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CONTINUOUS AUDITING – STATUS OF AND REASONS FOR CURRENT ADOPTION LEVEL AMONG GERMAN INTERNAL AUDIT DEPARTMENTS

Dissertation to obtain a PhD degree

Written by:
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Supervisor:
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Dissertation to obtain a PhD degree

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To my parents

English abstract

This thesis covers a two-step analysis aiming to identify the current state of adoption of continuous auditing (CA) among German internal audit departments as well as to find the reasons for the current adoption level of CA. In accordance with findings from the U.S.A. and other countries, it is hypothesised that the overall CA adoption level is low and that ‘framework conditions’, ‘auditors’ skills’, ‘imprecise results’, ‘lack of resources’, and ‘missing support’ all have a negative impact on CA adoption. The analyses are based on two independent surveys which were distributed among German internal auditors. Collected data was assessed by variance analyses and correlation analyses. As the analyses show, the overall CA adoption rate is at a medium level. Also, ‘lack of resources’ and ‘missing support’ are found to have a negative impact on CA adoption.

German abstract

Diese Dissertation umfasst eine zweistufige Analyse zur Ermittlung des aktuellen Umsetzungsstands von Continuous Auditing (CA) in deutschen Innenrevisionen, sowie zur Identifikation von Gründen für den aktuellen Umsetzungsstand. Auf Basis von Erkenntnissen aus anderen Ländern wird ein geringer Umsetzungsstand angenommen und davon ausgegangen, dass sich einzelne Variablen negativ auf die Umsetzung von CA auswirken. Die durchgeführten Analysen umfassen zwei unabhängige Umfragen unter Innenrevisoren deutscher Unternehmen. Die erhobenen Daten wurden mittels Varianz- und Korrelationsanalysen ausgewertet. Die Untersuchungen ergeben, dass die Umsetzung von CA insgesamt auf einem mittleren Niveau liegt und dass sich die Variablen ‘mangelnde Ressourcen‘ und ‘fehlende Unterstützung‘ negativ auf die Umsetzung von CA auswirken.

Preface

This thesis was written as part of the four-year long doctoral study offered at the István Széchenyi Doctoral School of Economics and Management at the University of Sopron. It represents the final piece of work to obtain a PhD degree and covers a scientific discourse about continuous auditing, a comparably new auditing methodology among internal auditors. Specifically, this thesis includes an empirical analysis about the adoption rate of CA among German internal audit departments and corresponding reasons.

This thesis would not have been possible without a range of people. First of all, I would like to express my deepest gratitude to my supervisor, Prof. Dr. Markus Mau as well as to Prof. Dr. Nicole Mau for their ongoing support throughout the processes of writing this thesis. Without their guidance and persistent help this dissertation would not have been possible.

Also, I want to thank dean Prof. Dr. Csilla Obádovics, former deans Éva Kiss and Prof. Dr. Csaba Székely as well as the members of the examination board for their feedback and continuous support during the process of writing my thesis. Furthermore, I would like to express my deepest appreciation to all professors, lecturers, and staff members of the faculty of economics at the University of Sopron.

I owe my deepest gratitude to a range of fellow colleagues at the DIIR and the German chapter of ISACA who helped me to identify participant for my research. Also, I owe a very important debt to all internal auditors who participated in my research.

I am particularly grateful for the editorial assistance provided by Garvin Filby and Robert Mason. Moreover, I thank a range of former colleagues at PwC and Business Brothers for their constructive comments and their generous support throughout the doctoral program.

Last, but not least I am deeply grateful to my parents for their patience and encouragement over the whole of my life.

For reasons of better readability, the masculine form is used for personal names and personal nouns throughout this thesis. Corresponding terms apply to all genders in the sense of equal

treatment. The abbreviated language form is used for editorial reasons only and does not imply any valuation.

Sopron, 2021

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List of abbreviations

AICPA	American Institute of Certified Public Accountants
ANOVA	Analysis of variance
approx.	approximately
BAIT	German: Bankaufsichtliche Anforderungen an die IT (= IT requirements by banking supervision)
CA	Continuous Auditing
CAATTs	Computer-assisted audit tools and techniques
CAE	Chief Audit Executive
CFO	Chief Financial Officer
CICA	Canadian Institute of Chartered Accountants
cf.	confer
CM	Continuous Monitoring
COSO	Committee of Sponsoring Organizations of the Treadway Commission
EAM	Embedded Audit Module
EC	European Commission
e.g.	Latin: exempli gratia (= for example)
ERMIS	Emergency Response Management Information System
ERP	Enterprise Resource Planning
et al.	Latin: et alii (= and others)
etc.	Latin: et cetera (= and so on)
et sq.	Latin: et sequens (= and the following, singular form)
et sqq.	Latin: et sequentes (= and the following, plural form)
EU	European Union
GDP	Gross Domestic Product
HR	Human Resources
i.e.	Latin: id est (= that is)
IFRS	International Financial Reporting Standards
IIA	Institute of Internal Auditors
ISACA	Information Systems Audit and Control Association
IT	Information Technology
IMF	International Monetary Fund
KPI	Key Performance Indicator

KRI	Key Risk Indicator
MCL	Monitoring Control Layer
MS	Microsoft
p.	page
PCAOB	Public Company Accounting Oversight Boar
PhD	Latin: philosophiae doctor (= Doctor of Philosophy)
pp.	pages
SOX	Sarbanes-Oxley Act
unpag.	unpaginated, without page numbers
XBPL	Extensible Business Reporting Language

1 INTRODUCTION

In this chapter, the topic of Continuous Auditing will be introduced and its relevance will be elaborated on. Also, the objectives of and the motivations for this research will be presented. Finally, the structure of this thesis is provided.

1.1 Relevance of topic

Striving for constant improvement has always been a decisive mission for those companies that wish to remain successful. Achieving improvements is not an easy task and requires a multitude of actions. Evaluating one's own business activities is certainly one of these actions (Gervais, Lemarchand, Margairaz, Rudy-Gervais, 2016). Responsibility for the regular evaluation of performance rests with the management of a company. However, the implementation of this activity can be passed on to other functions such as management accounting, controlling, in-house consulting, data analytic, or internal audit departments (Peemöller, Kregel, 2014, pp. 1-2).

Over the past few decades, the internal audit function has risen markedly in importance (Amling, Bantleon, 2007, pp. 81-83). It has developed to become a reliable partner of management and supervisory boards when it comes to evaluating company measures to ensure effectiveness and efficiency of structures and processes, compliance with laws and regulations, prevention and detection of fraud, safeguarding of assets, and other corporate dealings (Institute of Internal Auditors, 2012). Thus, many companies hold internal audit departments or receive internal audit services from external parties (e.g. from consulting companies). The popularity of internal audit departments arises not only out of self-interest, but is also backed by legislature that requires companies of specific industries (e.g. banking, insurance) to have internal audit departments in place (Amling, Bantleon, 2007, pp. 81-150).

In times of rapid change, companies need to constantly adjust to changes in their internal and external environments (Senior, Fleming, 2009, pp. 3-40). As part of this, the internal audit function plays an important role by assisting those corporate entities which identify and meet these changes. Furthermore, the internal audit department itself needs to undergo regular adjustments, so it can fulfil its duties and satisfy its own stakeholders' needs. On a regular basis, internal audit departments need to find new ways to reach results faster or with less effort. Financial and personnel resources are scarce and thus need to be used efficiently. Moreover, the internal

audit function needs to advance its auditing techniques, make effective use of technology, and react to the latest auditing trends. In many cases, the internal audit function needs to reinterpret its own role and shift from its traditional, finance-oriented investigation role to a more progressive, company-wide consulting role. Also, data has grown in extent and variety and requires the auditor to find new auditing methodologies (Peemöller, Kregel, 2014, pp. 97-108).

Since 2002 there has been an ongoing debate about the role of internal auditors. Corporate scandals over companies as Enron, Parmalat, and WorldCom have shifted public interest towards auditors and their responsibility in preventing fraud and misstatement of financial statements. The recent scandal of Wirecard has revived this debate and has increased pressure on regulating bodies to strengthen the independence of internal auditors and to hand them more responsibility (Der Bank Blog, 2010).

The academic world has come up with several new approaches to ease the internal auditors' struggle in accounting for the requirements arising out of these developments. One such concept is Continuous Auditing (CA).

CA was first introduced by Groomer and Murthy (1989, pp. 53-69) as well as by Vasarhelyi and Halper (1991, pp. 110-125). According to the American Institute of Certified Public Accountants (AICPA) and the Canadian Institute of Chartered Accountants (CICA) (1999), CA is "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 time after, the occurrence of events underlying the subject matter". More practically speaking, it is a risk-oriented, systematic auditing methodology, assisted by the usage of IT tools, covering the ongoing, or at least highly frequent analysis of different kinds of data by identifying deviations to previously defined target levels simultaneously or shortly after the occurrence of an event (Wagner, Lieder, 2016).

According to Vasarhelyi (2011, pp. 23-29), CA holds several subdisciplines, based on the subject the audit activity focuses on (i.e. Continuous Controls Monitoring, Continuous Risk Management and Assessment, as well as Continuous Data Assurance). Also, CA is often mentioned in close connection to similar disciplines such as Continuous Monitoring and, in parts, to Continuous Assurance (Vasarhelyi, Romero, Kuenkaikaew, Littley, 2012, pp. 31-35).

CA is brought to life via processual approaches. Most approaches discussed in theory cover multiple stages and/or align themselves to the four stages of the Plan-Do-Act-Check cycle (e.g. Institute of Internal Auditors, 2005, p. 17; Du, Roohani, 2007, pp. 133-146; Yeh, Shen, 2010, pp. 2554-2570). Although most definitions of CA do not require the use of technology, software solutions have eased auditors' efforts during the implementation of CA in practice (Flowerday, Blundell, von Solms, 2006, pp. 325-331). Several software architecture designs are discussed in theory and applied in practice, most of which can be reduced down to the two architecture designs: Embedded Audit Modules and Monitoring Control Layer. In this context, several programming languages (e.g. Extensible Business Reporting Language, Unified Modelling Language) have gained in popularity and are increasingly being used for CA solutions (Lin, Lin, Liang, 2010, pp. 415-422).

Academics have found a range of advantages that the application of CA provides. Among others, CA increases efficiency and effectiveness of the audit process by reducing audit costs and enhancing overall audit quality (Grasegger, Weins, 2012, pp. 231-238; Marks, 2009, p. 51). It helps companies to comply with law and regulations (Woodroof, Searcy, 2001, pp. 169-191). It allows handling large volumes of data and thereby enables auditors to approach subjects previously not auditable (Chan, Vasarhelyi, 2011, pp. 152-160). Due to its strict processual approach, it also strengthens auditors' independence and helps to clarify auditors' responsibilities (Institute of Internal Auditors, 2005, p. 5).

Before CA can function properly, barriers previously identified by academics need to be overcome. Diverse and heterogeneous data can make it difficult to apply CA as data needs to be standardised in many cases (Li, Li, 2007). Also, IT and training investments will be necessary to implement CA (Baksa, Turoff, 2010). As CA represents a methodology significantly different from traditional auditing, disruptions in daily operations of internal audit departments can occur (Hoffer, 2007, pp. 1-19). Furthermore, the rigid procedures that are required by CA interfere with the need for flexibility in daily auditing operations (Sun, 2012, pp. 59-85).

Vasarhelyi, Alles, Kuenkaikaew, and Littley (2012, pp. 267-281) see CA as the ultimate stage of internal auditing. Their underlying assumption is that the internal audit function of a company matures over time and becomes more and more sophisticated in its structures and processes. Specifically, they assume that internal audit functions pass through several stages (i.e.

‘1-traditional’, ‘2-emerging’, ‘3-maturing’, ‘4-fully continuous’), starting at a level with uncoordinated audit activities and ending at a level with strictly structured, automated audit activities.

1.2 Objectives of research

Despite the promising nature of this concept, CA does not get off the ground in practice. Academics do not establish a clear picture regarding the extent of usage of CA. On a global scale, publications from the practical field indicate a strong belief in the abilities of the concept, but also emphasis the severity of obstacles during the introduction. Specifically, two studies find that companies make wide use of CA. The auditing company PwC (2006) performed a study covering a sample of 392 U.S.-based companies. They found out that 50% of all companies use CA techniques and 31% have already made plans to implement CA in the near future (Alles, Tostes, Vasarhelyi, Riccio, 2006, pp. 211-223). In a study covering 305 companies, the software company Galvanize (formerly known as ACL) and the IIA (2008) concluded that the use of CA in practice is widespread. They found that 30% of companies were using a form of CA, while another 15% had planned to start with the CA implementation the following year (CaseWare, 2008; McCann, 2009).

On the contrary, five other studies provide proof that the adoption of CA is low. By performing a regression analysis based on global data, Gonzalez, Sharma, and Valletta (2012, pp. 248-262) found that only few companies have CA fully implemented. Additionally, they found that the usage of CA is affected by the perceived ease of use and social pressure. While North American internal auditors are more likely to use CA due to soft social pressure from peers and higher authorities, Middle Eastern internal auditors are more likely to use CA if it is mandated by higher authorities. Vasarhelyi, Alles, Kuenkaikaew, and Littley (2012, pp. 267-281) concluded that most companies which had participated in their survey found themselves between stages 1-traditional and 2-emerging regarding the level of CA adoption. Tumi (2013, pp. 2-10) investigated whether auditors in Libya were making use of CA and concluded that CA was rarely used. Moturi and Gaitho (2014, pp. 1644-1654) analysed to what extent CA was being used among public sector organisations in Kenya. They found that most state departments were changing their behaviour and that they were preparing to advance from traditional auditing to CA. In another study featuring U.S.-based companies, Vasarhelyi, Kuenkaikaew, Littley, and

Williams (2015) concluded that all participating companies were between the traditional and the emerging stage.

Consequently, present publications do not give a clear indication about the extent of CA usage. Nor do they distinguish among any subdisciplines of CA or company-specific parameters. Furthermore, detailed empirical research regarding the adoption of CA among German internal audit departments has not been conducted so far.

Thus, the first objective of this research will be:

> **RO_A**: To identify and analyse the current status of CA adoption among German internal audit departments

In this context, "German internal audit departments" is defined as the sum of internal audit departments of companies located in Germany. The degree of CA adoption is defined as the extent to which German internal audit departments apply elements of CA in their daily work.

To quantify the degree of CA adoption, it is measured in terms of one of four stages (i.e. '1-traditional', '2-emerging', '3-maturing', '4-fully continuous') of the CA maturity model by Vasarhelyi, Alles, Kuenkaikaew, and Littley (2012, pp. 267-281). Companies which find themselves between stages '1-traditional' and '2-emerging' are considered to feature a low adoption level. Companies which find themselves between stages '2-emerging' and '3-maturing' are considered to feature a medium adoption level. Companies which find themselves between stages '3-maturing' and '4-fully continuous' are considered to feature a high adoption level.

Research activities regarding RO_A presented in this thesis include an analysis of the overall CA adoption level as well as further analyses over the adoption levels of single CA subjects. Furthermore, this research accounts for internal audit function-specific and company-specific parameters to provide a more differentiated view on CA adoption.

In relation to RO_B, research literature has brought forward a range of influencing factors which either support or restrict the use of CA in practice (e.g. Grasegger, Weins, 2012, pp. 231-238; Taylor, Murphy, 2004, pp. 280-289). However, the strength of these factors has not been subject to empirical research in much detail. Also, dedicated research regarding the reasons for or

against CA among German internal audit departments has not yet been conducted. Therefore, the second objective of this research is:

RO_B: To discover the reasons behind the current CA adoption level

For this second objective, this research will measure whether single factors discussed in literature significantly impair CA usage or not. Research activities regarding RO_B will also aim to identify new, unknow factors impairing the usage of CA.

To account for both objectives, this thesis covers two areas of research (main research A and main research B) as well as one preliminary research. Main research A covers all steps to analyse the current state of the adoption of CA among internal audit departments in German companies. Given the considerable extent of uncertainty arising from findings in theory, a preliminary research is carried out to clarify the general understanding of CA in practice and to help specify further research activities of main research A. Main research B tries to find out reasons for the current state of adoption.

Both areas of research follow a structured procedure. They start with a closer description of the research dilemmas before research questions and hypotheses are formulated. For both main research A and main research B, dedicated research designs (including research elements such as type of research, data collection methods, sampling procedures, target groups) will be defined. Data collection and data analysis will be performed in consistent ways to guarantee the integrity of the research results.

The sum of internal auditors of all companies in Germany represent the target group of this thesis. Therefore, all research activities are geared towards internal auditors. Specifically, surveys used to gather data will be addressed exclusively to internal auditors of Germany-based companies, unless stated otherwise.

1.3 Motivations for chosen topic

Behind the two objectives mentioned above, there are several motivations for the research:

Attractiveness of internal auditing

The field of internal auditing has gained in attractiveness and importance over the last decades (Amling, Bantleon, 2007, pp. 81-83). In its early days, the internal audit function was primarily charged with validating financial figures. Little to no attention was paid to topics outside the financial field. Also, audit engagements were conducted in an inflexible manner, i.e. in strict adherence to predefined plans (Kagermann, 2006, pp. 16-23). Over the years, internal auditing was influenced by a range of developments, resulting in the function becoming more open to non-financial business aspects. Audit activities were realigned to foster shareholder value. Focus also shifted from validating results to evaluating causes. Moreover, processes and IT systems have increasingly become subject to internal audit activities (Peemöller, Kregel, 2014, pp. 19-20).

Consequentially, these developments have affected the auditor's role. As part of their daily work, auditors gain knowledge over a wide field of business topics, receive information from different hierarchy levels, and are among the first ones to be informed about relevant news. In many companies, auditors have developed to take over an internal consulting role (Amling, Bantleon, 2007). As a result, job satisfaction has improved considerably and the profession is perceived as more and more appealing. Given this positive change, companies have started to use their internal audit department as a prime entity to employ applicants with high potential (Peemöller, Kregel, 2014, p. 154). Internal auditing can therefore be said to be in vogue.

CA as a promising methodology to overcome meta challenges

Over the last decade, there has been a striking public debate about buzz words such as 'big data', 'industry 4.0', or 'digitalisation' (Tecchannel, 2016). Indeed, companies are faced with growing volumes of data. At the same time, data itself is becoming more and more heterogenous and complex in its structure (BigDataMadeSimple, 2015). Also, with digitalisation progressing, companies increasingly have to cope with streamlining and automising their processes (McKinsey, 2019).

Inevitably, internal auditing will continue to be subject to these external challenges. Auditors need to adapt in what they do to ensure their services still provide the expected value. Moreover, changes in the business environment will create the necessity for auditors to shorten the time between the trigger of an audit engagement (e.g. identification of a major deficiency) and the

conduction of an audit engagement as well as between the conduction of an audit engagement and the publication of its results (Coderre, 2007).

CA, as a comparably new methodology, is already being credited for helping auditors to overcome the aforementioned challenges (Moeller, 2004). Many advantages are discussed in theory. By applying CA, auditing is said to increase the efficiency and effectiveness of the audit process by reducing audit costs and enhancing overall audit quality (Grasegger, Weins, 2012, pp. 231-238; Marks, 2009, p. 51). It is intended to help companies comply with laws and regulations (Woodroof, Searcy, 2001, pp. 169-191). It is found to allow the handling of large volumes of data and thereby enables auditors to approach subjects previously not auditable (Chan, Vasarhelyi, 2011, pp. 152-160). Due to its strict processual approach, it is also supposed to strengthen auditors' independence and help clarifying auditors' responsibilities (Institute of Internal Auditors, 2005, p. 5).

Given these positive attributes, the concept of CA is very promising. From a purely scientific standpoint, this methodology can be considered as an "all-purpose weapon" which, from a practical perspective, is too good to be true. Therefore, a detailed analysis of the practical applicability of CA is the logical consequence of the previous academic discussion around CA.

No clear picture of adoption rate and its reasons

The degree of adoption of CA has been subject to only a few academic articles. Comparing these articles, it is difficult to find a common line. While some authors claim that CA adoption rate is high (e.g. PwC, 2006; Galvanize/IIA, 2008), others find that only a few companies make partial or full use of CA (e.g. Vasarhelyi, Alles, Kuenkaikaew, Littley; 2012). There is no empirical research explicitly covering the reasons for a given adoption rate, nor is there any empirical research which break CA down into its elements and analyse the adoption rate on a more detailed level.[1] Thus, the current scientific discussion leaves considerable gaps which this research intends to close.

German internal audit departments as an unexplored research object

Many CA research articles are based on data from the U.S.A. There is little research that covers other countries or which features an international approach (e.g. Gonzalez, Sharma, Galletta,

[1] Based on a literature review covering database EconLit and GoogleScholar

2012). Yet, Germany can be considered as a suitable research object when it comes to CA due to several reasons:

- Germany has one of the leading economies worldwide. According to the IMF's figures of 2019, German has the 4th largest GDP worldwide (behind the U.S.A., China, and Japan) and is the third largest export country (International Monetary Fund, 2019). According to the World Economic Forum (2018), Germany also ranks fifth on the global competitive index. Assuming that the high number of U.S.-based CA research articles is a result of the U.S.-American economy being among the largest economies worldwide, Germany represents a comparable and thus equally appropriate market for CA research.

