AUDUNIV	We have modified / I expect that we would modify our audit and risk universe and/or understanding of the controls landscape in order to adopt Continuous Assurance.	Wir haben unser Audit- und Risiko-Universum und/oder unser Verständnis des Kontrollumfelds angepasst um Continuous Assurance zu liefern. / Ich erwarte, dass wir unser Audit-Universum, unsere Risikotaxonomie und/oder unser Verständnis des Kontrollumfelds anpassen würden, um Continuous Assurance einzusetzen.	Nous avons modifié / Je prévois que nous modifierons notre univers d'audit interne et de risques et/ou notre comprehension du dispositif de contrôle pour adopter l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
REENGINEER_REENGINEER	We have re-engineered / I expect that we would re-engineer our audit procedures to adopt Continuous Assurance methods.	Wir haben unsere Auditprozesse überarbeitet um Continuous-Assurance-Methoden einzusetzen. / Ich erwarte, dass wir unsere Auditprozesse überarbeiten würden, um Continuous-Assurance-Methoden einzusetzen.	Nous avons réaménagé / Je prévois que nous réaménagerons nos procédures d'audit interne pour adopter les méthodes d'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
REENGINEER_EFFECTIVE	We have / I expect that we would have effective processes in place to perform, document and report on our Continuous Assurance work.	Wir haben wirksame Prozesse für die Durchführung, Dokumentation und Berichterstattung über unsere Continuous-Assurance-Arbeit. / Ich erwarte, dass wir wirksame Prozesse für die Durchführung, Dokumentation und Berichterstattung über unsere Continuous-Assurance-Arbeit hätten.	Nous avons établi / Je prévois que nous établierons des processus efficaces pour effectuer, documenter et rendre compte de notre travail pour l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
REENGINEER_PERSON	We have / I expect that we would have a dedicated person or team that is responsible for driving, coordinating, and reporting on our Continuous Assurance work.	Wir haben eine dedizierte Person oder ein dediziertes Team, das für das Vorantreiben, Koordinieren und die Berichterstattung über unsere Conntinuous-Assurance-Arbeit verantwortlich ist. / Ich erwarte, dass wir eine dedizierte Person oder ein dediziertes Team hätten, das für das Vorantreiben, Koordineren und die Berichterstattung über unsere Continuous-Assurance-Arbeit verantwortlich wäre.	Nous avons / Je prévois que nous aurons une personne ou une équipe dédiée responsable de la conduite, de la coordination et de rendre compte de notre travail pour l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
IT_STAND	Our organisation's IT is highly standardised and integrated.	Die IT unserer Organisation ist hoch standardisiert und integriert.	L'informatique de notre organisation est hautement standardisée et intégrée.
IT_DIGITAL	Our organisation's processes are highly digitalised.	Unsere Geschäftsprozesse sind hoch digitalisiert.	Les processus de notre organisation sont hautement numérisés.
IT_FLEXIBLE	Our IT is flexible to adapt to our needs.	Unsere IT ist flexibel um sich unseren Bedürfnissen anzupassen.	Notre informatique est flexible pour s'adapter à nos besoins.
IT_QUALITY	Our organisation's data quality is high.	Die Datenqualität unserer Organisation ist hoch.	Les données de notre organisation sont de haute qualité.
IT_ITGCASSU	Our IT auditors provide strong assurance over the effectiveness of the organisation's IT general controls.	Unsere IT-Revisoren liefern starke Assurance über die Wirksamkeit der IT General Controls (ITGC) unserer Organisation.	Nos auditeurs informatiques fournissent une assurance solide sur l'efficacité des contrôles généraux de la technologie de l'information (CGTI).