- At the same time, Germany is found to be among those countries which are highly regulated in the economic field (Die Deutschen Versicherer, 2020). Labour laws are strict, production is shaped by many production rules, and the amount of consumer protection regulation is extensive (Welt, 2015). Meanwhile, the existence of internal auditing and its growth in Germany over the last 30 years has been influenced positively by laws and regulations imposed by legislature (e.g. International Professional Practices Framework issued by the Institute of Internal Auditors (IIA) in 2008 or the DIIR Revisionsstandards no. 2 to 5 issued subsequently). Especially in highly regulated industries (e.g. banking, insurance), legislature has introduced several laws and regulations (e.g. the Mindestanforderungen an das Risikomanagement of 2005, the Basel standards resulting from the financial crisis of 2007/2008) which requires companies to run internal audit departments and to appoint chief audit executives (CAEs). Internal auditing can therefore be considered as a significant (in parts even obligatory) function of German companies (Amling, Bantleon, 2007, pp. 81-150).

- As a further reason, cultural habits of the Germans provide a solid framework for the application of CA. Time is of central importance to German culture. Also, knowledge is of high value. Many Germans seek to obtain as much relevant information as possible before they make decisions. Germans also believe in solid procedures and have a strong feeling for structure and conformity. Obeying rules is of importance and business is considered a serious matter (Lewis, 2010, pp. 228-231).

- CA aims at providing prompt and relevant information. If CA is thoroughly applied, it will deliver precisely the pieces of information that the auditor requires for further procedures. Other unnecessary pieces are omitted. Solid procedures which are consequently followed play a decisive role and ensure the proper functioning of CA models (Chan, Vasarhelyi, 2011, pp. 152-160). Thus, the aforementioned German values support the underlying preconditions of CA.

- Germany has not been an explicit subject to any CA adoption research before. Simply because of this non-consideration, coverage of German internal audit departments as a research object bears the potential for totally new scientific discoveries.

1.4 Structure of thesis

This thesis is divided into seven chapters. After this introduction, the chosen research approach is described in chapter 2. This includes a discussion about the overall research procedure as well as the single phases of the approach.

In chapter 3, internal auditing, its nature, and its objectives will be explained. Subjects covered by internal audit departments will be presented and the internal auditor's role in each of these subjects will be clarified. Moreover, it will be demonstrated how the internal audit function can be aligned in the organisational structure of a company. Internal audit approaches as well as current developments in internal auditing and their effect on internal audit departments will also be discussed.

The concept of CA will be introduced in chapter 4. It will define CA and explain its history, its subareas, and the subjects it can be applied to. Also, differences to related disciplines will be pointed out. Methodological and technological components of CA will be presented as well. Furthermore, benefits of CA will be worked up and barriers for its introduction will be examined. The chapter will also provide an overview of the current status of CA adoption in literature from both the academic world and the practical field. The literature review includes articles from academic journals, books, conference proceedings, as well as Internet sources and covers findings from around the world.

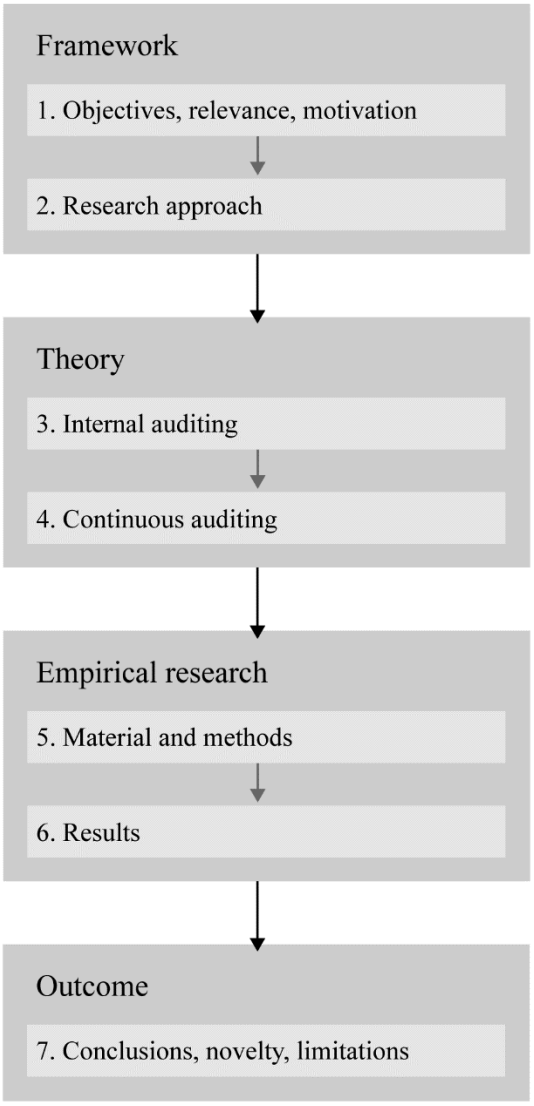
Chapter 5 of this thesis covers an extensive description of the material and methods of the empirical research of this thesis. The chosen research activities are based on the research approach from chapter 2. They detail all research activities undertaken to address the two research objectives. For both objectives, research dilemmas are described, research questions and hypotheses are developed, and specific research designs are set up.

Chapter 6 includes a description of the results of this research. Specifically, statistical tests and corresponding calculations are explained and findings from these tests are presented in detail.

Based on comparisons with previous academic findings, conclusions from the research will be drawn in chapter 7. Also, the novelty of this research as well as limitations to this research are presented. The chapter also includes recommendations for further academic research.

The structure of this thesis is presented in the following diagram:

Figure 1: Structure of thesis



Source: Own resource

2 RESEARCH APPROACH

This chapter covers the research approach chosen to address research objectives A and B. It describes the single stages in sequential order and links these together. The chapter starts with a description of the research dilemmas, the research questions, and the hypotheses. Afterwards, the research design as well as the research conduction and the data analysis are explained. The chapter ends with a critical appraisal to this research approach.

2.1 Research dilemmas, research questions, and hypotheses

Scientific research can be defined as a systematic activity undertaken to increase the stock of knowledge, including knowledge of man, culture, and society (OECD, 2018). To achieve this, data is collected, interpreted, evaluated, and published (Çaparlar, Dönmez, 2016). This process occurs in a sequential approach with clearly defined steps (Blumberg, Cooper, Schindler, 2005, pp. 52-90; Lang, 2014, p. 3). The approach and the single steps taken for the research covered in this thesis are outlined in appendix 1.

To address both research objectives introduced in chapter 1, the chosen approach covers two main investigations (main research A and main research B) as well as one preliminary research.

Main research A addresses the first research objective which reads as follows:

> **RO$_A$**: To identify and analyse the current status of CA adoption among German internal audit departments

Thus, main research A covers all steps to analyse the current state of CA adoption among internal audit departments in German companies. It can be considered as applied research of descriptive nature. By investigating the current status of CA adoption among German internal audit departments, it tries to discover answers to a given situation.

Main research B addresses the second research objective which reads as follows:

> **RO$_B$**: To discover the reasons behind the current CA adoption level

Main research B therefore tries to find out reasons for the identified state of adoption. In contrast to main research A, main research B is of explanatory nature as it goes beyond descriptive research. It tries to deliver explanations to the given state of CA adoption and tries to provide an understanding of why the adoption levels identified in main research A are the way they are.[2]

During both main research A and main research B it is assumed that a research environment exists externally and therefore surrounds the researcher. The researcher himself is not part of this environment which is looked at in a purely objective manner. He is independent and assumes the role of an objective analyst.[3]

Both main research A and main research B follow the same pattern. The starting point of both areas of research is the description of research dilemmas. The nature of these dilemmas can be positive (representing an opportunity) or negative (representing a problem). The dilemma is vague, as it represents the initial stage of the research (Blumberg, Cooper, Schindler, 2005, pp. 52-54). Main research A covers a total of three dilemmas, while main research B covers one dilemma. All four dilemmas cover factual problems.

To make the dilemmas more specific and more precise, they are converted into research questions. Doing so, it is important to understand the true nature of the dilemmas and to clearly differentiate between problems/opportunities and symptoms. The research questions are fact-oriented and aim at gathering information. Also, they aim to be answerable and do not imply any bias which affects the objectivity of the further research (SOAS University of London, 2017).

Once research questions have been brought forward, research objectives are made even more specific by translating research questions into hypotheses. A hypothesis is defined as declarative statement of tentative or conjectural nature. They represent the very statements to be confirmed or falsified. Therefore, they guide the direction of the research approach and help to identify those elements that are of relevance for the further research. Each hypothesis represents one alternative action to solve the research dilemma. However, only reasonable alternatives are

[2] Definition of types of research for main research A and main research B are based on SOAS University of London, 2017
[3] Definition of 'research environment' based on Blumberg, Cooper, Schindler, 2005, pp. 18-25

regarded. The hypotheses also provide guidance regarding the appropriateness of research designs and assist in deciding on the most suitable ones. Furthermore, they represent the foundation for any conclusions which can be derived from the findings (Blumberg, Cooper, Schindler, 2005, p. 36-39).

Given the considerable extent of uncertainty arising from findings in the researched CA literature, the formulation of hypotheses for main research A is not possible in a straightforward way. To overcome this obstacle, a preliminary research is carried out. This preliminary research covers a range of general aspects of CA and aims at obtaining an understanding about how CA is applied in the practical field. Also, it validates assumptions made on the basis of the literature review regarding their appropriateness and completeness. The preliminary research therefore delivers valuable details for main research A. Hypotheses for main research B will be derived directly from the research dilemmas/research questions, i.e. without a preliminary research.

2.2 Research design

Once all hypotheses have been brought forward, the design of the research will be set. The research design is the blueprint for conducting the research and answering the research questions. Both main research A and main research B are sample-based and involve primary data which is collected via surveys. As part of the research design, data collection and sampling represent decisive elements (Blumberg, Cooper, Schindler, 2005, pp. 64-65, 132-137). Therefore, arrangements from both will be discussed in more detail below.

Data collection design

The choice of an appropriate data collection design is decisive for the strength of the research results. Only if the design matches the objectives of the research and clearly addresses the hypotheses, will the results be meaningful (Blumberg, Cooper, Schindler, 2005, pp. 36-39).

In research theory, a large number of data collection methods are discussed. An overview of these methods is shown in the table below:

Table 1: Data collection methods

Data collection method	Description
Survey	A research method to gather data via quantitative and qualitative questionnaires or interviews.
Observation	The systematic recording, categorisation, and analysis of behavioural activities in specific situations according to previously defined criteria.
Experiment	A research method in which dependent variables are systematically varied by the researcher to measure an effect on the independent variable.
Content analysis/review	An analytical method in which the objects examined are not persons, groups of persons, or events, but media in the broadest sense.
Group discussion	A guided discussion based on a guideline, between a group of selected people on a research topic of interest.
Secondary analysis	Re-evaluation of existing data which does not involve the collection and analysis of new data.
Panel	A repeated collection of data where measurements (e.g. observation, questioning) are carried out over a longer period of time on the same subjects using the same method.
Sociometry	A research method for recording social relationships in groups.
Mystery research	A research method as part of which the researcher secretly slips into the role of the target group (e.g. customer, buyer) and evaluates the research object based on a predefined set of criteria (e.g. customer orientation, competence, friendliness, intensity of consultation).
Diary	A research method in which a test person records his own behaviour in the form of writing on a regular frequency.
Non-reactive methods	Experiments, content analyses, or observations in which a stimulus is set, followed by the researcher observing respondents' reactions upon their contact with the stimulus.

Source: Own resource, based on Lang, 2014, pp. 6-11

Both main research A and main research B are being performed by means of quantitative surveys which are distributed among internal auditors. This form of data collection method bears the advantage that it is comparably easy to administer, includes a large number of questions, and allows to cover large samples (Lang, 2014, p. 14). The surveys take the form of structured questionnaires with mostly closed-ended questions. Consequently, each respondent is confronted with the same survey setup. This standardisation delivers a consistent picture and allows for broad coverage of a specific topic. They also deliver a strong representation of results and thereby provide a sound basis for comparisons. The surveys are therefore suitable for gathering information (in contrast to opinions) in a most neutral manner. Due to the high numerical focus of the surveys, their results can be analysed with statistical methods.

There is a risk that quantitative surveys do not deliver differentiated results as they do not account for individual response options (Oak Rich Institute for Science and Education, 2017). To overcome this shortage, the questionnaire used in main research B allows respondents to phrase individual responses with an additional open-ended question. Also, there is a risk that questions are misunderstood or that the survey structure (e.g. order of questions, type of answer alternatives) systematically influences the answering behaviour, if the survey is not conducted personally (Oak Rich Institute for Science and Education, 2017). Therefore, the questionnaire of main research A is accompanied by a guideline to provide further details to respondents. For main research B, further details and instructions are orally provided to the respondents.

The data collection method chosen for the preliminary research differs from the approach chosen for the main research A and main research B. The focus of the preliminary research is about understanding rather than describing how practitioners deal with CA. Nor does it aim to establish any causal connections. Therefore, a qualitative approach is chosen. This not only does do justice to the high complexity of CA, but also allows a deeper analysis than a quantitative analysis would do. It enables the researcher to manage the train of discussion in a more flexible way while respondents can answer more generously. At the same time, results from this in-depth research complement and validate findings from the literature review.

Sampling design

When doing research, the researcher needs to determine whether he wishes to make use of a sample to conduct his research or whether he wants to conduct a census study. A census is appropriate when the population is small, and elements of the population are different from each other. Both preconditions are not true for either main research A or main research B. Instead, the use of samples (as a subset of the population) is more advantageous due to the following reasons: Firstly, making use of samples comes at a lower cost. Secondly, data collection is faster than under a census. Thirdly, research quality is increased as there is a higher chance of outliers not being considered in the samples (Blumberg, Cooper, Schindler, 2005, p. 202).

Sampling can occur by using one of several techniques. The most prominent ones are shown in the following table:

Table 2: Overview of sampling techniques

Probabilistic basis	Non-probabilistic basis
Simple random	Convenience
Complex random: • Systematic • Stratified • Cluster • Double	Purposive: • Judgement • Quota
	Snowball

Source: Own resource, based on Blumberg, Cooper, Schindler, 2005, pp. 206-209

The preliminary research features a convenience sampling approach during which amount and sort of elements (i.e. internal auditors) are assembled at the researcher's discretion to become the sample. This approach is chosen as it is considered the easiest and most cost-effective sampling technique. On the downside, precision of this techniques is low. However, this disadvantage is neglected, as the preliminary research "only" is the starting point for further research activities (Blumberg, Cooper, Schindler, 2005, pp. 206-209).

Main research A and main research B feature judgemental sampling techniques. In both cases, the sample is composed of elements selected by chance based on predefined criteria (i.e. internal auditors of German companies).

Alongside the sample technique, the sample size is of central importance. Finding the right sample size (to ensure representativeness) when doing research is not an easy task. Blumberg, Cooper, and Schindler (2005, pp. 212-213) mention specific rules which need to be true in order to achieve a sound representativeness. These rules are listed below:

- A minimum sample size needs to be achieved, whereby absolute size is not the ultimate goal. Instead, focus lies on appropriate fit.
- The more homogeneous the population, the easier it is to achieve representativeness and the fewer elements are needed.

- The more complex and detailed the evaluation of data is planned to be, the more elements are needed.
- The more reliable the conclusions need to be and the lower the error tolerance is, the more elements are needed.

Given these general rules, a total of eight elements are chosen to be sufficient for the preliminary research. For main research A and main research B, the exact sample size will depend on the level of responsiveness of addressees.

2.3 Research conduction and data analysis

The research will be conducted as described in the research objectives, the research questions, and the research design. The preliminary research will be conducted in form of qualitative interviews during which questions are posed face-to-face to the interviewee. Doing so, the interview will be led into the correct direction and misinterpretations will be prevented. If necessary, additional information can be provided to the interviewee throughout the interview. As the conduction of the preliminary research involves direct interaction with respondents, care will need to be taken. According to Lang (2014, p. 21), the following points require special attention:

1) Upfront familiarisation with all interview questions.
2) Conduction of trial interviews to account for any shortcomings.
3) Maintenance of a friendly and patient attitude towards any respondents, even in difficult situations.
4) Creation of a positive atmosphere which supports the respondents in acting as natural as possible.
5) Consistency and precision when providing explanations and posing questions.
6) Oral explanations provided to the respondents will not contain any interpretations.
7) Notes taken during the interview are recorded in a clear and structured manner to prevent misinterpretations at a later point in time. Original statements will be noted down, paraphrasing will be prevented.

Main research A will include an analysis of the degree of CA adoption at an overall level and at CA subject-level. The research is being performed by means of a questionnaire which is distributed digitally (i.e. via emails) and manually (i.e. during personal encounters) with internal auditors. This survey will include dichotomous and multiple-choice questions. The former

sort of questions features two, mostly opposing response options (e.g. ‘yes’ and ‘no’) and requires from the respondent a choice of one option. The latter sort of questions provides more than two response options and allows the respondent to pick one answer option for each question (Lang, 2014, p. 15).

Main research B will be conducted during an internal auditing conference. During this conference, a questionnaire is digitally provided to all participants. This questionnaire covers both rating questions and free-response questions. Rating questions ask the respondent to assign a specific rate (e.g. a number) to a given statement. The respondent thereby expresses his level of agreement to each single statement and thus provides the basis for an absolute ranking of all provided statements. For this response type to work properly, the rating logic needs to be explained to the respondent beforehand. Free-response questions (also known as open-ended questions) do not provide any options for answers and require from the respondent active thinking about potential answers (Lang, 2014, p. 15).

After conduction of the research is finalised, data is cleaned, transformed, and modelled to discover useful information for decision making. This task will be performed by performing statistical calculations. These will cover both 1-dimensional and 2-dimensional descriptive statistics which aim at summarising data and presenting it in numerical or graphical form. 1-dimensional descriptive statistics analyse only one variable at a time and will include location parameters (e.g. arithmetic mean, maximum, minimum), dispersion parameters (e.g. standard deviation, spread), as well as parameters of skewness and kurtosis (Zwerenz, 2015; Stiefl, 2018). 2-dimensional descriptive statistics evaluate the association and dependencies of two variables and comprise advanced statistical calculations (e.g. correlations, analyses of variance) (Brosius, 2011).

Apart from the aforementioned parameters, data will be summarised in graphical ways. Data will be presented in form of histograms and box plots. Histograms are set up in a tabular form, denoting the values of a specific variable on the horizontal axis and the frequencies of occurrence of these values on the vertical axis. The frequencies of each of the given values is marked in the table and afterwards connected with the x-axis by drawing bars. For an easier identification of the frequencies of single values it is convenient to draw frequency distribution charts before drawing histograms. These give a detailed overview about how frequently certain values

occur for a given variable. Box plots will be used to visualise location and dispersion parameters. They consist of a rectangle, two lines (whiskers) which extend the box, and, if applicable, circles or stars extending the whiskers. The box also holds a separating line (Blumberg, Cooper, Schindler, 2005, p. 494; Zwerenz, 2015; Stiefl, 2018).

To successfully manage the large amounts of data collected during the research, a suitable computer program as a tool for collecting, structuring, analysing, and reporting data is needed. Especially when data sets largely or fully consist of numbers and figures, statistical software is indispensable for performing mathematical calculations, identifying and understanding reoccurring patterns, and depicting various functions (SOAS University of London, 2017). Thus, the statistical software SPSS by IBM is used.

To ensure data integrity, data is validated for incomplete or incorrect data records before any analyses are performed. Also, it will be tested that the selected analysis tools (i.e. SPSS and Microsoft Excel) function effectively. If necessary, single data records will be cleaned, summarised, sorted, or split up before the analysis. However, data will not be distorted or altered in any case (Wagner et al., 2019).

As an outcome of the data analyses, results will be brought forward in an unambiguous and well-reasoned manner. They will be presented in a clear, straightforward way. Conclusions will be derived transparently from results. Limitations and suggestions for further research will be disclosed as well. Graphs and diagrams are added to ease understanding of complex matters (Lang, 2014, p. 26; Blumberg, Cooper, Schindler, 2005, pp. 475-489).

The following two chapters 3 and 4 cover the topics of internal auditing and continuous auditing and thereby present the theoretical framework of this thesis. The empirical research activities building upon the explanations made this chapter are specified in chapter 5.

2.4 Critical appraisal to research approach

This chapter discussed the research approach chosen for this thesis. Yet, the discussion holds limitations:

- This chapter does not feature a complete discussion of all elements of scientific research. Only those relevant to this thesis are covered.

- The research process presented in this chapter was selected because it aligned most closely with the purposes of this research. Other research approaches and their specific designs mentioned in literature were not discussed in this chapter.
- The list of data collection designs in this chapters does not represent a complete list. Other designs are present in literature as well. The same is true for the sampling techniques mentioned.
- The steps for conducting research mentioned in this chapter are to be understood as minimum requirements. Other steps will be necessary, depending on the specific characteristics of the research.
- Data analyses can be done in an almost infinite number of ways. Those mentioned in this chapter represent popular examples, but do not feature a complete coverage of all possible data analysis methods.

3 INTERNAL AUDITING

This chapter introduces internal auditing. It provides a definition and distinguishes it from other corporate functions. Moreover, this chapter elaborates on potential audit subjects and provides details about the organisational alignment and the structure of the internal audit function. The audit approach is discussed and the latest developments in internal auditing are brought forward.

3.1 Definition

For a long time, people have engaged in trade and other forms of commercial activities (Watson, 2005). While doing so, evaluating and optimising one's own activities to maximise profits and/or minimise costs has been in the interest of merchants and entrepreneurs (Gervais, Lemarchand, Margairaz, Rudy-Gervais, 2016). Although these very early and vague forms of auditing did not resemble present-day audit activities, manual auditing techniques have been in place since Roman times and have undergone a constant development ever since then (Marks, 2010, pp. 5-8).

Many definitions exist around the world of what internal auditing actually is. Beeck (2018) differentiates between internal auditing as function and internal auditing as institution. Internal auditing as function is understood as the sum of audit activities performed by internal, independent persons. Internal auditing as institution is seen as the organisational position or sum of positions inside a company (e.g. a department) which is engaged with the execution of audit activities.

The most popular definition was established by the Institute of Internal Audit (IAA) which acts as the globally leading regulation body for internal auditing (by the number of members). According to the IAA (2019), internal auditing is defined as "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."

This definition implies several aspects. It clearly identifies those elements subject to internal auditing, namely governance, risks, and controls. Also, it delivers further details about the nature of the internal audit function. Other than indicated by its name, the internal audit function not only takes over auditing tasks, but can also engage in consulting jobs and issue expert opinions. This is acceptable so long as personal and organisational independence and the objectivity of the internal audit function are maintained and the auditors' activities add considerable value to the business. Moreover, the definition implies that internal audit activities are carried out in a systematic and structured approach that follows set objectives (Institute of Internal Auditors, 2012, p. 3).

Internal auditing is not to be confused with management accounting/controlling or other audit-like functions such as the compliance function or the risk management function. While internal audit (in its traditional form) is focused on analysing past events, management accounting/controlling aims at assisting management in decision making by providing both historic and future information (Weber, 2019).

3.2 Audit subjects

The internal audit function has the task of supporting management in fulfilling its monitoring responsibilities. In its early days, internal auditing focused primarily on providing assurance on a company's financial information. Nowadays, internal audit activities not only cover the verification of compliance with laws, regulations, plans, or guidelines, but also aim to provide information to decision makers. Therefore, internal auditing can cover any area of a company (e.g. purchasing, sales, production, personnel, or marketing), except for the company's senior management which mandates the internal audit function. Thus, the internal audit function carries out audit or consulting engagements focusing on a wide range of topics (Beeck, 2018).

Yet, the core activity of the internal audit function is the evaluation and optimisation of corporate structures and processes. Content-wise, the internal audit function centres around, but is not limited to the fields of corporate governance, risk management, and internal control. These three subjects are not mutually exclusive and thus overlap. Still, they can be considered as separate disciplines (Institute of Internal Auditors, 2012, p. 11). These disciplines are discussed below:

Corporate governance

Corporate governance is the legal and factual framework for leading and steering companies (Werder, 2018). It determines how single corporate bodies (i.e. management and supervisory board) fulfil their responsibilities (Root, 1998). Therefore, it sets the ethical background of business dealings (Berwanger, 2018).

Corporate governance comprises significant laws imposed by legislature as well as nationally and internationally recognised regulations set out by companies' owners and aims at providing a solid and lawful basis for directing and controlling corporate affairs. To work effectively, it must balance the necessity of holding the supervisory board and management to account towards shareholders and the necessity of providing a sufficient level of flexibility to allow good faith business decisions without fearing litigation (Root, 1998).

By complying with corporate governance requirements, companies strengthen trust towards shareholders, customers, employees, and the public. Also, corporate governance aims at creating transparency and comprehensiveness (Regierungskommission Deutscher Corporate Governance Kodex, 2015). Moreover, corporate governance directs corporate activities towards responsible, sustainable, and long term-oriented value creation (Österreichischer Arbeitskreis für Corporate Governance, 2015). It can thus be assumed that companies with good corporate governance are more successful than those with inadequate management modalities (Werder, 2018).

As one of its major tasks, the internal audit function is mandated to verify the effectiveness of corporate governance (i.e. its design and its degree of implementation) and assist management in optimising governance structures and processes. Performed activities largely depend on the degree to which corporate governance is in place. According to the Institute of Internal Auditors (2012, p. 11), these activities include:

- Communicating corporate values
- Promoting appropriate ethics
- Communicating risk and control information

According to Peemöller and Kregel (2014), the internal audit function also covers activities such as:

- Controlling the achievement of corporate objectives
- Assisting management in aligning responsibility

Risk management

A company and consequently its objectives are influenced by internal and external forces. All of these forces represent either a risk which must be responded to or an opportunity ready to be exploited. Thus, risk is the possibility of an event occurring which will impact on previously set objectives. Risk is the downside or negative impact, whereas an upside or positive impact is considered an opportunity (Vaughan, 1997, pp. 53-72).

Risk management is defined as a process to identify, assess, manage, and control potential events or situations to provide reasonable assurance regarding the achievement of the organisation's objectives. Consequently, the strategic objectives announced by the management or the supervisory board of a company represent the starting point for all further risk management activities. As the outcome of future corporate activities is uncertain, the risk of not achieving set objectives is inherently given (Institute of Internal Auditors, 2009).

Risk management follows a cyclic approach with several steps (Illetschko, Käfer, Spatzierer, 2014, pp. 55-136; Vaughan, 1997, pp. 34-38). The exact number and extent of single steps depend on many factors and can therefore vary from company to company. However, at a generic level, the risk management cycle can be represented by the four steps depicted in the following diagram:

Figure 2: Risk management cycle

Source: Own resource

Risk identification

The first step to manage risks in a structured and systematic approach is the preparation of a risk register with details about all significant risks. This register is used as a guiding document throughout the complete risk management process. By creating such a structured document, companies are forced to analyse risks in regard to their origins, characteristics, and other features. Therefore, the company's strategy, objectives, culture, and environment play a decisive role, as these set the tone among involved parties for what is considered relevant or significant (Illetschko, Käfer, Spatzierer, 2014, pp. 55-136).

Risks can originate from multiple sources. They arise internally from activities within a company, but also arise externally and impact a company from the outside. Periodic reviews of the internal and external environment the company is active in represent a sound basis for risk identification. Checklists and benchmarking are useful tools to enhance the degree of formalism and to ensure that all significant steps during risk identification will be covered. Scenario or process analyses represent another methodology to help a company identify its risks in a structured approach (Vaughan, 1997, pp. 106-127). Depending on the number of risks documented in the risk register, risks can be classified and divided among various groups (e.g. by function,

department, hierarchy level, process, area of impact, or activity). A universal way of classification does not exist. Instead, risk groups need to be tailored to the best purpose of the company (Vaughan, 1997, pp. 34-38).

Risk analysis and evaluation

The second step of the risk management process is the analysis and evaluation of previously identified risks. This step covers a risk analysis to explore identified risks in even more detail. Doing so, appropriate risk criteria need to be defined for a clear and continuous understanding and evaluation of risks. The most common criteria are likelihood and impact. Likelihood indicates the probability or the frequency of a given risk. The actual affect to a company caused by a specific risk is measured by the impact. Alternatively, risk can also be measured by vulnerability (indicating how sensitive a company is to a specific risk), volatility (expressing the variance in probability of a certain risk occurring), interdependency (indicating how far two or more risks materialise at the same time), or correlation (expressing to what extent one risk changes, if another one occurs) (Illetschko, Käfer, Spatzierer, 2014, pp. 55-136).

After having chosen appropriate criteria, the extent of risks needs to be determined on an individual basis in accordance with the chosen criteria. There are multiple ways to express the extent of the chosen criteria. In many companies it is common to rate impact in qualitative terms (e.g. problematic, disruptive, or catastrophic) or by numbers (e.g. 1 = low impact; 5 = high impact). The extent of the scale (i.e. the number of stages) is thereby at the discretion of the company. Similarly, likelihood is scaled in qualitative terms (e.g. unlikely, possible, or likely) or in quantitative terms (e.g. as percentage of probability). Constantly rating risk criteria in quantitative terms enables companies to determine a specific risk severity across all risk criteria and expresses each risk with a specific figure. However, a purely numerical approach bears the risk of oversimplifying the reality or leading to underestimations of risks (Beaver, 1995, pp. 197-217).

In theory, other deterministic methods (e.g. best/worse/probable scenarios analysis) and stochastic methods (e.g. Monte Carlo simulation) for risk measurement are discussed. In practice, however, these approaches are rare and found mostly at financial institutions. (Vanini, 2012, pp. 157-208).

Once measured, risks are ranked as far as possible to prioritise subsequent risk response activities (e.g. by applying a 2-dimensional risk map, with impact on the one axis and likelihood on the other). Risks that are near the zero point are of less priority than those that are far from that point with either a high likelihood or impact, or even both (Nicholsen, Baker, 2013, pp. 86-100).

Risk response

After risks have been identified, measured, and prioritised, appropriate risk responses are determined for each risk. The response represents any action taken to modify identified risks. The type of risk response is linked to the company's risk culture and accounts for limitations (indicated by the risk capacity). According to Vanini (2012, pp. 223-248), there are four types of risk response a company can choose from to address risks:

- Risk avoidance: Companies opt to terminate the activity or withdraw from the situation which causes the risk. This option is advisable if costs of treatment of a risk are high and risk consequences would be very harmful for the company.
- Risk mitigation: Implementing internal controls mitigates risks by reducing either their likelihood, their impact, or both.
- Risk transfer: Risks (or parts of risks) are transferred to a third party (e.g. in form of an insurance). In rare cases, risks are shared (although not completely transferred) in form of a joint venture with one or several other companies.
- Risk acceptance: If risk is completely understood and considered to be bearable, the company decides to accept it as it is. By doing so, companies assume that tolerated risks have a small impact or likelihood and treatment costs would exceed resulting benefits.

Risk reporting and monitoring

Proper reporting provides to management and the board of directors information about the effectiveness of risk management. Ideally, reporting is integrated into daily routine activities and takes into account the need of internal and external stakeholders. The extent of reporting depends on factors such as the size of the company, the extent of risk management activities, and the extent of stakeholders' needs (Vanini, 2012, pp. 223-248; Nicholsen, Baker, 2013, pp. 115-117). As the risk management process works in an environment with altering conditions, situations, and objectives, it needs to be reviewed periodically in order to achieve continuous improvement (Illetschko, Käfer, Spatzierer, 2014, pp. 152-160; Kendall, 1998, pp. 211-212). As

a result, changes in the company's internal and external environment are recognised, weaknesses in the risk management process are identified and repaired, and deviations from corporate objectives are corrected (Nicholsen, Baker, 2013, pp. 72-117).

In the context of risk management, one of the core roles of the internal audit function is to provide assurance. Thus, the internal audit function takes over a range of tasks in this field. It provides assurance on risk management processes performed by the risk management function, validates that risks are correctly evaluated and reacted to by management, evaluates the reporting of key risks to internal and external stakeholders, and reviews the overall management of key risks (Nicholsen, Baker, 2013, pp. 165-173).

Other activities potentially sacrifice the internal audit function's independence or objectivity. However, these activities can be carried out by the internal audit function regardless, so long as certain safeguards are in place to ensure independence and objectivity. Under these circumstances, the internal audit function can facilitate the identification and evaluation of risks, coach management in responding to risks, coordinate risk management activities, consolidate risk reporting, maintain and develop risk management frameworks, champion the establishment of risk management structures and processes, and develop a risk management strategy (Nicholsen, Baker, 2013, pp. 165-173).

However, the internal audit function must refrain from activities such as setting risk appetite, imposing risk management processes, managing assurance on risk or risk management process, implementing risk responses on management's behalf, and assuming ownership of and/or accountability for risk management. All of these activities violate the internal audit function's independence (Institute of Internal Auditors, 2009).

The exact role of the internal audit function as well as the composition of its activities are determined by senior management and influenced by the company's strategy, culture, objectives, and the competencies of the internal audit function (Institute of Internal Auditors, 2009).

Internal control

The Sponsoring Organizations of the Treadway Commission (COSO) is a private sector organisation established in the U.S.A. and globally accepted as the leading organisation for internal control. According to them (COSO, 2013, p. 3; COSO, 2004, pp. 109-112), internal control is

defined 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 in the following categories:

1. Effectiveness and efficiency of operations
2. Reliability of financial reporting
3. Compliance with applicable laws and regulations

To make this definition more specific, COSO established an internal control framework which consists of five components and articulates a total of 17 principles. This framework assists companies in achieving the aforementioned objectives. The principles do not stand by themselves, but function in an integrated manner (Weaver, 2013).

The components and their principles are listed in the following table:

Table 3: COSO internal control framework

Component	Principles
Control environment	• Demonstrate commitment to integrity and ethical values • Exercise oversight responsibility • Establish structure, authority and responsibility • Demonstrate commitment to competence • Enforce accountability
Risk assessment	• Specify suitable objectives • Identify and analyse risk • Assess fraud risk • Identify and analyse significant change
Control activities	• Select and develop control activities • Select and develop general controls over technology • Deploy control activities through policies and procedures
Information and communication	• Generate and use relevant information • Communicate information internally • Communicate information externally
Monitoring activities	• Conduct ongoing and/or separate evaluations • Evaluate and communicate deficiencies

Source: Own resource, based on Weaver, 2013

To operationalise these principles, a large number of possible controls can be used. According to COSO (2004, pp. 61-66), these control activities can be aligned to the following categories:

Segregation of duties is an organisational measurement to avoid, detect, and eliminate errors and fraud. An example for segregation of duties is the division of a task into planning, editing,

controlling, and correcting. These steps are fulfilled by different employees. It is common in practice that an employee is responsible for generating and updating data of a supplier, whereas another employee is responsible for initiating the payment of the supplier.

The **authorisation of transactions** implies that transactions are carried out only after their control and approval by an authorised employee. A typical example of this category are salary payments to employees. These payments are carried out only after the authorisation of the HR department which verifies the correctness of salary payments before they are made.

The **retention of records** ensures that important documents (e.g. invoices, bank statements) are stored, so the company is able to provide evidence for major transactions.

As part of the **supervision or monitoring of operations**, operational business activities are observed and verified on a continuous basis by supervisors/managers. This can be done by inquiries of supervised personnel, direct observation and reperformance of day-to-day activities, as well as by inspection of documents, ratios, and performance indicators.

Top-level reviews analyse results regarding the organisational aims or plans as well as regular operative evaluations.

IT application controls ensure the completeness and correctness of data processing inside and among IT systems. A sequence number control to verify the complete processing of data in an accounting system are an example of this kind of control.

IT general controls are focused on IT systems (e.g. software, databases) or its environment (e.g. networks). They do not have a direct influence on financial accounts or regulatory requirements, but influence them indirectly by ensuring effective procedures in underlying IT processes, e.g. change management or user management of an accountancy system. According to the IT Governance Institute (2005), IT general controls typically comprise logical access controls over infrastructure, applications, and data, system development life cycle controls, program change management controls, physical security controls, system and data backup and recovery controls, as well as computer operation controls.

Alongside the aforementioned categories and their activity-level controls, companies can make use of entity-level controls (e.g. ensuring a proper assignment of authority and responsibilities, setting the right tone from the top, fostering efficiency and effective communication). These controls aim to strengthen the overall control environment at a company-wide level. Responsibility for these kinds of controls rests with senior management (Baden Gage & Schroeder, 2015).

Controls address different aims. Preventative controls (e.g. access controls to corporate facilities) reduce the underlying risk from occurring. Their aim is to narrow down the probability that a risk event occurs. Detective controls (e.g. error reports or inventory checks) detect the occurrence of risks and therefore reduce the impact of risks. Directive controls (e.g. employee training and process manuals) attempt to specify behaviour and handling and therefore reduce likelihood as well as impact. When risk events have already taken place, corrective controls (try to) reduce the impact as they attempt to restore the normal situation (Old Dominion University, 2015).

According to Bungartz (2017), the management of internal control follows a cyclic approach and comprises the following steps:

- Identification and risk-based prioritisation of processes
- Documentation of processes, risks, and controls
- Evaluation of controls regarding their design and operating effectiveness
- Identification and implementation of activities to close control gaps

In the field of internal control, the internal audit function performs audit activities to ensure the effectiveness of controls. This can be done in the form of dedicated internal control audit engagements, in which an audit opinion about the internal control system as a whole is issued. Alternatively, control tests can be part of other audit engagements. In this case only a selection of internal controls is subject to the audit engagement (among other audit objects) and the audit opinion is based on a more generic topic (e.g. effectiveness of financial reporting, compliance of a subsidiary) (Forum Interne Revision, 2015).

When auditing an internal control system, the specifics of the audit engagement’s scope can vary. The internal audit function can analyse the design of controls only and report on how far

controls are suitable to fully address risks (design effectiveness). Also, the internal audit function can evaluate the operating effectiveness and verify how far controls function as intended. In their audit engagements, the internal audit function can also focus on specific parts of the internal control system only (e.g. the control environment or monitoring activities) (Institute of Internal Auditors, 2012, p. 12).

If a (formalised) internal control system is not in place, the internal audit function can recommend to management to implement (formalised) internal controls. Provided that independence is not violated, the internal audit function can take over the role of a consultant and advise management before, during, and after the introduction of an internal control system (Institute of Internal Auditors, 2012, p. 12).

3.3 Organisational alignment and structure of internal audit function

Many companies carry out internal audit activities, irrespective of their size, industry, or location. However, the form, extent, and level of formalisation varies widely. In small companies, audit activities are loose and informal and are carried out by the owner or management. Once a certain size is reached, companies establish a formalised internal audit function with dedicated personnel. This formalised function does not necessarily have to be a separate organisational unit (i.e. its own department). Instead, internal auditors can also be allocated to existing departments or teams (Peemöller, Kregel, 2014, pp. 111-117).

The specific organisational alignment is also dependent on the internal audit function's objectives. In practice, it is common to establish the internal audit function as a separate function outside the regular chain of authority, yet with direct reporting lines to senior management. A direct alignment underneath senior management ensures independence and guarantees the internal audit function unlimited access to information sources. Moreover, an organisational alignment with direct lines to senior management enables the internal audit function to execute audit activities throughout the whole organisation while it would be limited in its area of influence if it only reported to the head of a specific department (e.g. chief financial officer/finance department). Responsibility for supervision of senior management itself rests with the supervisory board and is therefore not within the scope of the internal audit function's activity (Peemöller, Kregel, 2014, pp. 118-129).

In many companies, the internal audit function represents the third line in the so-called 3-lines model (formerly known as 3-lines-of-defence model). The model describes a multiple-tier procedure for approaching risks in companies. The first line is represented by lower and middle management which, at an operating level, identifies, analyses, evaluates, and mitigates any arising challenges or risks. The second line consists of supporting functions, such as risk management, compliance, or quality management, which are not a direct component of a company's value chain, but add value by assisting and controlling the first line. The internal audit function, as the third line, represents an independent entity which assists management in its surveillance responsibilities. It performs audit (and in part advisory) services to the first- and second-line departments to verify the effectiveness of the chosen risk management activities and to report findings to senior management and regulating bodies external to the company. The proper function of the 3-lines model itself is usually verified by external auditors (Institute of Internal Auditors, 2013b).

The internal audit function is headed by a CAE who acts as the main contact person of the internal audit function. In a best case scenario, the CAE has a wide understanding of corporate structures and processes and is well connected to all core employees of the company. Also, he is an experienced auditor and has a sound understanding of risk management, governance, and controls issues. Functionally, he reports to senior management or at least to someone who has a sufficient level of authority to promote internal audit's independence. For accountability measures, the CAE is appointed by the supervisory board (or the audit committee as a subunit of the supervisory board) to foster independence (Christ, Ricci, 2015).

Depending on its size, the internal audit function consists of further employees who support the CAE in fulfilling his duties. In many companies, internal auditors are specialised in specific fields (IT, law, accounting, processes, etc.). Irrespective of their role, all members of the internal audit function need to be objective in their work, have an unbiased attitude, and avoid any conflict of interest. If independence or objectivity cannot be ensured, the CAE must take corrective action or disclose failure of independence or objectivity to the appropriate parties (i.e. supervisory board or management) (Pickett, 2011).

From an organisational perspective, the internal audit function can feature diverse structures. If structured in a centralised approach, the CAE and his central audit unit are intensively involved in the planning and execution of audit activities. Decentralised audit units, i.e. local audit teams

in other countries or regions subordinate to the CAE, either do not exist or strictly follow central specifications and have little room for personal decisions. In a decentralised approach, the opposite is true. A high level of responsibility for audit activities rests with local audit units. They enjoy a high level of freedom of decision making as specifications by the CAE and the central audit unit are provided only to a minor extent (Amling, Bantleon, 2007, pp. 199-201).

Internal audit functions can also be structured functionally. Under this approach, the internal audit function is split into specialty audit units with dedicated auditors allocated to them based on their experience. Consequently, each specialty audit unit only focuses on specific fields (e.g. production, sales, finance, etc.) (Lehmann, 2020).

The internal audit function, as a whole or in parts, can be outsourced to external providers. Outsourcing can be advantageous if companies' resources are scarce and specialised knowledge needs to be brought into the company. However, there is the risk that external auditors are not as familiar with the company as internal auditors would be, have a lower availability, or are not allowed to perform certain audit engagements by law. As a compromise, it can be helpful to apply co-sourcing by which the internal audit function consists of internal personnel for core activities and obtains external support from service providers for special audit activities (Amling, Bantleon, 2007, pp. 202-205).