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
IT_ITGC	We can rely on the organisation’s IT general controls.	Wir können uns auf die IT General Controls (ITGC) unserer Organisation verlassen.	Nous pouvons faire confiance aux contrôles généraux de la technologie de l’information (CGTI) de notre organisation.
IT_PLATF	Our internal auditors use / I expect that our internal auditors would be able to use an integrated IT system for their Continuous Assurance work.	Unsere internen Revisoren nutzen ein integriertes System für ihre Continuous-Assurance-Arbeit. / Ich erwarte, dass wir eine integrierte Continuous-Assurance-Plattform für unsere Auditors nutzen könnten.	Nos auditeurs internes utilisent/ Je prévois que nos auditeurs internes utiliseront un système informatique intégré pour leur travail d’assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
IT_DOCU	The technology we use for Continuous Assurance supports us in documenting our work. / I believe the technology we would use for Continuous Assurance would support us in documenting our work.	Die Technologie, die wir für Continuous Assurance nutzen, unterstützt uns in der Dokumentation unserer Arbeit. / Ich erwarte, dass die Technologie, die wir für Continuous Assurance einsetzen würden, uns beim Dokumentieren unserer Arbeit unterstützen würde.	La technologie que nous utilisons pour l'assurance continue nous aide à documenter notre travail. / Je prévois que la technologie que nous utiliserons pour l'assurance continue nous aidera à documenter notre travail.
VISIBLE_MGMT	Our senior management has quickly recognized / I believe that our senior management would quickly recognize the added value of Continuous Assurance.	Unsere Geschäftsleitung hat den Mehrwert von Continuous Assurance rasch erkannt. / Ich glaube, dass unsere Geschäftsleitung den Mehrwert von Continuous Assurance rasch erkennen würde.	Notre direction générale a reconnu / Je prévois que notre direction générale reconnaîtra vite la valeur ajoutée de l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
VISIBLE_BOARD	Our board (or its audit committee) has quickly recognized / I believe that our board (or its audit committee) would quickly recognize the added value of Continuous Assurance.	Unser Verwaltungsrat (oder das Audit Committee) haben den Mehrwert von Continuous Assurance rasch erkannt. / Ich glaube, dass unser Verwaltungsrat (oder das Audit Committee) den Mehrwert von Continuous Assurance rasch erkennen würden.	Notre Conseil (ou son comité d'audit) a reconnu / Je prévois que notre Conseil (ou son comité d'audit) reconnaîtra vite la valeur ajoutée de l'assurance continue.
VISIBLE_AUDITORS	Our internal auditors have quickly recognized / I believe that our internal auditors would quickly recognize the added value of Continuous Assurance.	Unsere internen Revisoren haben den Mehrwert von Continuous Assurance rasch erkannt. / Ich glaube, dass unsere internen Revisoren den Mehrwert von Continuous Assurance rasch erkennen würden.	Nos auditeurs internes ont reconnu / Je prévois que nos auditeurs internes reconnaîtront vite la valeur ajoutée de l'assurance continue.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
IMPACT_PERF1	Continuous Assurance methods enable / would enable us to accomplish tasks more quickly.	Continuous-Assurance-Methoden ermöglicht es uns / würden es uns ermöglichen, unsere Aufgaben schneller zu erledigen.	Les méthodes d'assurance continue nous permettent / permettraient d'accomplir nos objectifs plus rapidement.
IMPACT_PERF2	Continuous Assurance methods increase / would increase our productivity.	Continuous-Assurance-Methoden erhöhen unsere Produktivität / würden unsere Produktivität erhöhen.	Les méthodes d'assurance continue augmentent / augmenteraient notre productivité.
IMPACT_PERF3	Continuous Assurance methods increase / would increase our chances of improving our financial position.	Continuous-Assurance-Methoden erhöhen die Chancen / würden die Chancen erhöhen, unsere finanzielle Situation zu verbessern.	Les méthodes d'assurance continue augmentent / augmenteraient nos chances d'améliorer notre situation économique.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
IMPACT_EASE1	Interacting with the technology used for Continuous Assurance is / would be generally clear and understandable.	Die Interaktion mit der für Continuous Assurance eingesetzten Technologie ist im Allgemeinen klar und verständlich / würde im Allgemeinen klar und verständlich sein.	Les interactions avec la technologie utilisée pour l'assurance continue sont / seraient généralement évidentes et compréhensibles.
IMPACT_EASE2	We find / We would find Continuous Assurance methods easy to apply.	Wir finden Continuous-Assurance-Methoden einfach anwendbar. / Wir würden Continuous-Assurance-Methoden einfach anwendbar finden.	Nous trouvons que les méthodes d'assurance continue sont faciles à appliquer. / Nous trouverions que les méthodes d'assurance continue seraient faciles à appliquer.
IMPACT_EASE3	Learning to provide Continuous Assurance is / would be easy for us.	Es fällt uns leicht / Es würde uns leichtfallen, die Durchführung von Continuous Assurance zu erlernen.	Apprendre à exploiter les méthodes d'assurance continue est / serait facile pour nous.