3.4 Audit approach

Traditionally, internal auditing includes several, mutually connected elements. These elements are described below:

Audit charter

The central element of the internal audit function and the starting point of all its activities is the audit charter. In this charter the internal audit function's purpose, authority, and responsibility is documented. It also describes the function's mission and scope of work and explains how independence is ensured. Therefore, an essential aspect of the charter is to state how far the internal audit function should engage in consulting activities or support functional units in any other form. The charter is initially approved and regularly reviewed by the supervisory board (ACA Compliance Group, 2020).

Audit universe

With the charter setting the boundaries, the internal audit function subsequently sets up an audit universe. The audit universe is a collection of potential audit engagements. It is updated regularly by the CAE and his staff. Input for the audit universe comes from internal sources (e.g. senior management, supervisory board, risk management function) or external sources (tax authorities, external auditor). While the former also includes documentation prepared internally (e.g. discussion notes or minutes of management board meetings, controlling reports, risk reports, budget plans, strategic plans, sustainability reports), the latter contains information provided externally (e.g. external audit reports, filings by stock exchanges, suppliers' and competitors' annual reports, relevant market research) (Kagermann, 2006, pp. 103-106).

Audit plan

Based on the charter and the audit universe, the internal audit function develops an audit plan which covers all audit engagements planned for a specific time frame (e.g. a year) in a prioritised form. Therefore, the audit plan links specific audit engagements to the company's strategic objectives accounted for in the audit charter (Auditnet, 2021).

The selection of audit engagement from the audit universe is based on a risk-oriented evaluation. For this evaluation, appropriate criteria by which each audit engagement is analysed needs to be defined. The exact choice of criteria lies in the discretion of the CAE. According to Peemöller and Kregel (2014, pp. 215-217), these criteria include the following:

- Financial impact of audit subjects covered in the audit engagement
- Strategic relevance of audit subjects covered in the audit engagement
- Functional stability of audit subjects
- Vulnerability of audit subjects covered in the audit engagement to changes in the company's internal environment
- Degree of coverage of audit subjects in previous audit engagements
- Complexity of audit engagement
- Other drivers (e.g. explicit proposal by management)

The audit plan must be as precise as possible and account for the availability of necessary personnel and costs as well as for time limitations (Auditnet, 2021).

Setting up a sound audit plan is a challenging task. The audit plan serves the internal audit function as guideline throughout the chosen time frame. Also, it provides a benchmark which the internal audit function is evaluated against. As a result, the plan must not be too vague and superfluous on the one hand as to avoid overseeing essential risks. On the other hand, the plan must not be too extensive and leave room for unscheduled engagements called for spontaneously or other forms of disruption (e.g. holiday season, sick leaves) (Kagermann, 2006, pp. 213-216).

Policies and procedures

Alongside the audit plan, the internal audit function makes use of general audit policies and procedures which auditors apply to a range of audit engagements. These documents provide guidance to internal auditors and include general information as sampling procedures, documentation requirements, communication formats, follow-up procedures, approval activities, requirements for communication with auditees, etc. For quality assurance purposes, audit policies and procedures are reviewed by the CAE at regular intervals (Amling, Bantleon, 2007, pp. 254-258).

Audit engagements

Audit engagements can take various forms. Beeck (2018) differentiates between financial audit engagements and operational audit engagement. While the former aim at evaluating the effectiveness of structures and processes linked to financial reporting (e.g. accounting or IT processes), the latter focuses on analysing compliance with internal regulations and evaluates how far action taken by management is appropriate and purposeful.

Peemöller and Kregel (2014, pp. 20-32) go a bit further by mentioning four different kinds of audit engagements. Alongside effectiveness-focussed and appropriateness-focussed audit engagements (similar to Beeck's financial audit engagements and operating audit engagements respectively), they also consider security-focussed and efficiency-focussed audit engagements as two further audit engagement categories. Security audit engagements relate to the verification of how far measures are in place to safeguard physical assets. Efficiency audit engagements analyse current practices and aim to identify potential savings in structures and processes.

Irrespective of their form, audit engagements are carried out in a standardised, multi-phase procedure. This procedure includes, but is not limited to the following phases (Auditnet, 2015):

Planning

The first phase covers detailed planning of the audit engagement in terms of content, time, and personnel. Audit subjects covered in the audit engagement are vaguely analysed, relevant information is gathered, and specific audit procedures are decided upon. Special requirements, e.g. the need for analytical tools, are evaluated and, if necessary, special preparations are performed accordingly. Furthermore, objectives and milestones of the audit engagement are defined. This task not only includes a decision on the type and extent of audit activities, but also defines the limits of the audit engagement and determines which elements are not covered (Institute of Internal Auditors, 2012).

Risks associated with the execution of the audit engagement are identified and evaluated. If necessary, appropriate countermeasures are taken. An audit engagement organisation needs to be built which includes the appointment of an engagement leader and the allocation of appropriate personnel resources to single audit activities. Additionally, the internal audit function prepares engagement-specific work programs for internal purposes. These documents serve as guidelines and workings aids. They detail procedures for identifying, analysing, evaluating, and documenting information relevant for all kinds of audit engagements. A standardised work program can be used for similar or repeating audit engagements. If, however, single engagements turn out to be complex, individual work programs need to be established. Work programs are reviewed and approved by the CAE before audit engagements begin (Kagermann, 2006, pp. 204-237).

As part of the planning, the audit engagement is announced to the auditee with an appropriate lead time. This is done in form of an engagement letter which is provided to the auditee in writing. This engagement letter serves as a kind of contract between the internal audit function and the auditee and covers important information about the engagement (e.g. nature, scope and objectives of audit engagement, background and motivation, planned activities and timeline, auditors' and auditees' responsibilities, framework to be used as a benchmark, as well as form of reporting of results). Under special circumstances (e.g. in case of a fraud detection audit engagement), the audit function can refrain from announcing the audit engagement to the auditee (Pratum, 2021).

Conduction

In this phase, the audit engagement is carried out in accordance with the audit engagement plan. Deviations from the audit program throughout the conduction of the audit engagement need to well-reasoned and documented in the audit engagement documentation. Before any audit activities are conducted, a kick-off meeting is held with the responsible personnel of the audited entity. During this meeting, all major audit activities are explained and framework conditions are agreed upon. Also, the contact persons of the audited entity are agreed upon (Institute of Internal Auditors, 2012).

According to the IIA (2012), the specific audit activities vary widely and depend on a range of factors. The audit engagement can focus on effectiveness, efficiency, security, compliance, or any other objective. Audit methods can comprise the following:

- Control tests to verify the design and/or the operating effectiveness of processes or systems
- Analytical procedures (e.g. trend analyses, correlation analyses, or benchmarking/best practice comparisons)
- Substantive tests (e.g. reconciliations of specific accounts, tests of details)
- A combination of these methods

Internal auditors apply one or several audit procedures such as inspections, observations, inquiries, or re-performances/recalculations. The audit engagement can be carried out on site or from a remote site. Furthermore, the auditor can choose between ex-ante and ex-post audit engagements. Yet, audit teams and the competencies they bring together via their team members have an influence on the design of single audit activities. Sources for audit activities come from internal sources or external sources, from information provided orally or in writing (PCAOB, 2021).

During the audit engagement, checklists are used to ensure that all planned audit activities are completed. Based on collected information, the internal auditor determines a current state (as is) of the respective audit subjects and compares this current state with a target state (as should be), represented by his expectations. Deviations between current and target states will be considered as findings. These comparisons can turn out to be a challenging task as they include in-

depth evaluations or analyses and require extensive auditors' judgement (Amling, Bantleon, 2007, pp. 278-302).

By the end of the execution phase, audit results are presented to the auditee and agreement is established among all parties regarding findings. This can be done in a closing meeting (and, if feasible, in an additional pre-closing meeting). Results and findings are presented as explicitly as possible to enable any third party to come to the same opinion within a reasonable time frame (Kagermann, 2006, pp. 238-266).

Follow-up

All audit activities as well as audit results and findings need to be documented in a consistent and appropriate manner. For each finding, the internal auditor establishes recommendations and advises the auditee on how to mitigate identified deficiencies. All results, findings, and recommendations are assembled in an audit report which is handed over to the auditee after the conduction of the audit engagement (Amling, Bantleon, 2007, pp. 303-326).

Before the final issuance of the audit report, the auditor also seeks confirmation from the auditee about results and findings. In a best case scenario, the auditor obtains a written response from the auditee on each finding as well as remediation steps, assigned responsibilities and deadlines. The final report and the auditee's response are sent to senior management and the supervisory board as well as to the initiator of the audit engagement, if applicable (Auditnet, 2015).

The final report and all working papers are archived in a permanent file, along with any evidence collected from the auditee. A follow-up list is prepared from the findings which will serve the internal auditor as a starting point for any follow-up engagements at a future point in time and/or as input for other audit engagements. The engagement leader also assembles the audit team to identify lessons learnt from the audit engagement. These lessons are reported to the CAE, so he can draw corresponding conclusions for future audit engagements (e.g. change of audit team's size, audit time frame, or audit methods) (Kagermann, 2006, pp. 267-306).

3.5 Recent developments

Although the general focus of internal audit work and its underlying objectives have remained similar, internal auditing has advanced over time. Several developments have been recognised

over the past few years and have been subject to discussions both in theory and practice. All of these developments require auditors to adjust their audit work and make use of sophisticated methods to handle these challenges. These developments as well as their influence on internal auditing are presented below:

Shorter audit cycles

Increasingly, stakeholders of the internal audit function (e.g. senior management, supervisory board) require the internal audit function to accelerate its activities and provide results sooner (Coderre, 2007). Under rapidly changing business conditions, providing senior management with a "post-mortem" solution after a problem has occurred is no longer of any benefit (KPMG, 2008a).

Internal auditors therefore need to undergo a change in their mind-set from being control-focused to risk-centric and thereby lift internal auditing to a level which accounts for this acceleration (Marks, 2009, p. 51).

Increase in data volumes

Globalisation has made companies become more international in their activities. Markets have overcome local borders and have become global networks. This is not only true for goods and services, but also for capital and labour markets as well as for a range of other corporate areas. Thus, the external environment companies act in has become more complex and companies are increasingly challenged to handle growing amounts of data acting upon them. At the same time, companies themselves are producing more data than ever before. This growing amount of corporate data and its increasing heterogeneity has made internal auditing even more challenging (CaseWare, 2009).

For internal auditors, the amount of relevant information has been growing as well. This has led to higher complexities in their work. As a result, auditing methodologies need to be adjusted continuously to keep up with the rapid growth of business-relevant data (Vasarhelyi, 2002).

More flexible corporate structures

Companies need to adjust their internal organisational structures to account for changes in their external environment and to remain competitive. As the frequency and intensity of necessary

changes have increased over the last 20 years, companies have learnt to adjust and as a consequence have become more flexible in their organisational setup (Senior, Fleming, 2009, pp. 3-40).

For the internal audit function, constant changes in the organisation and the increased level of flexibility make it challenging to provide well-founded statements about the effectiveness of risk management and internal control activities. To overcome this challenge, the internal audit function needs to be increasingly involved in change projects and has to schedule audit activities parallel to, or shortly after change has come into effect (Institute of Internal Auditors, 2020b).

Tighter regulation

The beginning of this century was marked by a range of corporate scandals which were characterised by companies such as Enron, Parmalat, and WorldCom boosting their financial statements and engaging in illegal management practices (Soltani, 2007, pp. 532-576). Although not the only cause, these events shifted public attention to topics such as risk management, internal control, as well as governance and compliance, and accelerated the further development and introduction of laws and standards in these fields. Since its introduction in 2002, the Sarbanes-Oxley Act has required all companies being listed on the U.S.-American stock exchange to implement internal control systems and to regularly report about their design and operating effectiveness (United States Congress, 2002).

Furthermore, a range of widely accepted standards, guidelines, and frameworks have emerged over subsequent years (e.g. COSO for enterprise risk management, internal control, and fraud deterrence to enable good organisational governance (2015), COBIT for governance and management of enterprise IT (2015), ISO 31000 for risk management to provide sound principles for effective management and corporate governance (2015)). These developed to become global cornerstones for corporate governance and risk challenges for both stock-listed and non-stock-listed companies.

In Europe, the international financial reporting standards (IFRS) were endorsed by the European Commission in 2003 to provide a common accounting ruleset to its member states (European Commission, 2021). Also, the introduction of the 8th EU directive in 2006 fostered the creation of audit departments and put further stress on the establishment of internal control

committees in companies (European Council, 2006). In many countries, national legislature has reacted to the increased demand of governance by defining specific principles in the form of national corporate governance codes which have been constantly redefined over the years. These codes ask companies to comply with its principles and to report on compliance with the code on a regular basis (European Corporate Governance Institute, 2015). These laws and regulations changed the role of internal auditors and have imposed new requirements on the internal audit function.

The increase in regulation has intensified the need for supervision and reporting. Responsibility for supervision and reporting rests with management. However, management increasingly relies on the internal audit function to perform this task. Thus, the increased regulation has led to the formation of new audit fields and tasks for the internal audit function. To account for these new fields and tasks, the internal audit function requires an increased level of automation (Rosenberg, Reineke, Schöllmann, 2012, pp. 297-321). Even beyond the pure transfer of new tasks, regulating bodies have explicitly addressed the role of internal auditors in legislation and standards and have thereby strengthened their position in companies. Inevitably, this upgrade will change the role of the auditor in the near future (Hass, Abdolmohammadi, Burnaby, 2006, pp. 835-844).

More frequent occurrence of fraudulent activities

The values and norms of companies and their employees can change over time. Sometimes these changes are questionable. Notably, fraudulent activities among employees have increased over the last 20 years. This development arises from three major factors. Firstly, employees increasingly consider grey zone activities as acceptable. Secondly, employees are misled by uncertainties arising from the companies' shift from stakeholder value approach to shareholder value approach. Thirdly, growing expectations by shareholders imposes pressure on companies and their employees. To counteract these tendencies, the internal audit function will need to focus increasingly on fraud. This includes audit activities to identify, counteract, and sanction fraudulent behaviour (McNeal, 2021; Amling, Bantleon, 2007, pp. 327-353).

Shareholder value approach

The concept to base corporate activities on satisfying shareholders' needs has led many companies around the world to shift their strategic focus. As a result, increasing shareholder value

has become the centre of corporate activities, but at the expense of neglecting other stakeholders' needs at the same time. While this approach yields short-term gains (especially in form of an increased market value at the stock exchange), the company's value suffers in the long run. Consequently, new risks arise from following this new approach (Liu, 2017).

To account for these new risks, internal auditors need to shift their audit approach, away from financial statement-driven audit activities that are focused primarily on value preservation, towards more value chain-oriented audit activities that are focused on value. This shift can result in an extension of audit activities, include a rethinking in audit planning, and/or even change the general role of the auditor creation (KPMG, 2009).

Higher focus on knowledge

Success of companies increasingly depends on the ability and speed to make use of available knowledge so that they can stay ahead of competition. This applies to a range of corporate activities, e.g. during the process of inventing new products or developing and implementing new technologies. However, many companies do not know which knowledge is present inside their organisations and how they can access and make optimal use of this knowledge. In this field, two essential challenges arise for the internal audit function. Firstly, due to its growing importance, knowledge management itself will increasingly be within the scope of audit activities. Consequently, the internal audit activities will be requested to evaluate actions taken by the companies and to make recommendations about potential improvements. Secondly, the internal audit functions will increasingly require to gain and store knowledge about their own processes and activities and to make this information available to all auditors on a constant basis (ISACA, 2018).

Diversity management

Diversity management is a concept which is based on achieving positive corporate developments by making use of the personal variety of employees. By doing so, many companies aim at employing personnel with different cultural and ethnic backgrounds. Because of this diversity, work for internal auditors becomes more complex. Firstly, ensuring compliance with laws and regulations becomes more challenging as cultural diversity leads to an enlarged set of requirements relevant to the company. Secondly, auditors increasingly need to consider and tolerate other (i.e. unknown or uncommon) norms and values when it comes to the evaluation of audit subjects (Institute of Internal Auditors, 2020a).

Advancement of IT

The usage of IT in the corporate world has been constantly growing over the past few decades. This growing importance of IT has influenced the internal audit function in two ways.

Firstly, IT as an audit subject has gained in popularity among auditors. This development has increased the need for specialised knowledge and experience among auditors and even has created a new job profile, the IT auditor (Institute of Internal Auditors, 2005, pp. 3-4).

Secondly, the usage of IT as an audit support mechanism has become popular among the audit functions of many companies. The first steps towards IT usage in internal auditing were made back in the 1960s when companies started developing and implementing audit modules which were embedded in legacy systems. As IT was a relatively young topic back then, administration of embedded audit modules was both costly and challenging. Therefore, usage was not very widespread. In the 1980s, computer-assisted audit tools and techniques (CAATTs) gained in popularity and were used for data analyses and unscheduled investigations. To a large extent, however, the audit profession lacked technical skills, suitable software tools, and the organisational will to overcome the challenges associated with this new audit approach. In the 1990s IT-based solutions for data analytics were introduced and increasingly used by the internal audit function to verify data and controls. Despite the solutions' potential to analyse data and controls on a large scale, auditors refrained from testing whole populations and kept relying on samples (Institute of Internal Auditors, 2005, pp. 3-4).

Over the years, IT has made the internal audit process more economic (Vasarhelyi, 1983, pp. 30-44). The internal audit function has learned to make use of IT by using audit software and other IT solutions for a variety of auditing activities, such as planning, execution, documentation, reporting, and follow-up. Computer-aided auditing systems, such as the generalised audit software, are widely used (Li, Huang, Lin, 2007, pp. 2-13). Also, auditors perceive the potential benefits associated with CAATTs more strongly now than in former times (Braun, Davis, 2003, pp. 725–731). In this context, they understand that the appropriate use of IT solutions helps them to increase the efficiency and effectiveness of their audit work (Weidenmier, Ramamoorti, 2006, pp. 205-291).

Still, the end of this IT penetration into internal audit practice is not reached yet. Instead, an even larger extent of IT usage is expected by both academics and practitioners. According to

the auditing and consulting company KMPG, IT-based auditing is expected to play a much larger role in the near future than today (KPMG, 2009). Simultaneously, the usage of IT will offer challenges and opportunities to internal auditors and will influence their attitude and actions (Bumgarner, Vasarhelyi, 2015, pp. 3-52).

To overcome future challenges, internal auditors' mere usage of IT will not suffice (Chan, Vasarhelyi, 2011, pp. 152-160). Instead, new audit methodologies will need to be developed. These will have an essential influence on the internal audit practice and will lift it to a more sophisticated level (Wang, Yang, 2009).

3.6 Critical appraisal to internal auditing

Despite all efforts, the discussion around internal auditing holds limitations:

- Corporate governance, internal control, and risk management represent core functions of the internal audit function and hold the highest relevance to this research. Yet, there are other important elements of internal auditing not covered in this chapter. Corporate governance, internal control, and risk management are presented in condensed form as a detailed discussion provides only limited benefit to this research. Thus, the discussion holds gaps and mostly refers to examples.
- Both structure and organisational alignment of the internal audit function can take various forms. Only the most popular ones are discussed in this chapter due to relevance reasons.
- Subchapter 3.4 (i.e. 'Audit approach') lists a range of elements which are typically used by internal audit departments. This does not imply that these elements are always used by all internal audit departments. Furthermore, internal audit departments can make use of other procedures, working aids, working programs, or tools which assist them in performing their work. Also, wording of these elements differs from one internal audit department to another.
- The presented audit procedure is one example of how audit engagement could be conducted. Certainly, there are other approaches mentioned in literature and applied in practice. The discussion in this chapter does not claim to be the leading or most popular procedural approach.

- The mentioned developments in the internal auditing field are not an exhaustive list, but include the most relevant ones for this research. Other trends, which also have an impact on internal auditing, can yet be found in literature and/or in the practical field.

4 CONTINUOUS AUDITING

This chapter features a review of the literature on CA covering articles from the last 30 years. In doing so, it addresses all significant elements of the topic. At first, CA is introduced and defined. Afterwards, synonyms and related terms are discussed. The differentiation to similar disciplines is elaborated on as well. Audit subjects covered by CA as well as methodological and technical aspects are explained. Benefits and shortages of using CA are provided and a maturity models is described. Finally, current findings about the state of CA adoption in practices are discussed.

4.1 Definition

As pointed out in the previous chapter, the internal audit function is confronted with a range of striking challenges. One audit methodology which tries to tackle these challenges and increasingly enters businesses' practice is the concept of CA. To obtain a better understanding about CA, a thorough literature review was carried out. This review is based on academic literature on CA found in database EconLit and via GoogleScholar. Used search terms were 'continuous auditing', 'continuous monitoring', 'continuous assurance', and 'continuous controls monitoring'. Literature included articles from academic journals, books, conference proceedings, as well as internet sources and covered findings from around the world.

For more than two decades, CA has been considered as one of eleven future key technologies for financial statement audits (Helms, Mancino, 1998, pp. 45-48) and is seen as the natural evolution of the integration of technology into the auditing domain (Woodroof, Searcy, 2001, pp. 169-191). Chen (2003, pp. 77-86) goes even further by saying that it is a must-have in today's digitalised environment. Lianghua, Yue, and Xiaoyan (2007) come to the conclusion that the latest developments in IT and accounting require CA. Yet, Aquino (2008) sees CA as fully realising its potential in the near future and proclaims that it will soon grow around the world. Other authors see CA as an inevitable development or audit trend (Hao, Zhang, 2010, pp. 442-446), consider it as an innovative approach to auditing in the environment of enterprise resource planning (ERP) (Shin, Lee, Park, 2013, pp. 592-627), or understand it as an alternative to more traditional auditing practices (Kokemuller, 2015).

The question which arises from these statements is what actually is behind CA.

The concept of CA was first introduced by Groomer and Murthy (1989, pp. 53-69) as well as by Vasarhelyi and Halper (1991, pp. 110-125) about 30 years ago. However, although CA has been discussed in theory over all these years and also companies have started to implement CA solutions in practice, the true definition of CA has been subject to active discussion among academics and practitioners (Mainardi, 2011). Given that many definitions of CA exist, the topic is difficult to narrow down and the debate about the exact nature of CA is ongoing (Consider, 2013). A few authors (e.g. McCann, 2009) have even written elaborate articles solely on the definition of CA and what specifically it is about.

On a simple, buzz word-like level, Moeller (2004) considers CA as a "change-the-rules auditing concept" which largely deviates from established auditing procedures. Singleton and Singleton (2005, pp. 17-27) understand CA as "low-cost instant auditing" which becomes possible with the establishment of continuous reporting structures. Yet, Ye, Wu, and Chen (2010, pp. 158-162) set up a more specific definition by stating that CA is an important form of CAATTs.

However, many other authors have put considerable thought into this issue and have come up with more sophisticated definitions. According to the CICA and the AICPA (1999), the concept of CA covers 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 time after, the occurrence of events underlying the subject matter. For Kogan, Sudit, and Vasarhelyi (1999, pp. 87-103), CA represents a type of auditing that produces audit results simultaneously with, or a short period of time after, the occurrence of relevant events. Yet, Woodroof and Searcy (2001, pp. 169-191) see CA as an assurance service where the time between the occurrence of events underlying a particular subject matter and the issuance of an auditor's opinion on the fairness of a client's representation of the subject matter is eliminated. Rezae, Sharbatoghlie, Elam, and McMickle (2002, pp. 150-158) define CA as a comprehensive electronic audit process that enables auditors to provide assurance on continuous information simultaneously with, or shortly after, the disclosure of the information. Warren and Smith (2006, pp. 27-35) have a wider view on the topic by stating that CA is any of the methods used by auditors to perform an audit on a continuous basis. In this context, CA verifies transactions based on prescribed criteria, identifies anomalies, and lays out the responsibilities of the auditor. Similarly, CaseWare (2009) sees CA as a process that brings together fundamental practices all auditors follow, including planning, risk assessments, control assessments, and use of technology to perform much of the audit work. Krass (2002) states that CA promises to transform the process

of financial auditing by changing it from an archival activity that is performed at the end of a month, quarter, or year to a process that is done on a continuous, nonstop basis. Förschler (2013) even comes up with two different definitions. In a narrow sense, he considers CA as software-supported, automated retrieval of information relevant to audit and audit planning. In a broader sense, he understands CA to cover the systematic retrieval and processing of all risk-related information relevant for the optimisation of audit processes.

As different and far-reaching as these definitions are, they bring to light a range of elements which are worth emphasising individually (Chan, Vasarhelyi, 2011, pp. 152-160):

1) CA is seen as a new auditing methodology which clearly differentiates itself from previous, more traditional forms of internal auditing. It is understood as a systematic approach to provide added value to the internal audit function.
2) CA deals with the testing of diverse business activities by means of identifying exceptions, alerts, deviations, or abnormalities, by comparing a current state with a previously set target state. Therefore, the auditor is directed to areas of increased risk for further (i.e. manual) audit activities. Areas without noted exceptions are left out of consideration for further actions.
3) Audit activities occur in a frequent or even ongoing manner. Thus, the frequency clearly differs from traditional auditing under which audit activities are subject to medium to long-term audit plans. Therefore, CA produces a higher number of audit reports and audit evidence.
4) The audit activity itself is conducted simultaneously or shortly after the occurrence of events underlying the audited subject matter. This allows the auditor to obtain audit results in a comparably fast manner and to overcome potential obsolescence of or distortions in the audit results that occur from an increased time gap between the occurrence of an event and the time of the audit.
5) A major aim of CA is providing written assurance to an addressee (i.e. senior management, the board of directors, or the audit committee as part of the board of directors). Also, the definitions above leave open the degree of assurance to be provided. Both of these conditions are present under the traditional approach as well. However, in contrast to traditional auditing which mostly features sample testing of an audit subject, CA covers an ongoing testing of 100 % of all relevant data of an audit subject. Thus, it provides auditors with an opportunity to go beyond the limits of traditional audit approaches and the limitations of sampling.

6) The definitions of CA do not limit its areas of application. Thus, CA can be applied to a range of corporate subjects and can cover controls, risks, transactions, or data.
7) CA can be applied not only for the mere analysis of data, but can also comprise other activities performed by the internal audit function, e.g. audit planning, data retrieval, or audit documentation.
8) Information technology is a central element of CA. Although, none of the aforementioned definitions states that IT is strictly required for applying CA, the use of software to support CA is of great help. It reduces manual activities and thus makes it more efficient.

Given the high number of definitions, there is a risk that the nature of CA is misunderstood. If regarded closely, the definitions covered above imply what CA is not. CA is not the sole automation of audit engagement. Neither it is a tool for data analysis, nor does it describe the deployment of sporadic evaluation of transactions or controls. Instead, it is a risk-oriented, systematic auditing methodology, assisted by the usage of IT tools, covering the ongoing, or at least highly frequent analysis of different kinds of data by identifying deviations to previously defined target levels simultaneously or shortly after the occurrence of an event (Wagner, Lieder, 2016).

4.2 Synonyms and related terms

In academic literature, a wide range of different terms can be found in the discussions about CA. This variety results from the fact that the topic of CA has been discussed for over 30 years and has undergone many redefinitions. Still, most terms actually mean similar things and are used as synonyms for each other. Thus, these terms will be explained below.

Singleton and Singleton (2005, pp. 17-27) developed the term Continuous Auditing and Reporting, while Chen, Zhang, and Jiang (2007, pp. 521-528) talk about Data-oriented Online Auditing. Both are relatively close to what is defined as CA above. The same is true for the term Continuous Online Auditing which was established by El Masry and Reck (2008, pp. 779-802), amongst others.

When applied in practice, CA is found in the form of models which represent a more or less structured framework for applying CA. Based on their setup, they vary in their names and the

elements they emphasise. Li, Roge, Rydl, and Hughes (2007, pp. 430-436) discuss a Continuous Auditing Web Services Model. Chou, Du, and Lai (2007, pp. 2274-2292) talk in their article about an Agent-based Continuous Audit Model. A Web-service-based Continuous Auditing Model is central to the discussion of Ye, He, and Xiang (2008, pp. 746-755). Yet, Chen and Sun (2007, pp. 47-52) elaborate on a Collaborative Continuous Auditing Model, while Vasarhelyi and Halper (1991, pp. 110-125) consider their model as a Continuous Process Audit Methodology which is used alongside a Continuous Process Auditing System.

Other authors use the term ‘system’ to describe their CA activities, using the term as synonym for both ‘systematic approach’ (similar to ‘models’) and ‘technical application’. For example, Chen, Li, Huang, and Hung (2007, pp. 460-472) talk about a Continuous Auditing Assistance System. Yet, other terms are common as well. Cantu, Liu, and Zhou (2008) use terms such as Continuous Auditing and Financial Reporting, Continuous Assurance Metrics, and Automated Continuous Transaction Verification Environment. Alles, Brennan, Kogan, and Vasarhelyi (2006, pp. 137-161) discuss the term Continuous Monitoring of Business Process Controls.

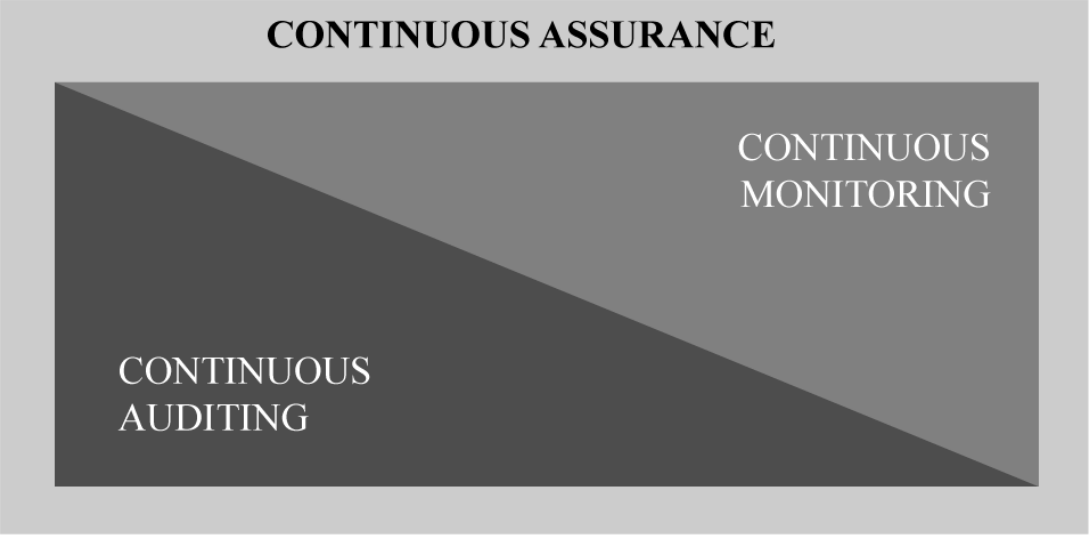
Still, this list is not exclusive and a range of further terms can be found in literature. For simplicity reasons, however, there will not be any further differentiation in this thesis. CA models and systems will be discussed more generally later in this chapter.

CA is often mentioned in close connection to Continuous Monitoring (CM) and, in part, also to Continuous Assurance. The relationship between these three terms is often the subject of divisive discussions.

The ISACA (2010a) defines CM as a management process to monitor whether policies, procedures, and business processes are operating effectively on an ongoing basis. Figuratively expressed, Verver (2008) considers CA and CM as the twin peaks of continuity**.** Still, he finds that CA and CM clearly differentiate from each other. The author defines CA as audit activities performed by the internal audit function on a regular basis to provide ongoing assurance and more timely insights into risk and control issues. Meanwhile, CM is understood as a constant assessment by management covering key business process transactions and controls. Also Duscha considers both topics to be of separate and distinct nature (2014, pp. 214-217).

Continuous Assurance is understood as a combination of Continuous Monitoring (as performed by management) and CA (as performed by the internal audit function) that allows management as well as IT audit and assurance professionals to monitor controls and risk on a continuous basis and to gather selective evidence using technology (ISACA, 2010a). Similarly, the Institute of Internal Auditors (2005, pp. 9-10) considers Continuous Assurance as the overlying, surrounding body, holding CA and CM as essential elements. Specifically, they consider CA and CM to be in an inverse relationship. This implies that the more management relies on CM as a monitoring tool and the more sophisticated these CM models are, the less extensive the internal audit function needs to apply CA as internal auditors rely on management's CM findings instead.

Figure 3: Relationship of Continuous Auditing, Continuous Monitoring, and Continuous Assurance



Source: Own resource, based on Institute of Internal Auditors, 2005, pp. 9-10

This form of coalition is beneficial to both management and the internal audit function as CA in conjunction with CM will satisfy a company's demands for assurance, ensure that control procedures are effective, and that information produced for decision making is relevant and reliable (ISACA, 2010a). Vasarhelyi, Romero, Kuenkaikaew, and Littley (2012, pp. 31-35) underline the relationship of CA and CM under the roof of Continuous Assurance.

Meanwhile, CaseWare (2008) see CM as a spinoff of CA. They do see the key distinction between CA and CM in the ownership, with the internal audit function being responsible for CA

and management being responsible for CM. However, the authors note that this distinction becomes blurred if the internal audit function acts in management's interest and assists in the implementation of CM models or CM systems. In this context, Leech (2005, pp. 1-11) warns that management responsibility to assess and report on control effectiveness must not be sacrificed by joined CA-CM activities and that reliable CA systems need to be in place to properly assess and validate management's work. Despite the clear theoretical foundation, the internal audit function encounters difficulties when differentiating between CA and CM in practice. As Khargi (2010) puts it, companies are having a hard time defining whether specific projects are to be allocated to CA or CM. Mainardi (2011) raises the same finding and points out that both CA and CM share the same limitations and are thus hard to keep apart.

Alongside the differentiation of CA and CM, there has been an ongoing debate about the organisational ownership of CA (i.e. who is the core organisational entity to apply CA). As discussed above and clearly pointed out by Warren and Smith (2006, pp. 27-35), CA is the responsibility of the internal audit function. However, other authors (e.g. Weins, 2012) have been reasoning that CA can also be used by external or tax auditors, regulatory authorities, or other external audit functions. These external parties apply their own CA models, analysing data directly drawn from the auditee, or they rely on audit evidence gathered by internal auditors via CA (Warren, 2004). This approach can be pursued for their own purposes (e.g. for stating an audit opinion) or on behalf of stakeholders external to companies, such as investors, financial institutions, tax authorities or rating agencies (Murthy, Groomer, 2004, pp. 139-163).

4.3 Subjects

CA theory mentions a range of subjects which can be covered by CA. The most striking ones found frequently in the literature are risks and controls (ISACA, 2010a).

There are multiple reasons why CA is used to address risk. From an internal perspective, CA allows a flexible, goal-oriented way to identify risk due to its processual approach (Rau, Rühl, 2008, pp. 232-234). It also sets the basis for a proper delivery of insight into areas of risk and opportunity (KPMG, 2008a). From an external perspective, stakeholders demand that management continuously improves governance capabilities so as to manage risk more appropriately. At the same time shareholders give credit to CA to satisfy this demand (KPMG, 2010a).

CA delivers a methodological basis for an ongoing evaluation of controls (PwC, 2006; Marks, 2010, pp. 5-8). Ratios, such as key risk indicators (KRIs) or key performance indicators (KPIs) represent a significant CA element, enabling auditors to repeatedly measure a provided status of controls and to assess their proper functioning (Weins, 2012). PwC (2012) even considers controls as such an elementary aspect of CA that they regard it as a distinct, separated sub-discipline. In this context, they define CA as a technique that analyses configurations, master data, or transactions to identify exceptions that indicate an issue with that control's effectiveness.

Yet, other authors see data as a central point of CA. Warren and Smith (2006, pp. 27-35) find that CA is often used to tests transactions. Similarly, Reibel (2010) argues that CA is especially useful at the transactional level. Calling it Continuous Transaction Monitoring, PwC (2012) even frames their own term for it and considers it as a technique that analyses all transactions or other data to identify exceptions that indicate an abnormal (i.e. out of policy) transaction.

Moreover, CA can be applied to project management. The problem with traditional auditing is that project management activities are inefficient and cost overruns occur if appropriate interventions are not rendered immediately after the incidence or on a real time basis. To overcome this time lag, CA models can be used for complex projects that require constant monitoring and exception reporting (Sharbatoghlie, Sepehri, 2009).

Other academics argue that CA activities are not centred around a small number of subjects, but can be applied to a wide range of auditors' activities. For example, CaseWare (2009) considers CA as a process that brings together fundamental practices which all auditors follow, including planning, risk assessments, control assessments, and the use of technology to perform much of the audit work.

CA also covers elements not typically associated with internal auditing. Vasarhelyi, Kogan, and Alles (2002, p. 80) find that CA also provides assurance on processes that are not necessarily of financial nature. Even beyond a company's boundaries, web-service-based CA models have the ability to cover the activities of suppliers and other third parties (Ye, He, Xiang, 2008, pp. 746-755).

Vasarhelyi (2011, pp. 23-29) puts a structure on these thoughts by deriving three sub-disciplines of CA:

- Continuous Controls Monitoring
- Continuous Risk Management and Assessment
- Continuous Data Assurance

Continuous Controls Monitoring covers the ongoing assessment of internal controls. These controls originate from different departments such as finance, IT, accounting, or personnel and cover different hierarchy levels. By using Continuous Controls Monitoring, the auditor obtains an early indication about the existence of potential weaknesses in theses departments, as well as in the departments' structures and processes. To identify any weaknesses, KPIs are used to measure whether controls have been implemented and whether the implementation was performed in line with time targets (Vasarhelyi, 2011, pp. 23-29).

Continuous Risk Management and Assessment refers to the activities used by auditors to identify and assess the levels of risk or changes to the level of risk. Thus, KRIs (rather than KPIs) measure abnormalities in departments, processes, or IT systems. Most importantly, these KRIs need to be of a forwards-looking character, i.e. they indicate developments which cause a risk to arise or to change negatively in the near future (Vasarhelyi, 2011, pp. 23-29).

Continuous Data Assurance includes all other activities by auditors to verify data on an ongoing basis. In most cases these analyses feature data at transaction or account level, but also cover data from more aggregated levels. Thus, Continuous Data Assurance uses KPIs to identify undesired developments in the chosen subject matters which are not primarily considered as control or risk, e.g. continuous scans of master data changes, authorisations, and parameters in IT systems, or transaction data (Vasarhelyi, 2011, pp. 23-29).

Due to the wide range of areas CA can be applied to, the objectives of CA can be extensive. CA can follow the same objectives as ordinary audit engagements (e.g. financial audit engagements, operational audit engagements, compliance audit engagements, forensic audit engagements). Therefore, the ability of an internal audit department to rely on CA largely depends on the digital availability of audit subject data as well as on the objectives to be achieved by the chosen audit activities (Abdolmohammadi, Sharbatouglie, 2005; Institute of Internal Auditing, 2013).

4.4 Methodological aspects

Because it is effected by multiple definitions, CA has many different designs in the practical field. Thus, one organisation's version of CA can differ significantly from another organisation's implementation (ISACA, 2002).

In order to allow a best practice approach to develop, methodological structure is of decisive importance when it comes to the introduction and application of CA. Therefore, there is an urgent need for new approaches, new standards, new software, and a new way of thinking among internal auditors (ISACA, 2006). At the same time, companies need to become more strategic and pursue long-term approaches when it comes to applying CA (Littley, 2013).

Structure and order not only need to be assigned to the CA methodology as a whole, but also to single elements of CA. Data, for example, can be considered as raw material for CA. Thus, the success of any CA model largely relies on the structure of data and information present in companies. If data is dispersed and heterogeneous, CA models need to incorporate correcting measures. To eliminate the problem of data diversity, Li and Li (2007) propose a log-based CA model. Moreover, solid data flows need to be present in companies to support the applicability of CA (Vasarhelyi, Pinto Alves, 2007, pp. 471-507).

To implement CA smoothly and with as little organisational resistance as possible, companies need to start off with only a selection of audit subjects, instead of aiming for full coverage of all audit subjects. Most likely, auditors will make their first attempts in areas they are comfortable with and in which they have already gained experience. Also, they will focus on areas where automation efforts have already been undertaken, instead of starting from scratch in areas which are solely manual (Alles, Kogan, Vasarhelyi, 2008, pp. 195-214). Borthick (2012, pp. 153–166) recommends applying CA preferably to highly automated processes. According to Majdalawieh, Sahraoui, and Barkhi (2012, pp. 304-327), CA needs to aim at connecting existing, automated controls inherent in systems for an easier implementation.

Irrespective of the audit subject, initial CA activities are of greatest value when focus rests with data levels that are as detailed as possible. Therefore, emphasis should rest with transactions (Marques, Santos, Santos, 2012, pp. 363-369).

Chou and Chang (2010, pp. 4-32) studied the conditions under which different audit approaches can be applied best. They conclude that CA is the most appropriate auditing approach for finance-related audit subjects, with data being provided through web-based technology.

Chen and Sun (2007, pp. 47-52) find that CA needs to make use of existing frameworks to ease implementation efforts. Often, aspects such as inaccuracy of data, the missing timeliness of audit engagement, and the inflexibility of audit activities are mentioned as factors causing companies difficulties when it comes to CA. Ye, Chen, Gao, and He (2008, pp. 400-405) therefore conclude that service-oriented models have the ability to convert data for real-time business transaction validation and thereby offer a high potential to overcome these difficulties.

Yet, other authors find that CA models need to be aligned to existing corporate disciplines which are highly frequent in their nature, are based on the usage of IT, or share other characteristics of CA. Hunton and Rose (2010, pp. 297-312) argue that decision support systems form the basis for CA and thus foster the popularity of CA. Meanwhile, Baksa and Turoff (2010) find that emergency response management information systems (ERMIS) can be used as a prototype to help overcome obstacles during the implementation of CA. Turoff et al. (2004, pp. 1-24) even go further by proposing to integrate CA in ERMISs. Bo, Ying, and Geng (2011) suggest linking CA with models used for fraud prevention, fraud detection, and other forensic activities. Moreover, companies (in particular banks) are found to apply CA models which incorporate existing ERP or finance systems (e.g. SAP, Navision) and their methodological logic (Vasarhelyi, Voarino, 1999, pp. 33-35).

A self-learning function will play an import role during the development of CA models in the future. However, strong frameworks enabling artificial intelligence will need to be developed first (Ye, Wu, Chen, 2010, pp. 158-162).