Table A.2: Survey statements. Where two variants are given, the first was presented to users of CA while the second was presented to respondents not yet using CA.

Code	English	German	French
IMPACT_SOCIAL1	People or parties who influence our behavior think that we should provide Continuous Assurance.	Personen oder Parteien, die unser Verhalten beeinflussen, denken, dass wir Continuous Assurance bieten sollten.	Des personnes qui influencent notre comportement pensent que nous devrions utiliser les méthodes d'assurance continue.
IMPACT_SOCIAL2	Our senior management has been / would be helpful in the use of Continuous Assurance methods.	Unsere Geschäftsleitung war / wäre hilfreich beim Einsatz von Continuous-Assurance-Methoden.	Notre direction générale a aidé / aiderait à l'utilisation des méthodes d'assurance continue.
IMPACT_SOCIAL3	In general, our organisation has supported / would support the use of Continuous Assurance methods.	Insgesamt hat unsere Organisation den Einsatz von Continuous-Assurance-Methoden unterstützt. / Insgesamt würde unsere Organisation den Einsatz von Continuous-Assurance-Methoden unterstützen.	En général, notre organisation a soutenu / soutiendrait l'utilisation des méthodes d'assurance continue.

Table A.3: Path coefficients for the original, unchanged model (without IMPACT_PERF3) for comparison. Shown are coefficient bootstrapping sample means and p-values from PLS-SEM bootstrapping. Significance levels: * = 10%, ** = 5%, *** = 1% level.

	Coefficient	p value
Reengineer (H1a) → Performance	0.285	0.018**
Delineate 3LoDs (H1b) → Performance	0.017	0.704
Visible (H1c) → Performance	0.361	0.008***
Robust ITGC (H1d) → Performance	0.015	0.590
Need (H1e) → Performance	0.071	0.528
Skills (H2a) → Effort	0.537	0.000***
Corp IT (H2b) → Effort	0.189	0.235
CA System (H2c) → Effort	-0.026	0.984
CA Processes (H2d) → Effort	0.074	0.654
CAE and Board (H3a) → Social	0.154	0.166
Mgmt Support (H3b) → Social	0.512	0.000***
Change Mgmt (H3d) → Social	0.244	0.065*
Performance → Intention	0.123	0.445
Effort → Intention	0.194	0.144
Social → Intention	0.264	0.091*
Size Proxy → Intention	0.052	0.952
Size on Perf → Intention	0.041	0.930

Table A.4: Responses to the question "Are there other features you would expect from a Continuous Assurance front-end system?". (Answers such as "no" or "empty" have been removed for brevity.)

It should tap directly into the systems (ERP, HR, etc.) to get actual, on-the-fly data.
Data visualization tool
Analytics that serve both continuous auditing and risk-assessment purposes

Table A.4: Responses to the question “Are there other features you would expect from a Continuous Assurance front-end system?”. (Answers such as “no” or “empty” have been removed for brevity.)