CA models comprise a considerable number of analyses. In part, these analyses turn out to be complex. Thus, several authors support CA models in which analyses are broken down into stages. Kogan, Alles, Vasarhelyi, and Wu (2010) propose a two-tier CA model which features analyses of aggregated data in the first stage and additional analyses of un-aggregated data in a second stage. The second stage thereby functions as a safety net for the first stage, in case abnormalities remain undetected. Nigrini (2000) suggests differentiating between analytical and diagnostic procedures and to cover them in separate tests. Chou (2001) meanwhile favours

a generic framework which incorporates two sub-models: the online control testing model and the continuous substantive testing model. Yet, Nelson (2000, pp. 33-37) recommends separating direct reporting tests (exception-based tests directly reported to client) and indirect reporting tests (including manual follow-up and application of professional judgement).[4]

Several approaches on how to operate CA have been discussed in literature. These range from high-level phase models to detailed process flow models (e.g. Abdolmohammadi, Sharbatouglie, 2005; Mainardi, 2011; Institute of Internal Auditing, 2015). Borthick (2012) suggests a four-stage model with the following phases:

Table 4: CA process model

Stage	Description
1	Examination of existing processes and controls to identify the monitoring and testing that is suitable for CA and confirmation of sufficient data access
2	Definition of metrics for evaluating transaction data
3	Development of rule-based analytics as benchmarks for determining internal control violations
4	Describing an audit-by-exception approach for determining the level of material errors, omissions, and other anomalies

Source: Own resource, based on Borthick, 2012, pp. 153-166

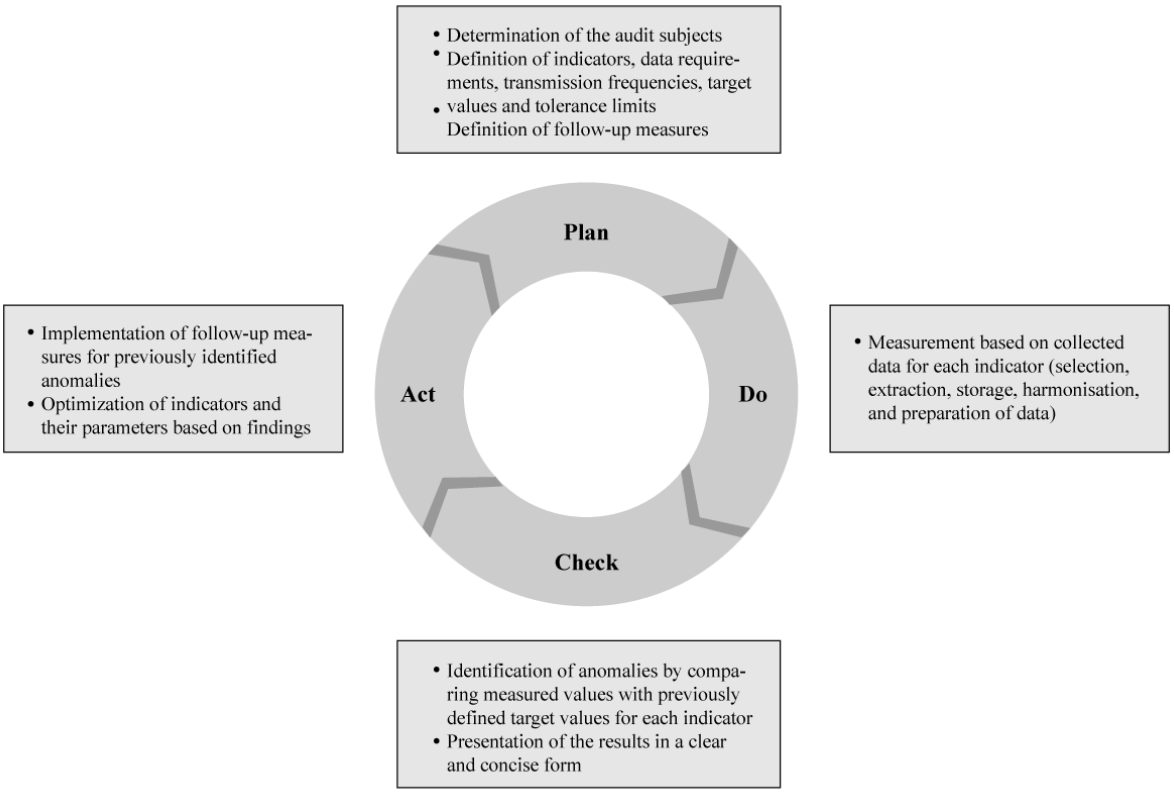
Meanwhile, the Institute of Internal Auditors (2005, p. 17) suggests covering at least the following stages during the implementation of CA models:

- Set CA objectives
- Define data access and usage
- Perform continuous control and risk assessments
- Report and manage results

[4] As these CA models do not have an impact on the further progress of this thesis, they are not discussed in further detail.

As companies are subject to constant change arising from their internal and external environments, CA approaches need to bring along a minimum degree of flexibility. Several authors (e.g. Du, Roohani, 2007, pp. 133-146) have therefore built upon existing approaches and have introduced cyclical approaches as they believe that CA functions best if applied in a kind of ongoing cycle. These cycle approaches include multiple stages and cover activities such as data retrieval, data analysis, data control, and data monitoring (Yeh, Shen, 2010, pp. 2554-2570). Although single models are mostly unique in their individual setup and their practical application differs based on differing CA subjects and objectives, a general pattern can be identified. Thus, the cycle approach can be broken into four phases following the plan-do-check-act cycle:

Figure 4: Continuous Auditing cycle model



Source: Own resource

According to the Institute of Internal Auditors (2005, p. 17), Du and Roohani, (2007, pp. 133-146) as well as Yeh and Shen (2010, pp. 2554-2570), the four phases cover the following activities:

The **plan-phase** is of critical importance, especially during the initial introduction of CA. During this initial phase, objectives to be achieved as well as the desired level of assurance to be obtained by using CA are defined. Also, the audit subjects to be analysed by CA need to be determined. As discussed above, these include risks, controls, data, processes, IT systems, or other corporate elements. Choices made are based on a medium- to long-term, risk-oriented audit planning. Audit subjects which require an increased level of manual audit activities are preferably chosen for CA as these offer an increased potential for efficiency gains.

In accordance to previously set objectives, measuring points (i.e. KPIs/KRIs) need to be defined for each audit subject. These represent the basis for measurements performed at a later phase. The definition of KPIs/KRIs is a challenging task as their quality directly influences the explanatory power of CA results. As KPIs/KRIs express a specific matter in condensed form, valuable information which would have been gathered during a manual audit activity, is lost. Auditors therefore compensate for this shortage by defining a considerably high number of KPIs/KRIs. Contrarily, the performance (i.e. the actual measurement) of KPIs/KRIs binds resources and therefore needs to be limited to a minimum. Thus, a fixed number of measuring points is difficult to define as the extent of KPIs/KRIs depends on the complexity of the audit subject and the desired degree of assurance. To find a suitable solution, it is advisable to closely analyse the audit subject's design before developing measuring points. Moreover, appropriate measurement frequencies for data transmission need to be set. These do not necessarily need to be perfectly continuous, but need to match in CA objectives.

For each KPI/KRI, target values need to be defined which will later be used as reference for the comparison with measured values. These target values are set in a way that they allow the auditor to make meaningful conclusions about the audited subject. If target values are set too high or too low, exceptions are either identified in excess (so-called false positives) or not identified at all. Systematically structuring multiple KPIs/KRIs (as common in indicator systems) helps to overcome this risk (Alles, Brennan, Kogan, Vasarhelyi, 2006, pp. 137-161).

Follow-up activities which are to be performed upon identification of an exception are defined in this stage as well. In practice, it turns out to be useful to document these proceedings and provide them to the employees in charge of carrying out follow-up activities. Optimally, this documentation does not only include activities to be performed, but also points out responsibilities, timelines, etc.

As this planning work is time and cost-intensive, it is advisable to concentrate on the most critical audit subjects only and to not choose more measuring points per audit subject than ultimately necessary.

The **do-phase** includes the actual analysis and evaluation of the audit subject. Specifically, KPIs/KRIs are calculated based on collected data at previously defined points in time (e.g. every morning at 8:00 am). The exact course of action depends on the previously set objectives and the extent of CA activities as well as on the company's technical capacity. Activities in this phase comprise, but are not limited to the following tasks:

- Data selection
- Data extraction
- Data storage
- Data harmonisation
- Data preparation
- Calculation of KPIs/KRIs

At first, the required data needs to be identified at the place of origin. This identification will turn out to be challenging, if relevant data is part of a larger data set and not separated from irrelevant data. In this case, relevant data needs to be marked off before it can be used for further purposes. This delimitation is based on different parameters (e.g. time, range, content, key words) and is used to ensure that the data selection is as suitable as possible to meet the requirements of any subsequent analysis steps.

Selected data needs to be extracted and transferred to the entity conducting the audit activity. While doing so, it must be ensured that original data is not altered and that only a duplicate of the original data is transferred. The audit entity can be an auditor (in case CA is performed manually), an audit module which is integrated in the legacy system holding the audit subject, or a separated audit system (Kuhn Jr. and Sutton, 2010, pp. 91-112). The transferal itself varies from the auditor transferring data on a storage device to data being transmitted automatically via a technical interface between the legacy system and the audit module/system. Once transferred, original data is stored and must not be modelled in any way in the further process. Instead, data analyses are performed on the basis of further duplicates of the stored data. Before analyses are performed, data needs to be prepared. This preparation includes steps as grouping,

restructuring, or filtering. When data is drawn from different data sources or turns out to be heterogeneous by nature, harmonisation of data is an essential element of this stage. Finally, KPIs/KRIs are calculated, either manually or by the applied CA software.

These single steps are not necessarily obligatory and can vary in order. If the CA model is of a manual nature (i.e. no usage of CA software), single steps will turn out to be time-consuming. Using CA software to automate proceedings therefore yields significant time savings.

After measurements have been made for each KPI/KRI, results can be compared to previously defined target values in the **check-phase**. If optional tolerance levels were defined, these are to be considered accordingly. Depending on whether CA is performed in a manual or automated manner, results can be presented in various forms. In audit modules/systems, identified derivations between measured values and target values are shown as alerts. They also make use of traffic light diagrams (red, yellow, green), two-level scales (pass, fail) and/or automatically send emails to the responsible entity (e.g. the auditor) to notify him about the alert. Irrespective of the actual form, it is advisable to display results as clearly as possible to simplify identification of areas needing further attention.

Follow-up activities to be performed in the **act-phase** need to be tailored to the alerts identified by the KPIs/KRIs. Thus, they vary in form and extent and range from analytical procedures to case-by-case activities as inspections, inquiries, observations, or re-performances. Findings discovered by these follow-up activities are used to verify previous results from CA activities as well as to formulate (or strengthen) audit opinions. Also, findings are used for optimising KPIs/KRIs, measuring frequencies, target values, and tolerance levels for future CA activities. Moreover, identified findings render themselves useful when it comes to the re-evaluation of audit subjects' appropriateness for CA purposes. If adjustments are made to the CA model, corruption of previous results must be prevented by backing up data.

4.5 Technological aspects

A number of academics recommend using IT in order to make CA more efficient. Flowerday, Blundell, and von Solms (2006, pp. 325-331) note that CA strongly depends on technology. Kokemuller (2015) states that CA is heavily technology-driven. Also, ISACA (2003) fundamentally considers CA as a technology and thereby lays emphasis on its IT-based nature. Thus, to maximise speed and reduce the amount of manual work, CA is most beneficial when performed with IT support.

Yet, academics find that IT is not necessarily needed for CA. Mainardi (2011) frankly states that it is a misbelief that in order to implement CA successfully, the internal audit department must be supported by an automated technology. Nor is it feasible to strive for a fully automated auditing approach over all possible audit subjects. As Khargi (2010) puts it, a small number of subjects will always need to be checked manually and other manual elements as auditor's judgement will always be a key to internal auditing.

In practice, reservations about the usage of IT for CA purposes are found only to a limited extent. For many companies, IT is understood to be a central cornerstone of CA. The external auditing and consulting company PwC (2006) finds that the internal audit function can significantly improve assurance quality with technology-enabled CA as it allows the auditor to validate full populations (instead of samples) within a short time. As a result, CA software has become more and more popular and has moved from being an academic concept to a practice-oriented solution (Vasarhelyi, Alles, Kogan, Sun, Warren, 2005). Many software vendors have developed applications that can analyse significant amounts of data on a frequent basis and provide dashboard reporting and alerts (KPMG, 2008a). Many out-of-the-box solutions even reduce implementation and customising efforts (ISACA, 2010b).

However, care needs to be taken when picking the right software for CA purposes as IT brings along high financial costs (Marks, 2010, pp. 5-8). Software solutions range from $2,000 to more than $1,000,000, with further costs for support activities by internal and external resources coming on top (CaseWare, 2009).

Many CA software solutions operate in a similar fashion as data is displayed in an interactive mode, providing auditors with a work platform to examine extracted data and prepare auditing

reports (Vasarhelyi, Halper, 1991, pp. 110-125). Still, several scientific articles feature a vivid discussion about the technical architecture of CA software (e.g. Kuhn Jr., Sutton, 2010, pp. 91-112). The most frequently quoted literature differentiates between two architecture types: Embedded Audit Module (EAM) and Monitoring Control Layer (MCL) (Lin, Lin, Liang, 2010, pp. 415-422).

At the core of the EAM architecture is an audit module which is embedded in a legacy system (digitally representing the audit subject) and is therefore an integral part of this legacy system. To ensure technical compatibility of the audit module with the legacy system, both must use the same programming language and logic. This setup enables very short processing times, even with large amounts of data. From the user's point of view, EAMs integrate seamlessly into the legacy system, so that the user only needs a comparatively short familiarisation phase due to the functional and visual similarity to the legacy system. Data access and data extraction is carried out according to known procedures. Also, analysed data does not leave the legacy system and therefore is not subject to additional security or data protection requirements (Debreceny, Gray, Jun-Jin Ng, Siow-Ping Lee, Yau, 2006, pp. 7-27).

On the downside, running complex CA models inside the legacy system via an EAM has a negative impact on the performance of the complete system (Khargi, 2010). Also, management of the legacy system and thus of the EAM rests with data owners which in most cases is not the internal audit function, but the functional department (e.g. finance department). Influence by the internal audit department on access rights and security parameters of the EAM as well as on other measures ensuring data integrity is therefore low. Furthermore, although research found that EAMs are effective and efficient, support from auditors is limited due to a lack in demand (Debreceny, Gray, Jun-Jin Ng, Siow-Ping Lee, Yau, 2006, pp. 7-27).

MCL architectures include technically independent auditing systems, placed outside the legacy system. Relevant data is extracted from the legacy system and analysed externally. In this architecture variant, the auditing system thus represents a separate layer which can take over tasks such as data extraction, data filtering, data harmonisation, data analysis, and result presentation. Due to its independent nature, the auditing system can use data from different sources more easily and is therefore suitable for companies with many IT systems or with a heterogeneous IT landscape. Auditing systems as part of MCL architectures often fall under the responsibility

of the internal audit functions and thus ensure a higher degree of independence and self-determination of the auditors. This allows an increased level of sharing and collaborative working among internal auditors. Also, auditors do not have direct access to the source data, preventing them from accidently changing these during their analysis activities. Due to their external location, however, MCLs often require a higher level of data privacy and security measures, especially when data is stored or processed external to the company (e.g. directly at the audit system's provider or in an external cloud) (Wu, Shao, Bih-Yih, Tsair-Yuan, 2008, pp. 355-360).

Over the last 20 years, web-based CA solutions have gained in popularity. Chen, Zhang, and Jiang (2007, pp. 521-528) introduce a third architecture model called Data-oriented Online Auditing which they consider as promising regarding CA. Similarly, Ye, He, and Xiang (2008, pp. 746-755) favour a web-based architecture to facilitate CA in future, while Koskivaara and Back (2007, pp. 29-45) conclude that artificial neural networks are equally competitive compared to other architectures.

In addition to these architecture models, a range of hybrid variants in various forms can be found in practice. The selection of the architecture variant or the specific application therefore depends on the individual situation. Factors to be considered include the nature of the existing IT infrastructure, the objectives and scope of the planned CA activities, and the auditor's experience with such IT applications. Relevant prerequisites (e.g. availability of data, encryption of data, compliance with security parameters) must be identified and taken into account (Kuhn Jr., Sutton, 2010, pp. 91-112).

The academic discussion around CA architecture has fuelled the evolution of programming languages. Rezaee, Elam, and Sharbatoghlie (2001, pp. 150-158) have noticed an increased usage of extensible business reporting language (XBRL) in accounting and reporting software to foster real-time, technology-based auditing. Wright (2002) finds evidence that XBRL is a suitable vehicle to provides stakeholders with timelier audit information. The Unified Modelling Language has been applied for CA solutions as well (Chou, 2001).

4.6 Benefits and barriers

Research articles covering CA mention a range of benefits arising from the usage of CA, both to the internal audit function and to the company as a whole. These benefits differ considerably

in their strength to which they drive the adoption of CA. Also, single benefits may be interrelated or hold interfaces to each other. Yet, they provide an answer to the requirements arising from recent developments on the internal audit function (see chapter 3.5). The CA benefits most relevant to this research are discussed below:

Increases efficiency and effectiveness of internal auditing

CA is found to increase efficiency and effectiveness of activities performed by the internal audit function (Grasegger, Weins, 2012, pp. 231-238). It helps auditors to identify areas of high risk more easily and thus supports prioritisation of audit activities (Chan, Vasarhelyi, 2011, pp. 152-160). Internal weaknesses are detected more precisely and audit objectives are reached more accurately and with less effort (Shin, Lee, Park, 2013, pp. 592-627). This increase of effectiveness leads to a reduction of internal auditing costs and aids the internal audit function in realigning tasks. As Li (2007) points out, the introduction of CA also enables audit staff to make better professional judgments and fosters the development of audit software.

Fulfils stakeholders needs / Adds value to internal auditing / Enhances audit quality

CA can be understood as a methodology to foster the added value provided by internal auditing (Institute of Internal Auditors, 2005, p. 21). Both Grasegger and Weins (2012, pp. 231-238) as well as Marks (2009, p. 51) conclude that CA improves the value of audit output and therefore helps to fulfil the growing requirements of the internal audit function's shareholders (e.g. senior management, supervisory board). Furthermore, Yeh and Shen (2010, pp. 2554-2570) find evidence that CA enhances audit quality as it helps to monitor business systems and their procedures, activities, transactions, and events more easily (compared to traditional auditing).

Strengthens auditors' independence

While auditors' independence and objectivity are of great importance, traditional audit activities more easily draw internal auditors into violating these principles. The IIA (2005, p. 5) finds that CA helps to define the role of internal auditors more precisely and thereby limits the risk of auditors' violating their independence. Daigle, Daigle, and Lampe (2008) agree to this finding and believe that the value internal auditing provides to the company is thereby increased. Du and Roohani (2007, pp. 133-146) analyse the subject of independence on the basis of different architecture types of CA tools. They conclude that, when using a technically separated MCL, responsibilities among internal auditors, management, and business departments are clearly set and that auditors' independence is thereby enforced.

Accelerates audit activities

The introduction of CA in practice is driven by the need for shorter reaction times (Einhorn, Einhorn-Schurig, 2007, pp. 166-169). At a general level, Aquino (2008) finds that CA accelerates audit activities since single activities (e.g. retrieval or analysis of data) are performed in a shorter time period. Also, KPMG (2012) concludes that the use of CA results in a timelier oversight of compliance across the company. Meanwhile, PwC is a bit more specific by stating that CA considerably shortens audit cycle times as they believe that each stage of the audit cycle (e.g. audit planning, audit conduction, audit reporting) is accelerated (CaseWare, 2008). Even with a more differentiated view on the single stages of the audit cycle, proof can be found that CA accelerates the identifications of abnormalities as well as the conduction of audit activities. Moreover, it closes the time gap between the conduction of audit activities and the communication of results (Chan, Vasarhelyi, 2011, pp. 152-160). Also, the extent of audit delays is found to decrease by using CA (in contrast to other auditing methodologies) (Masli, Peters, Richardson, Sanchez, 2010, pp. 1001-1034).

Counteracts shortage in skilled staff

Many internal audit departments face shortages in skilled staff. These are reinforced by the growing complexity inside and outside of companies as well as by shorter reaction times granted to the internal audit function. However, this is not a purely quantitative matter. As the number of audit engagements for which speciality knowledge is required is growing, the right skillset is missing in many cases. Specifically, a proper understanding of risks and controls as well as a thorough set of competencies have been reported as lacking (Einhorn, Einhorn-Schurig, 2007, pp. 166-169).

As solid CA models point out areas of increased risk and omit areas of less concern, the auditor is guided in his activities to focus on the most severe issues. The auditor’s overall workload is thereby reduced. By using CA, fewer auditors are needed to generate the same amount of assurance (Eßer, Roth, Vollrath, 2011, pp. 20-24). Due to its structured approach, CA is also seen as less sensitive to missing skilled staff, in comparison to other audit approaches, and therefore helps to overcome shortages in competent personnel (Institute of Internal Auditors, 2005, p. 5).

Allows quick reaction to changes in the internal and external environment

Evolving regulatory environments, increased globalisation, market pressure to improve operations, and rapidly changing business conditions force companies to adjust their activities frequently. Alongside these external forces, internal operations become more and more complex (Einhorn, Einhorn-Schurig, 2007, pp. 166-169). Thus, the internal audit function continuously needs to evaluate whether its output still meets stakeholders' needs. In this context, CA is granted credit for allowing quick reactions to change in the external and internal environment of companies (Sabau, Sabau, Sgardea, Budacia, 2011, pp. 45-48).