Ein Feedback-Loop i.S.v. einer Wiedervorlage von Erkenntnissen aus vergangenen Analyseläufen, bis hin zzueinem selbsttätigen Einordnen und ggf. Hochspülen relevanter Auffälligkeiten. *[A feedback loop in the sense of a follow-up of findings from past analytics runs, up to an independent classification and maybe re-emergence of relevant anomalies.]*
Miteinbezug der Ergebnisse anderer Assurance Providern in den anderen Verteidigungslinien als auch aus regulären Revisionsberichten selber. *[Inclusion of the results of other assurance providers in the other lines of defence as well as from the regular audit reports themselves.]*
Strong management and control over data classification and access rights.
Maybe easy to use, user friendly, easy reports produced, Access to underlying data, good Quality for underlying data
Sécurité des données *[data security]*
Flexibilité dans les analyses effectuées et la documentation des travaux effectués *[Flexibility in the analyses run and documentation of the work performed]*
Interaction avec les audités si le suivi des recommandations est intégré *[Interaction with the auditees if the tracking of recommendations is integrated]*
User experience with a capability to manage and report results for further benefit is critical to success and utilization of CA
Möglichkeit die Dokumentation, Revisionsergebnisse und Analyseinformationen zurück über die Zeitachse schnell im Zugriff zu haben und wo möglich vergleichen zu können. *[Possibility to quickly access the documentation, the audit results and the analytical information across time and where possible to be able to compare it.]*

Table A.5: Responses to the question "What continuous development options would you expect from e.g. IIA Switzerland to better prepare auditors for Continuous Assurance?". (Answers such as "no" or "empty" have been removed for brevity.)

Avoir disponible des cours sur le Continuous auditing (en français) *[Availability of continuous auditing courses in French]*
Montrer les différentes solutions, comparer, mise en place *[Show the different solutions, compare them, set-up]*
Grundlagenschulung zum Thema mit Praxisbeispielen *[Basic training on the topic with examples from practice]*
Erfa-Veranstaltungen zum Thema *[Exchanges of experience on the topic]*
Workshops
Data analytics + exemples de Tools + panorama des possibilités... *[Data analytics, examples of tools, panorama of possibilities]*
Die bestehenden Angebote im Markt sind ausreichend *[The available offerings in the market are sufficient.]*
Die Ausbildungsangebote von IIA Switzerland zu meiner Zeit als Leiter Interne Revision waren sehr beschränkt auf Basisthemen und formalen Aspekten. Wir haben uns deshalb der Audit Excellence Group angeschlossen, welche sehr gute Ausbildungen und Lehrgänge angeboten hat, die primär auf die praxisorientierte Umsetzung (Werkzeuge, Handwerk, Vorgehne) ausgestaltet waren (von Pratiker für Pratiker). *[The education offering of IIA Switzerland during my time as CAE was very much limited to basic topics and formal aspects. We have thus joined the Audit Excellence Group, which offered very good trainings and courses which were primarily focussed on practice-oriented implementation (tools, craftwork, approach; from the practician to the practicican).]*
Data analytics, formalisation du SCI et plan d'audit basé les risques *[Data analytics, formalisation of the internal control framework and risk-based audit planning.]*
Training; seminars; case studies
The key issue with Continuous Assurance is the process more than the tool. I would expect more opportunities to discuss practical examples of companies which implemented Continuous Assurance.

Table A.5: Responses to the question "What continuous development options would you expect from e.g. IIA Switzerland to better prepare auditors for Continuous Assurance?". (Answers such as "no" or "empty" have been removed for brevity.)

Use Cases, Events, possible Tools
Datenanalysen und Big data *[Data analytics and Big Data.]*
Weniger hohe Theorie, dafür praxisorientiere Inhalte, Beispiele, erprobte Tools und Vorgehensweisen, Ideen, Umsetzungsberichte, Erfahrungsaustausch. *[Less high theory, instead practice-oriented content, examples, proven tools and methods, ideas, implementation reports, exchange of experiences.]*
Online resources from former courses: why to pay CHF 750 per day and waste one working day to follow a PPT presentation? Those courses sound more as a "educational conformity business" for validate a certification rather than professional development.
ACL courses
Help with introducing tools on the market
Aufzeigen von erfolgreich eingeführten CA in einer Firma. Von Beginn an mit Einführung CM in der ersten und zweiten Verteidigungslinie über die Einführung des CA in der Internen Revision. Aufzeigen der einzelnen Schritte von der Idee bis Umsetzung in den Systemen 1./2./3. Verteidigungslinie. Mit Aufzeigen der Fallstricke. *[Show successfully implemented CA in a company. From the beginning with introduction of CM in the first and second line of defence to introduction of CA in internal audit. Show the individual steps from the idea until implementation in the systems of the 1st/2nd/3rd line of defence. Include showing the pitfalls.]*
Concepts to implement CA
Courses for example together with university of applied science (Certificate of advanced studies)
I do believe options are available. I participate in trainings myself, internally and with IIAs.
Explaining the term.
Data Scientist Methoden *[Data science methods.]*
Mehr Kurse im Bereich Datenanalyse *[More courses in the area of data analysis.]*