Increases efficiency and effectiveness in other business areas

A number of authors find evidence that CA increases effectiveness and/or efficiency in other business areas. At a general level, Marques, Santos, and Santos (2013, pp. 304-309) find that Continuous Assurance helps to improve effectiveness of organisations. CaseWare (2009) finds that CA has a positive impact on the effectiveness of internal controls by management. KPMG (2012) comes to the same conclusion and adds that this improved level of effectiveness will lead to an overall reduction in costs and effort in various business departments. They also find that CA helps to fine-tune corporate objectives (KPMG, 2008b). Chen, Li, Huang, and Hung (2007, pp. 460-472) state that CA delivers the basis for strengthening information systems throughout the company. Khargi (2010) even claims that CA is business crucial and necessary to keep internal controls functioning in future.

Decreases errors in other business areas

CA also helps to decrease errors in other areas of business. KPMG (2012) believes that CA reduces errors in the long run and improves the error remediation process. Farkas and Murthy (2014, pp. 102-121) meanwhile investigate the perceived, incremental value of CA among non-professional investors and find that CA decreases the likelihood of material errors and asset misappropriation. Masli, Peters, Richardson, and Sanchez (2010, pp. 1001-1034) conclude in their study that internal controls monitoring leads to a lower likelihood of material weaknesses presented in auditors' reports.

Reduces costs in other business areas

CA also has a positive impact on costs in other areas. Yeh and Shen (2010, pp. 2554-2570) conclude that by applying CA, overall internal compliance costs (e.g. time for compliance re-

porting, salaries of auditees engaged in providing information and documents to internal auditors) can be reduced. They argue that this was archived by the increased automation brought along by CA. Davidson, Desai, and Gerard (2013, pp. 41-59) reason that a stronger internal audit function, evoked by using CA, leads to external auditors increasingly relying on work performed by the internal audit function which again leads to a reduction in external auditing costs.

Enhances information integrity

Relying on accurate and reliable information is vital to businesses (Vasarhelyi, Kuenkaikaew, Littley, Williams, 2015). In this context, Flowerday and von Solms (2005, pp. 12-16) find that CA influences data integrity in a positive way. Similarly, Hardy and Laslett (2015, pp. 183-194) claim to recognise that companies are placing renewed hope in CA as they consider it suitable to handle the volume, velocity, and variety of present data. For the same reason, current trends such as data warehousing and data mining inherently increase popularity of CA (Abdolmohammadi, Sharbatouglie, 2005).

Enhances internal and external communications

By using CA, auditors can provide information timelier than under other approaches. This not only improves communications between the internal audit function and its own stakeholders (e.g. management, supervisory board), but also between the company as a whole and its outside stakeholders (e.g. customers, suppliers, financiers) (Chou, Chang 2010, pp. 4-32).

Increases investors' confidence

CA is found to also increase investors' confidence. El-Masry and Reck (2008, pp. 779-802) examine investors' perceptions of the usefulness of CA. They find that investors assume a company to be less prone to risk of fraud or financial misstatement and that investors are increasingly confident in their investing decisions when a company is applying CA. Kurt, Marsap, and Ucma (2014, pp. 50-63) identify a positive impact of CA on the corporate accountability mentality of companies listed on the Istanbul Stock Exchange ISC-100 index which results in increased trust among investors.

Enables compliance with regulation

The connection between the usage of CA and compliance with laws and regulations is the subject of various articles. Specifically, CA is found to be suitable to promote compliance with the

Sarbanes-Oxley Act. Li, Roge, Rydl, and Hughes (2007, pp. 430-436) find that IT-supported functions subject to CA are more likely to achieve SOX compliance when compared to other functions. Woodroof and Searcy (2001, pp. 169-191) conclude that CA is suitable for measuring compliance of debt covenants. KPMG (2012) concludes that CA enhances oversight of compliance and considers CA capable of ensuring a more comprehensive reporting on compliance with an internal and regulatory requirement. The IIA (2005, pp. 11-16) finds that CA supports regulatory compliance by simplifying the identification and evaluation of deficiencies in processes, fostering sustainability, saving resources, defining materiality more precisely, helping to set priorities more appropriately, and reporting on financial risks more effectively.

Other authors find a relationship between the usage of CA and compliance with laws and regulations which is geared towards the opposite direction (i.e. regulation triggers CA, not vice versa). According to Dal-Ri Murcia, Cruz de Souza, and Alonso Borba (2008, pp. 1-17), CA has emerged as a response to recover the credibility of the auditing profession as well as to meet requirements set by SOX. Similarly, Aquino, Lopes da Silva, and Vasarhelyi (2015) state that SOX, amongst others, gives momentum to CA. Industry-specific growth of regulation, as common in the banking sector, is also found to be a driving force for the introduction of CA (Eßer, Roth, Vollrath, 2011, pp. 20-24).

Assists in integrating and enhancing technology

CA can be used to handle the growth of IT and the risks arising from this development (Institute of Internal Auditors, 2005, pp. 17-25). Kogan, Sudit, and Vasarhelyi (1999, pp. 87-103) conclude that CA facilitates necessary monitoring activities of online services, such as online retailing, online securities trading, and online procurement. Yet, Rezae, Sharbatoghlie, Elam, McMickle (2002) see CA as a result of IT's popularity. Due to the growth of corporate IT, internal auditors feel pressure to enhance audit techniques to account for real-time auditing. Also, reports with a retrospective view on companies' dealings are considered to be of limited value to investors (Vasarhelyi, Kogan, 1999, pp. 17-18). Thus, higher audit frequencies have become inevitable. The wide-spread use of computers and networks make it possible for internal auditors to increase the frequency of audit activities and therefore to overcome this challenge (Kogan, Sudit, Vasarhelyi, 1999, pp. 87-103).

Facilitates the prevention and detection of fraud

CA models can be aligned in a way that they prevent or detect fraud. At a general level, Kaya and Tez (2014, pp. 104-109) consider CA as a strategic tool to counteract fraud effectively. Kearns (2011) argues that CA is an effective methodology to support the internal audit function in combating fraud. Vasarhelyi, Kogan, and Alles (2002, p. 80) even elaborate on whether CA could have prevented large corporate scandals such as Enron or Parmalat. More specifically, CA can be used to manage the early detection of fraudulent financial reports (Lin, Lin, Liang, 2010, pp. 415-422). Moreover, Krass (2002) believes that by utilising CA illegal financial transactions can be detected before any damage is done. The IIA (2005, p. 8) concludes that the identification of theft as well as the alignment of responsibility for fraud management can be facilitated with CA in an appropriate manner.

However, Alles, Kogan, Vasarhelyi (2004c, pp. 183–202) have also demonstrated the limitations of CA in this respect by pointing out that CA is not capable of preventing and detecting all possible fraud scenarios, especially when managers and auditors collude to deliberately mislead investors. In these cases they find CA to be no more effective than other auditing approaches.

Alongside the aforementioned benefits, CA theory also mentions a range of challenges which potentially prevent companies from utilising CA. Thus, these challenges need to be mastered before CA can be applied successfully (Hardy, Laslett, 2015, pp. 183-194). The CA barriers most relevant to this research are discussed below:

Heterogeneous and unspecific data

Companies use IT to support many business functions. Many IT applications are in place and are connected via complex networks. These IT applications produce a large amount of data in all kinds of data formats (Blundell, 2007). Being part of these companies, the internal audit function is confronted with increasing data volumes relevant for their audit activities (Kiesow, Zarvic, Thomas, 2015). Especially when it comes to collecting, analysing, and retaining audit evidence, this development is a major challenge (Ye, Ruan, Huang, Wang, 2011, pp. 192-198). Li and Li (2007) even argue that data diversity is the main barrier to implement CA. Furthermore, accuracy of data can turn out to be another limiting factor. Depending on the specific CA model, data needs to feature increased accuracy levels. If this increased level of precision cannot be provided, CA will ultimately fail (Ye, Chen, 2008).

High implementation and management costs

The introduction and management of CA comes with large investments (e.g. costs for purchasing a CA software tool, time for developing CA models and setting up a CA organisation) which is seen as a major obstacle by several authors (e.g. Tumi, 2013, pp. 2-10; Taylor, Murphy, 2004, pp. 280-289). Organisational, procedural, and technological changes need to be implemented to build a foundation for the proper functioning of any CA model. Baksa and Turoff (2010) believe that costs are driven by formalising and automating the auditors' judgement. Hoffer (2007, pp. 1-19) states that costs during the CA implementation mainly come from the need for additional support from auditors as well as from senior management. Yet, Vasarhelyi, Kuenkaikaew, Romero (2010) consider costs not to represent a major challenge. In parts, they argue that costs from implementing the technology have already fallen to acceptable levels.

Feared disruption of audit plan / vulnerability

Under traditional auditing approaches, audit engagements are the result of a thorough audit plan which goes back to input from different sources, weighted for risk and prioritised accordingly. Over the years this balanced approach has been applied, it has provided confidence to CAEs, and has reinforced their feeling about doing the right thing. Under CA, auditors are asked to rely on IT-based CA models when it comes to planning and executing their audit activities. Especially during the early stages of CA introduction, trust among auditors in the new approach is low and fear is felt that audit activities do not provide the desired confidence (Hoffer, 2007, pp. 1-19). Also, in the event of fraud, auditors feel more vulnerable when relying on automated auditing procedures (Alles, Kogan, Vasarhelyi, 2004b, pp. 1-21).

Rigidity of IT-supported CA activities

Under certain circumstances, internal auditors need to diverge from their audit plan and their work programs. During audit engagements this can be the case when unforeseen events occur or the found state does not turn out as expected. Events can even be so severe that unscheduled audit engagements need to be called up. In any case, the auditor needs to improvise and adjust to changing circumstances. Applying CA with an intense support of IT can result in an increased level of rigidity of audit activities and thus contravene auditors' need to remain flexible. Internal auditors may therefore refrain from accepting CA as a suitable solution (Sun, 2012, pp. 59-85).

Missing organisational support

A proper level of support from senior management and all involved parties is crucial to guarantee the acceptance of CA (Vasarhelyi, Kuenkaikaew, Romero, 2010). The same is true about the willingness of employees outside the internal audit function to cooperate and assist in the implementation of the CA application (Khargi, 2010). As Hunton, Mauldin, and Wheeler (2009) found out, employees understand change as a threat. Especially when it comes to CA, personnel fears that the increased transparency over their activities brought to light by CA will have a negative impact on them. Thus, they are tempted to refuse support for the introduction of CA. Yet, companies need to address this fear to achieve the desired level of acceptance.

Reluctance among internal auditors to rethink auditing

CA requires internal auditors to question current auditing procedures and to adopt a new mindset. As Vasarhelyi, Teeter, and Krahel (2010, pp. 405-423) put it, CA comes with various changes, namely changes to the function of internal auditors within companies, changes to auditing technology, and changes to auditors' way of thinking regarding their attitude, their technical competences, and their behaviour. Moreover, they need to understand the steps necessary to support an effective CA process and thereby to meet corporate audit objectives (Aquino, Lopes da Silva, Vasarhelyi, 2015). Currently, auditors show confusion when it comes to adopting CA. Firstly, the differentiation between CA and CM is not entirely clear among auditors and other parties. Secondly, the new role of CA as a kind of meta control is not fully understood among auditors. Thirdly, internal auditors fear a loss of independence (Vasarhelyi, Teeter, Krahel, 2010, pp. 405-423).

Missing technical skills among internal auditors

The implementation of CA requires internal auditors to possess technical skills and experience in dealing with IT-based auditing (Zhao, Yen, Chang, 2004, pp. 389-400). However, not all internal audit departments employ dedicated IT auditors or auditors with extended technical skills (Braun, Davis, 2003, pp. 725–731). Vasarhelyi, Kuenkaikaew, and Romero (2010) argue that each internal auditor will need basic knowledge or skills of audit-aid technology and tools in the near future. Consequently, extensive training for auditors is found to be urgent (Moturi, Gaitho, 2014, pp. 1644-1654; Braun, Davis, 2003, pp. 725-731). These trainings should not be a one-time event, but should be held regularly and in various forms (e.g. individual mentoring, group learnings, online training) (Sun, 2012, pp. 59-85).

Performance limits of current IT systems

Performance of applications holding the audit subject can turn out to be a limiting factor when it comes to the usage of CA. For CA purposes, data is either extracted from a legacy system via reports and/or interfaces or analyses are run directly in the legacy system. Both methods occur at a high frequency. Workload for the legacy system is high and performance therefore declines. Older IT systems bear an increased risk of being unable to assist CA activities due to an insufficient performance level. Thus, IT capacities need to be increased in these cases (Khargi, 2010).

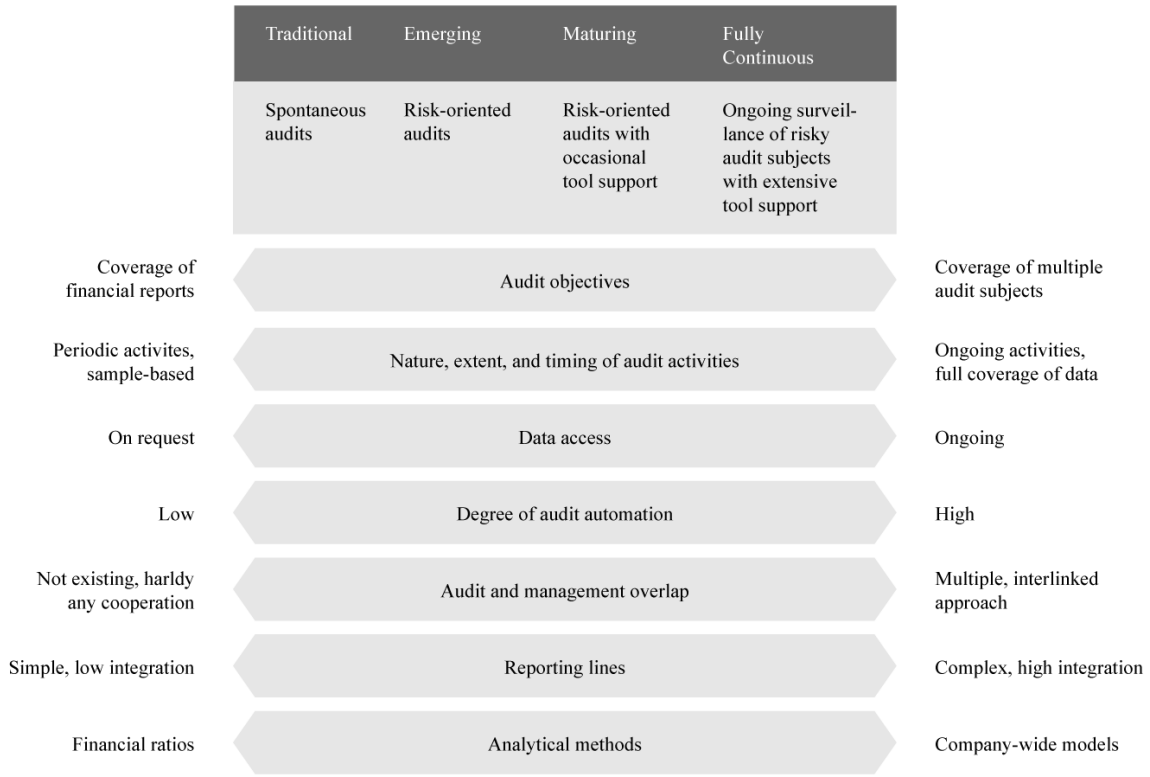
4.7 Continuous Auditing maturity model

Several authors agree in stating that CA leverages internal auditing to a higher maturity level due to its fundamental difference to traditional auditing and the far-reaching changes it imposes on both the internal audit function and the company as a whole. Yet, opinions diverge whether CA is to be understood as an auditing approach complementing or replacing traditional auditing. Einhorn and Einhorn-Schurig (2007, pp. 166-169) believe that CA can be applied as an additional approach delivering additional benefit. Chou and Chang (2010) argue that CA is most appropriate for specific auditing purposes (e.g. audit of web-based data), while they favour traditional (i.e. periodic) auditing for other purposes. Other authors (e.g. Chan, Vasarhelyi, 2011, pp. 152-160; Vasarhelyi, Alles, Kuenkaikaew, Littley, 2012, pp. 267-281) assume CA to be the ultimate maturity stage of internal auditing. In these cases, the underlying assumption is that the internal audit function of a company matures over time and becomes more and more sophisticated in its structures and processes.

CA theory mentions several maturity models to reflect this maturation process (e.g. Deloitte, 2010; Chan, Vasarhelyi, 2011, pp. 152-160; Vasarhelyi, Alles, Kuenkaikaew, Littley, 2012, pp. 267-281). These maturity models cover multiple stages, starting with uncoordinated audit activities in the first stage and ending with strictly structured, automated audit activities in the final stage. In this context, the internal audit function is assumed to mature over time and pass through the single stages of the model (Khargi, 2010). The models are similar to each other and differ only to a minor extent (e.g. by the exact number of stages). Yet, the model by Vasarhelyi, Alles, Kuenkaikaew, Littley (2012, pp. 267-281) offers the largest degree of detail and can therefore be considered as leading.

The figure below depicts the CA model by Vasarhelyi, Alles, Kuenkaikaew, Littley (2012, pp. 267-281), including its phases on the horizontal axis and its criteria on the vertical axis:

Figure 5: Continuous Auditing maturity model



Source: Own resource, based on Vasarhelyi, Alles, Kuenkaikaew, Littley, 2012, pp. 267-281

To determine the maturity of an internal audit function and its belonging to a specific stage, the authors use the following seven criteria:

Audit objectives

The objectives and the scope of auditing activities provide a strong indication about the maturity of an internal audit function. Traditional auditing includes a long-term plan which sets forth single audit activities aiming at obtaining assurance on financial reports. Other topics are merely covered. CA meanwhile aims at company-wide coverage of a range of audit subjects. Also, audit activities covering large data volumes are frequently found in CA. Focus also rests with the improvement of data quality.

Nature, extent, and timing of audit activities

The traditional audit approach includes periodic audit engagements as well as irregular, unscheduled audit engagements. Due to its nature, traditional auditing is centred on drawing meaningful samples from a defined population. Therefore, audit results largely depend on the sample and are distorted if sampling methods are applied inappropriately or simply by sampling bias. Also, audit results are obtained sometime after the event has occurred and therefore bear the risk of being obsolescent. Based on this time gap, unfavourable events may already have caused damage to the company without the auditor having the opportunity to counteract. CA, instead, occurs frequently or even follows a real-time frequency. It takes into consideration the full population and ensures 100% coverage of the audit subject. Audit reports are provided to the auditor immediately or shortly after the event's occurrence. The auditor can therefore act on short notice and resolve identified exceptions before they cause serious damage to the company.

Data access

The reputation of the internal audit function within a company largely determines the power it has over other departments and the extent to which it can push through its interest. Internal audit functions with limited internal power face the problem of having only limited access to required data. This can be a result of other functions refusing to provide access or granting access only after formal requests (with senior management involvement) have been posed. Under CA, the audit function comprises unlimited or almost unlimited access to all corporate data. If necessary, access to data can be granted on short notice and without much organisational resistance.

Audit automation

Traditional auditing makes only limited use of technology. For the most part, audit planning is done without IT assistance and audit activities are performed manually. Audit reports are typically stored in hard copy. The usage of technology generates large efficiency gains under CA and is therefore highly recommended. This IT usage is not limited to audit activities, but also covers audit planning at a previous phase as well as the audit documentation at a later phase.

Audit and management overlap

Apart from any regular (obligatory) reports of the internal audit function to management, the audit function operates independently from management under traditional auditing. Cooperation between these two parties hardly takes place and coordination of audit scopes or objectives

is rare. Under CA, audit activities go hand in hand with management's activities. Planning is largely harmonised, areas which are of less interest for management are preferably covered by the internal audit function. Due to this close integration, one function makes use of the other's results. Also, the audit function verifies management's activities.

Reporting lines

Under traditional auditing, reporting structures are comparably simple. The internal audit function is supervised by the finance function. Regular reporting is provided to senior management and the supervisory board. Under CA, activities by the internal audit function are largely coordinated with other audit-like functions such as risk management, compliance, and external auditing.

Analytical methods

Traditional auditing is centred on financial aspects. Thus, analytical methods mostly include the calculation of financial ratios. Other corporate areas (e.g. sales, purchasing, human resources) are subject to audit activities with less priority. In cases when these areas are indeed subject to audit activities, these are performed independently from other audit activities and are rarely interlinked. The situation is the complete opposite under CA. Financial topics are not necessarily the central audit subject. Instead, audit activities are spread over diverse topics and cover a wide range of areas. Audit activities are interlinked and complement each other in formulating an auditor's opinion. Analytical methods not only cover single indicators or ratios, but include company-wide models functioning as an early warning system.

Based on these criteria, internal audit departments are allocated to one of the following four phases:

1-Traditional

In the traditional phase, financial issues are in the primary focus of the internal audit department and single audit engagements are performed periodically (e.g. once per year). Also, audit activities are of a spontaneous nature and do not cover the requirements of management or other audit-like functions such as compliance, security, risk management etc. Audit activities are based on sampling, access to data is provided only on request. The degree of automation is comparably low.