Table A.5: Responses to the question “What continuous development options would you expect from e.g. IIA Switzerland to better prepare auditors for Continuous Assurance?”. (Answers such as “no” or “empty” have been removed for brevity.)

Schulungen zu analytischem Denken *[Courses on analytical thinking.]*
Wie funktionieren Datenbanken? Was sind "JOINs" etc...? *[How do databases work? What are JOINs etc.?]*
Ausbildung, die die IR im Aufbau einer Cont. Assurance unterstützt inkl. des Einsatzes von geeigneten Tools *[Education that supports internal audit in building up CA including the use of suitable tools.]*
An Overall Guideline / roadmap showing eg Best practices, best tips, best Tools, key challenges
Provide sufficient information to all the CAEs to ensure that continuous Assurance is taken seriously!
Formations sous formes de workshop sur des thématiques du type: Méthodes d’évaluation continue des risques, Méthodes d’évaluation continue des contrôles, Mise en œuvre de l’assurance continue (trucs, astuces, problématiques fréquentes, pièges), Échange d’expériences. *[Trainings in the form of workshops about topics in the areas of: Methods of ORA, methods of OCA, set-up of CA (tips and tricks, common problems, pitfalls), exchange of experiences.]*
Sessions with peer organizations and subject matter experts.
Support for middle banks for possible fields in continuous auditing. A platform for the exchange of experiences and results.
Praxisorientierte Prüffelder und Prüfvorgehen für mittlere und kleine Banken. *[Practice-oriented audit areas and audit approach for medium-sized and small banks.]*

Appendix B

Glossary

3LoD three lines of defence.

AAA American Accounting Association.

American Accounting Association is an American association of accountants in academia, focussing on teaching and research and publishing various journals such as the *Accounting Review*.

AMS audit management system.

API application programming interface.

application programming interface is an interface within one software or hardware component that provides well-defined ways for another software to interact with the software or hardware component that provides this application programming interface.

audit management system is a software package for internal audit activities that adresses audit planning, audit fieldwork, audit reporting and audit documentation (using electronic working papers functionality). Commonly used audit management systems are Audimex[1] or TeamMate[2].

CA continuous assurance.

CAAT computer-assisted audit technique.

CAE chief audit executive.

[1] `https://www.web-audimex.com/`.

[2] `http://www.teammatesolutions.com/`.

CB-SEM covariance-based SEM.

chief audit executive “describes the role of a person in a senior position responsible for effectively managing the internal audit activity in accordance with the internal audit charter and the mandatory elements of the International Professional Practices Framework. The chief audit executive or others reporting to the chief audit executive will have appropriate professional certifications and qualifications. The specific job title and/or responsibilities of the chief audit executive may vary across organizations” (IIA, 2017c).

CM continuous monitoring.

comma-separated values is a data exchange format in which tabular data is stored as text files where each record is stored as one line with the fields being separated by a separator character. Contrary to the name of the format, the separator does not necessarily have to be a comma, in particular the semicolon is also a frequently used separator.

computer-assisted audit technique is the application of general or specialized IT tools (such as *IDEA* or *ACL*) to analyze data in support of audit objectives (e.g. searching through large data sets for specific criteria or statistic outliers).

continuing professional development encompasses all education and professional development measures that support the adherence to the IIA’s Code of Ethics rule of conduct 4.3: Internal auditors “shall continually improve their proficiency and the effectiveness and quality of their services” (The Institute of Internal Auditors [IIA], 2009).

continuous assurance can refer to “a methodology that enables independent auditors to provide written assurance on a subject matter using a series of auditors’ reports issued simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter”

(CICA, 1999, p. 5) in matters not limited to financial reporting (for external auditors) or to the combination of continuous auditing with independent assurance over management's CM activities (for internal audit). Unless specified otherwise, this paper uses the latter definition.

continuous auditing is a methodology to achieve more timely assurance by leveraging technology to conduct more frequent risk analysis and audit procedures.

continuous monitoring is a "a management process that monitors on an ongoing basis whether internal controls are operating effectively" (Ames et al., 2015b, p. 3).

covariance-based SEM describes methods to evaluate SEMs which are based on the idea that they try to minimize the difference between the model-estimated covariance matrix and the observation-based covariance matrix. Covariance-based SEM are the original SEM modelling approaches as implemented in tools such as LISREL and the term is primarily used to distinguish them from PLS-SEM.

CPD continuing professional development.

CSV comma-separated values.

design science research is a research method that aims to answer questions by designing and evaluating innovative artefacts (Hevner & Chatterjee, 2010). While descriptive research seeks truth, DSR seeks usefulness (Winter & Aier, 2016).

DSR design science research.

EAM embedded audit module.

embedded audit module is a section of "code built into application programs that capture[s] information of audit significance on a continuous basis" (Groomer & Murthy, 1989, p. 1).

Enterprise Resource Planning integrates business processes across an organization into one unified IT system. "The business processes are grouped into different models and different components of ERP are designed in such a way that each software component can take care of independent models. All these models are finally integrated to give the organization unified views. The basic concept behind using this unified system is the usage of the organization or enterprise database" (Ganesh, Mohapatra, Anbuudayasankar, & Sivakumar, 2014, p. 7).

ERP Enterprise Resource Planning.

ETL extract, transform, load.

extract, transform, load processes are the software processes that "facilitate the population of" a data warehouse. "ETL processes are responsible for (i) the extraction of the appropriate data from the sources, (ii) their transportation to a special-purpose area of the data warehouse where they will be processed, (iii) the transformation of the source data and the computation of new values (and, possibly records) in order to obey the structure of the data warehouse relation to which they are targeted, (iv) the isolation and cleansing of problematic tuples, in order to guarantee that business rules and database constraints are respected and (v) the loading of the cleansed, transformed data to the appropriate relation in the warehouse, along with the refreshment of its accompanying indexes and materialized views" (Vassiliadis, 2009, p. 2).

FTE full-time equivalent.

full-time equivalent is the number of employees of an organisation scaled to account for part-time work, for example an employee on a 80% contract will count as 0.8 FTE.

governance, risk, and compliance are terms that are commonly combined to "GRC", especially in the context of enterprise software solutions in this area. GRC "is an integrated, holistic approach to organisation-wide governance, risk and compliance ensuring that an organisation acts ethically correct and in accordance with its risk appetite, internal policies and external regulations through the alignment of strategy, processes, technology and people, thereby improving efficiency and effectiveness" (Racz, Weippl, & Seufert, 2010).

GRC governance, risk, and compliance.

Heterotrait-monotrait ratio of correlations is a criterium to evaluate discriminant validity. Discriminant validity "ensures that a construct measure is empirically unique and represents phenomena of interest that other measures in a structural equation model do not capture". HTMT is "the average of the heterotrait-heteromethod correlations (i.e., the correlations of indicators across constructs measuring different phenomena), relative to the average of the monotrait-heteromethod correlations (i.e., the correlations of indicators within the same construct)" (Henseler et al., 2015).

HTMT Heterotrait-monotrait ratio of correlations.

ICS internal control system.

information systems are the "combination of hardware, software, infrastructure and trained personnel organized to facilitate planning, control, coordination, and decision making in an organization" ("Information system", n.d.).

internal control system is the overall system of policies, procedures and responsibilities in an organisation pertaining to internal control. Internal control is "a process, effected by an entity's board of directors, management, and other personnel, designed to provide reasonable assurance regarding the achievement of objectives relating to operations, reporting, and compliance" (COSO, 2013b, p. 3).

IS information systems.

IT general controls are controls to address risks associated with the reliance on IT. Contrary to application controls, IT general controls apply to the IT function overall. They "apply to all aspects of the IT function, including IT administration; separation of IT duties; systems development; physical and online security over access to hardware, software, and related data; backup and contingency planning in the event of unexpected emergencies; and hardware controls" (Arens et al., 2014, p. 392).

ITGC IT general controls.

key risk indicator quantitatively measures the likelihood and/or potential loss of some risk.

KRI key risk indicator.

OCA ongoing control assessment.

OCR optical character recognition.

ongoing control assessment is "the ongoing evaluation of internal controls against a baseline condition and subsequent changes to control configurations, through the use of technology-based audit techniques" (Ames et al., 2015b, p. 3).

ongoing risk assessment is "the ongoing identification and assessment of risks to the achievement of business objectives through the use of technology-based audit techniques" (Ames et al., 2015b, p. 3).

optical character recognition is “the mechanical or electronic conversion of images of typed, handwritten or printed text into machine-encoded text” and “is a common method of digitising printed texts so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as cognitive computing, machine translation, (extracted) text-to-speech, key data and text mining” (“Optical character recognition”, n.d.).

ORA ongoing risk assessment.

partial least squares structural equation modeling is “a second generation regression model that combines a factor analysis with linear regressions, making only minimal distribution assumptions” (Gefen et al., 2000, p. 70).

PLS-SEM partial least squares structural equation modeling.

QAIP quality assurance and improvement program.

quality assurance and improvement program is required for internal audit activities by IIA Standard 1300ff and is “designed to enable an evaluation of the internal audit activity’s conformance with the Standards and an evaluation of whether internal auditors apply the Code of Ethics. The program also assesses the efficiency and effectiveness of the internal audit activity and identifies opportunities for improvement” (IIA, 2017a).

RSS is an XML-based data exchange format that “is currently used for a number of applications, including news and other headline syndication, weblog syndication, and the propogation of software update lists” (Nottingham, 2001). Software applications such as Microsoft Outlook allow to “subscribe” to so-called RSS feeds, which are then periodically retrieved from the hosting web server and any new entries are displayed to the user.

SEM structural equation modeling.

structural equation modeling describes a set of techniques to develop and evaluate models based on a set of linear regression equations that allow to simultaneously estimate the measurement model for latent variables and the structural model between those variables (Bollen, 1989).

TAM Technology Acceptance Model.

Technology Acceptance Model is a model for user acceptance of information systems. It stipulates that user acceptance depends on the perceived usefulness and the perceived ease of use of the system.

three lines of defence is a model of the roles and responsibilities in risk management and governance. "Its underlying premise is that, under the oversight and direction of senior management and the board of directors, three separate groups (or lines of defense) within the organization are necessary for effective management of risk and control" (Anderson & Eubanks, 2015, p. 2). The first line owns and manages risk, the second line supports management in monitoring and control and the third line provides independent assurance on the effectiveness of risk management.

Unified Theory of Acceptance and Use of Technology is a model for user acceptance of information systems. It builds on the Technology Acceptance Model (TAM) and describes three antecedents that "will predict behavioral intentions: performance expectancy (formerly perceived usefulness), effort expectancy (formerly perceived ease-of-use), and social influence (not in the original TAM model). A direct antecedent of actual behavior is facilitating conditions. Finally, control variables moderate the relationships of the four antecedents of intentions: gender, age, experience, and voluntariness of use" (Gonzalez et al., 2012, p. 250).

UTAUT Unified Theory of Acceptance and Use of Technology.

value-at-risk is a measure of risk. For a given probability and time frame plus underlying assumptions on the distribution of outcomes, losses over this time frame will exceed the value-at-risk only with the given probability given the assumptions on the distribution of outcomes are correct (McNeil, Frey, & Embrechts, 2015).

VaR value-at-risk.

variance inflation factor is a measure of intra-construct collinearity. It is calculated as the inverse of the tolerance (TOL), which represents the amount of variance of one indicator not explained by regressing it on the other indicators in the same construct (i.e. $1 - R^2$ for this regression). Values of 5 and higher indicate a potential collinearity problem (Hair et al., 2011; Hair et al., 2017, p. 207).

VIF variance inflation factor.

Curriculum Vitae

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