2-Emerging

In the emerging phase, risk plays an enhanced role in the audit approach and the selection of audit subjects occurs in a more balanced manner. Increasingly, the internal audit function makes use of multi-year audit plans and detailed annual plans. Cooperation and/or coordination with management is fostered. In addition to financial issues, other departments such as purchasing, sales, or human resources are subject to audit engagements. Furthermore, compliance requirements become more and more subject to audit activities.

3-Maturing

In the maturing phase, risk focus of the internal audit department is high. Audit engagements follow a formalised procedure and are well-balanced in regard to chosen audit subjects. Occasionally, IT tools are used (e.g. for evaluating transactions or authorisations). Audit subjects are determined in close cooperation with management. Furthermore, the internal audit function has continuous access to key IT systems. Audit findings are increasingly based on processes and control tests as well as on analytical audit procedures.

4-Fully Continuous

In the fully continuous phase, CA is applied across a wide range of audit subjects. Audit activities are carried out continuously and are strongly supported by audit software. The internal audit function is granted permanent access to all essential IT systems. Tests are not based on sampling any longer. Instead, a full examination is carried out, in which 100% of the data population is validated. Audit cycles are short, so audit results are available immediately after the audit's completion.

In literature, the CA adoption level is often referred to by the terms 'low', 'medium', and 'high'. Applied to the CA maturity model, companies which find themselves between phases '1-traditional' and '2-emerging' are considered to feature a low adoption level. Companies which find themselves between phases '2-emerging' and '3-maturing' are considered to feature a medium adoption level. Companies which find themselves between phases '3-maturing' and '4-fully continuous' are considered to feature a high adoption level.

4.8 Degree of adoption

In 2013, Littley framed the question: “If you’re travelling down a path that never reaches its destination, would you stay on the same path or would you try a different approach? It’s a question worth asking, especially when it comes to CA.” With this statement he hits the nail on the head as, despite a very intense debate around the topic of CA, practitioners struggle with its implementation. A lot of research has been undertaken to find out how far companies have adopted CA. However, results differ considerably from each other and do not provide a clear picture about the degree of CA adoption.

At a general level, several authors find CA adoption to be low. Garrido (2011, pp. 83-90) finds that CA is extensively discussed in theory, but is not yet present in practice. Also Lin, Lin, and Liang (2010, pp. 415-422) conclude that CA has not been widely applied so far. Omoteso, Patel, and Scott (2008, pp. 23-44) point out that auditors and their clients are simply not yet ready to use CA. Searcy, Woodroof, and Behn (2003) conducted a survey among assurance partners of BIG4 accounting companies (i.e. PwC, KPMG, EY, and Deloitte). Similar to other academics, they find that companies still need to make considerable efforts to achieve a full CA implementation. The professional association ISACA (2002) concludes that CA is nothing more than an unrealised dream for many companies.

Contrary to these opinions, Shin, Lee, and Park (2013, pp. 592-627) find evidence that CA has already been implemented in the financial industry and the manufacturing industry. Also Hua concludes that the popularity of CA in China is growing (Hua, 2007).

To analyse the CA adoption rate in greater detail, a range of studies has been conducted by academics, institutions, and auditing companies over the last 15 years. An overview of these studies is provided in the following table. The degree of adoption thereby represents an interpretation by the author based on the extent to which companies have CA fully or partially implemented and to which preparations have been started.

Table 5: Previous studies about CA adoption

Researcher	Year	Findings	Found degree of CA adoption
PwC	2006	50% of surveyed companies use CA techniques, 31% have already made plans to implement CA.	High
Galvanize/IIA	2008	30% of surveyed companies are using a form of CA, 15% are planning to implement CA in near future.	High
Grant Thornton	2011	Approximately one third of all respondents performs CA.	Medium
KPMG	2011	7% of surveyed companies have embedded CA, 28% are in the process of implementing CA. 38% have considered, but have not started implementing CA.	Medium
Gonzalez, Sharma, and Valletta	2012	Only few companies have CA fully implemented.	Low
Vasarhelyi, Alles, Kuenkaikaew, and Littley	2012	Most companies find themselves between stages '1-traditional' and '2- emerging'.	Low
Tumi	2013	CA is rarely used.	Low
Moturi and Gaitho	2014	Most state departments are preparing to advance from traditional auditing to CA.	Low
Vasarhelyi, Kuenkaikaew, Littley, and Williams	2015	All surveyed companies are between the traditional and the emerging stage.	Low

Source: Own resource

The first larger scale analysis was performed by the auditing company PwC among a sample of 392 U.S.-based companies in 2006. They found out that 50% of all companies used CA techniques and 31% had already made plans to implement CA in the near future. Thus, they concluded that 81% were at least positive towards CA (Alles, Tostes, Vasarhelyi, Riccio, 2006, pp. 211-223; CaseWare, 2008).

In their study of 2008 covering 305 companies, the software company Galvanize (formerly known as ACL) and the IIA concluded that the use of CA in practice is widespread. They found that 30% of companies were using a form of CA, while another 15% had planned to start with the CA implementation the following year. From those companies using a form of CA, 57% of respondents had a quarterly CA cycle in place, 34% utilised monthly CA-based monitoring activities, and 9% had focused on daily applications of their CA processes (CaseWare, 2008; McCann, 2009).

In 2011, the auditing company Grant Thornton carried out a survey among CAEs and noted that approximately one third of all respondents performed CA. However, they also found that almost half of all CAEs saw their time commitment to CA increasing over the following twelve months (Stippich, 2011).

A survey by auditing company KPMG in 2011 revealed that only 7% of the companies had embedded CA (in form of real time alerting and follow up) in their audit departments. Another 28% found themselves in various stages of implementing CA. 38% had considered, but had not started implementing CA. The remaining 27% of the population had not come across CA and was thus unaware of the topic (Xie, 2012).

In their article of 2012, Gonzalez, Sharma, and Valletta (pp. 248-262) primarily deal with the antecedents of CA, but also analyse the extent of usage of CA. By performing a regression analysis based on global data, they found that only few companies had CA fully implemented. Additionally, they found that the usage of CA was affected by the perceived ease of use and social pressure. While North American internal auditors were more likely to use CA due to soft social pressure from peers and higher authorities, Middle Eastern internal auditors were more likely to use CA if it is mandated by higher authorities.

Vasarhelyi, Alles, Kuenkaikaew, and Littley (pp. 267-281) also dealt with this issue in 2012 and, amongst other topics, analysed the state of adoption of CA systems by internal auditors. At a general level, the authors concluded that most companies which had participated in their survey found themselves between stages ‘1-traditional’ and ‘2-emerging’ regarding the level of CA adoption. Given this observation, they concluded that the perceived usefulness of CA was low and did not provide additional benefits over other audit methodologies.

In 2013, Tumi (pp. 2-10) investigated on a larger scale whether auditors in Libya were making use of CA. As a result, he concluded that CA was rarely used.

Moturi and Gaitho (pp. 1644-1654) analysed in 2014 to what extent CA was being used among public sector organisations in Kenya. They found that most state departments were changing their behaviour and that they were preparing to advance from traditional auditing to CA.

In another study featuring U.S.-based companies in 2015, Vasarhelyi, Kuenkaikaew, Littley, and Williams concluded that all participating companies were between the traditional and the emerging stage. Thus, they did not find a significant change in the CA adoption level in comparison to their study of 2012.

In 2015, Sun, Alles, and Vasarhelyi (pp. 176-204) also conducted an analytical comparison between the CA adoption level in the U.S.A. and China. They found that, compared to the U.S.A., fewer companies made use of CA and elements of CA were less frequently applied in China. They concluded that the excessive government intervention in business, the lack of competition, the lack of independence of internal auditors, the smaller support from management, and the absence of CA-specific regulations in China were the main factors causing this difference.

4.9 Critical appraisal to Continuous Auditing

This chapter aims to provide a very detailed picture of the current state of research of CA and is based on a large number of articles of scientific journals, books, and conference proceedings. Yet, it cannot be entirely guaranteed that all pieces of literature covering CA are incorporated in this thesis. Thus, limitation for this chapter include the following:

- Alongside the elements discussed, literature provides even further definitions, subjects, benefits, and barriers. Due to relevance reasons, these are not covered in this chapter.
- Beyond those synonyms mentioned in this chapter, there are most certainly further synonyms present in literature and in the practical field. As the discipline of CA finds a lot of names in practice, scientific articles covering CA (but not using the term ‘CA’) are not included in the discussions of this thesis.

- While CM is presented to be at the same level of CA in some research articles, others consider it as a further subdiscipline of CA. Distortion therefore arises as it is unknown how authors of single CA articles understand the relationship of CA and CM in detail.
- Methodological and technological aspects mentioned in this chapter represent the most popular points of discussion. Yet, there are further elements not covered in this chapter due to their irrelevance for this research.
- The cycle approach to implement and maintain CA models is one example for how CA can be brought to life. Other approaches and model are discussed in literature, but are not covered in this chapter due to their limited relevance to this research.
- Alongside the presented EAM and MCL architectures, other architecture types can be found in literature. The ones presented in this chapter represent the most relevant ones for this thesis.
- The presented benefits and barriers aim to provide a picture as complete as possible. Yet, it cannot be guaranteed that all potential benefits and shortages are covered.
- The CA maturity model presented in this chapter represents the one model best matching to the purposes of this research. As mentioned above, there are further models existing which can be used to measure the level of CA adoption. As these models do not have an impact on the further progress of this thesis, they are not discussed in further detail.
- This chapter aims to provide a complete picture of empirical research about CA adoption. Despite very careful analyses, it cannot be ruled out that further investigations about the adoption level of CA exist.

5 RESEACH MATERIAL AND METHODS

This chapter brings forward four research dilemmas identified on the basis of the research objectives. Research questions and hypotheses are derived from the dilemmas. A preliminary research is performed to explore further details about CA and to specific hypotheses. Finally, the design of the entire research is explained.

5.1 Research dilemmas and research questions

As outlined in chapter 1, this research covers two research objectives, the first one of which is as follows:

> **RO_A**: To identify and analyse the current status of CA adoption among German internal audit departments

Along with RO_A, chapter 1 presents a second research objective which is as follows:

> **RO_B**: To discover the reasons behind the current CA adoption level

Main research A aims at providing answers to research question RO_A, while main research B addresses research RO_B. The overall research approach for both main research A and main research B is derived from the scientific research process outlined in chapter 2.

In respect to RO_A, the CA-specific literature review in chapter 4 brings forward three research dilemmas and thereby raises several research questions and hypotheses.

Dilemma 1

As discussed in chapter 4.8, evidence regarding the adoption rate of CA is inconclusive on an overall level. On the one hand, several researchers have found evidence that the CA adoption rate is high. PwC carried out a research among 392 U.S.-American companies across all industries and found that 81% of companies were at least positive towards CA. ACL and the IIA analysed 305 organisations worldwide and found that approximately 45% of their surveyed companies had implemented CA or were in the process of implementing CA. Grant Thornton interviewed CAEs of U.S.-American companies across multiple industries and discovered that

approximately one third of their sample applied CA. One the other hand, other researchers conclude that the overall adoption rate of CA is low. KPMG finds that only 7% make full use of CA. Gonzalez, Sharma, and Valletta validated the usage of CA among different regions of the world and concluded that only a few companies had CA fully implemented. Also, Vasarhelyi, Alles, Kuenkaikaew, and Littley see most of their surveyed companies between stages '1-traditional' and '2-emerging', indicating a low adoption level.

As indicated, the aforementioned investigations exhibit a strong focus on the U.S. market. Few research articles concentrate on specific countries (e.g. China, Libya) (e.g. Hua, 2007; Tumi, 2013, pp. 2-10) or have a global focus (e.g. Gonzalez, Sharma, Galletta, 2012, pp. 248-262). Explicit findings regarding the adoption of CA in Germany are not present. The first research question therefore is:

***Q_1**: What is the overall CA adoption rate among German internal audit departments?*

Although empirical evidence is ambiguous, there is a tendency towards a low adoption rate due to three reasons:

1. On a purely quantitative basis, a higher number of researchers (of those presented in chapter 4.8) expresses a pessimistic view at the adoption rate.
2. Three out of four researchers (i.e. PwC, KPMG, and Grant Thornton) who have found a high or medium adoption rate are not primarily active as research institutes, but represent auditing companies with economic interests. The objectivity and explanatory power of their results are therefore impaired.
3. As outlined in chapter 2, German internal audit departments are similar to their U.S.-American counterparts when it comes to their structure, their objectives, and their strength within companies. Thus, it can be assumed that the CA framework conditions for the usage of CA between the U.S.A and Germany yield a high similarity.

Based on these reasons, it can be assumed that the CA adoption rate among German internal audit departments is low. Applied to the CA maturity model presented in chapter 4.7, German internal audit departments are assumed to find them themselves in a stage not higher than '2-emerging'. The first hypothesis for this research therefore is:

***$H_{1\text{-}1}$**: The overall CA adoption rate among German internal audit departments is low.*

A general weakness prevails when it comes to the understanding of the term CA. When evaluating the adoption level of CA, having in place a common understanding of CA is of the utmost importance. If a common understanding is missing, there is the risk that the research topic cannot be outlined clearly and later research activities will be distorted.

CA theory offers a range of different definitions of CA. These cover different elements or feature different viewpoints. Many definitions are of academic nature and deliver only little benefit to practitioners. Although the definition of CA by CIPA and AICPA (1999) is the most substantial one, it is lengthy and requires from the reader a thorough understanding of the context. The practical usefulness of this definition is therefore questionable. The same also applies for various other definitions introduced in chapter 4.1.

Moreover, many other terms exist in literature which are very similar, if not equal to CA (e.g. continuous auditing and reporting, data-oriented online auditing, continuous online auditing, continuous process auditing). The distinction between these terms and CA are not always clear and thus leave practitioners puzzled. Even when talking about Continuous Monitoring, the relation to CA is seen differently across several academic articles.

To obtain a deeper understanding of how CA is understood in practice, it needs to be validated what practitioners actually mean when they talk about CA.

Dilemma 2

As discussed in chapter 4.3, CA can be applied to several subjects. Risks and controls are the prime subjects validated with CA, but also transactions or data are popular subjects of CA. Even corporate projects or activities by a third party (e.g. suppliers) are occasionally found to be subject to CA. Yet, there is no scientific research which investigates the degree of CA adoption and accounts for different CA subjects at the same time. Instead, existing research articles utilise the multifaceted nature of CA and consider CA as one large discipline. The second research question therefore is:

***Q_2**: In how far does the CA adoption rate differ among different CA subjects?*

To answer this question, it is necessary to determine relevant CA subjects which can be compared. However, present literature does not deliver a complete list of possible CA subjects.

Also, there is a lack of clarity regarding the nature of CA subjects. While some researchers use general terms (e.g. data), others are more specific (e.g. financial transactions).

On a qualitative basis, the subjects ‘risks’, ‘controls’, ‘data’, and ‘transactions’ are addressed most frequently in literature. These correspond suitably to the three CA subdisciplines Continuous Risk Management and Assessment, Continuous Controls Monitoring, and Continuous Data Assurance brought forward by Vasarhelyi (2011, pp. 23-29), with the subjects ‘data’ and ‘transactions’ being combined under the roof of Continuous Data Assurance. Therefore ‘risks’, ‘controls’, ‘data’ are considered as relevant CA subjects for the further research.

As there is hardly any empirical evidence regarding the subject-specific adoption rate, it is difficult to establish hypotheses indicating a specific trend to either direction (low adoption rate vs. high adoption rate).

Moreover, there needs to be certainty about other potential CA subjects (e.g. projects, third parties). These are mentioned by only few authors. Thus, from current research it cannot be taken for granted that these represent true CA subjects.

To overcome these shortages and suitably address Q_2, more information needs to be collected at first.

Dilemma 3

The review of CA-related literature did not bring to light any scientific research which validate whether the CA adoption rate is dependent on company-specific or internal audit function-specific parameters. Yet, literature implies that a certain composition of companies and their internal audit function supports the adoption of CA. Thus, the third research question is:

> ***Q_3**: In how far is the CA adoption rate influenced by company-specific or internal audit function-specific parameters?*

To approach this questions, suitable company-specific or internal audit function-specific parameters need to be defined. From the previous literature review, the following parameters can be derived:

Level of regulation

As discussed in chapter 4, the level of regulation a company is exposed to represents one company-specific parameter. In this context, CA was found to be a helpful approach to comply with regulatory requirements imposed on companies. Thus, CA is used to a higher extent in companies which are subject to increased regulation. CA also enhances information security, fosters internal and external communication, and increases investors' confidence. All three of these characteristics can typically be found in companies subject to higher regulation.

Research by Khargi (2010) and KPMG (2011) found that CA adoption is more extensive in the financial sector (compared to the industry sector) due to higher regulation. Also, companies from the energy industry (which are often state-run) are exposed to increased regulation. Consequently, it is assumed that companies from these industries apply CA more extensively. For the purpose of this research, banks and other financial institutions as well as energy companies are regarded as highly regulated companies.

Degree of IT expertise within the internal audit function

CA deals with a large amount of information and data, so the use of sophisticated CA software is necessary for efficiency reasons. For this, a certain level of IT expertise among internal auditors is necessary. As pointed out in the previous chapter, missing technical skills is among the core shortages when it comes to the introduction of CA. At the same time, CA was found to assist in integrating and enhancing technology. In line with this, Abdolmohammadi and Sharbatouglie (2005) found that CA is increasingly being used at companies rich in technology. Thus, it can be assumed that CA is increasingly being used by companies with an increased number of auditors possessing IT expertise.

Further company-specific or internal audit function-specific parameters are hard to make out by a pure analysis of present literature. Also for this research question, further details need to be gathered.

Dilemma 4

In respect to RO_B, the CA-specific literature review in chapter 4 brings forward another research dilemma. As discussed in chapter 4.8, several researchers have found that the CA adoption level among internal auditors is low. Also, researchers have found a range of negative factors which

potentially restrict companies in their decision to apply CA (see chapter 4.6). These reasons are listed below:

- Corporate data is mostly heterogeneous and unspecific and thus not suitable for CA
- Costs and time resources for implementing and maintaining CA are too high
- Auditors fear that CA disrupts their audit plans
- IT-supported CA activities are feared to be too rigid
- Sufficient organisational support is missing
- Internal auditors are reluctant to rethink auditing
- Internal auditors lack of technical skills
- CA makes current IT systems reach performance limits

However, the findings from the literature review offer only limited help when it comes to the strength of single compromising factors. Dedicated research investigating the strengths of reasons restricting CA adoption is non-existent, especially regarding internal audit departments of German companies. Given the large number of these factors, it is difficult for practitioners to identify the most relevant factors and use them constructively. The fourth research question can therefore be formulated as follows:

Q_4: *What factors primarily cause companies to refrain from adopting CA?*

Validating all potential compromising reasons for their effect on companies' decision regarding the adoption of CA is neither reasonable, nor feasible within the scope of this thesis. Thus, a more consolidated approach represents the better alternative. For better manageability throughout the further process of this research, the compromising factors mentioned above will be grouped. As a result, the factors are allocated to the following five factor groups:

Table 6: Groups of compromising factors

Factor group	Description of factor group	Allocated compromising factors
Framework conditions	Weak framework conditions (e.g. high boundaries for implementation, stable processes, rapidly changing environment)	• IT-supported CA activities are considered too rigid. • CA makes current IT systems reach performance limits.
Skills	Low level of technical and functional knowledge or other form of experience among auditors	• Internal auditors are reluctant to rethink auditing. • Internal auditors lack of technical skills.
Results	Imprecise results of CA (i.e. results do not provide enough audit information)	• Corporate data is mostly heterogeneous and unspecific and thus not suitable for CA. • Auditors are concerned that CA disrupts their audit plans.
Resources	Unreasonable effort required to implement and maintain CA (in terms of costs, time, and other resources)	• Costs and time resources for implementing and maintaining CA are too high.
Support	Missing/limited management or organisational support	• Sufficient organisational support is missing.

Source: Own resource

To validate whether these factor groups have a significant impact on companies' decision not to adopt CA, the following hypothesis is postulated:

> ***H*$_{4\text{-}1}$**: *Factor groups 'framework conditions', 'skills', 'results', 'resources', and 'support' have a significantly negative influence on the adoption of CA.*

5.2 Preliminary research

To overcome the identified shortages in Q_1, Q_2, and Q_3, the overall research is supplemented by a preliminary research. It is of exploratory nature and aims at collecting information to allow a further specification of research activities. The preliminary research is divided into four different stages. It starts with the definition of the specific research questions in stage 1 which build the foundation for the preliminary research. The description of the research design in stage 2 details how data was retrieved and how the research was done. Stage 3 elaborates on the

conduction of the research and presents the results. Stage 4 is the conclusion and the discussion of impact that the preliminary research has on further research activities of main research A.

5.2.1 Research questions

The prime intention of the preliminary research is to explore the topic of CA in practice, beyond any information found in the literature. The risk of distortions in later research results is thereby minimised. The preliminary research pursues the following three objectives:

1) Given the range of definitions and the far-reaching extent of CA, it is questionable whether practitioners have the same understanding of CA. This preliminary research therefore aims at clarifying what practitioners mean when they talk about CA.
2) This preliminary research aims at validating the aforementioned CA subjects. It is supposed to identify a trend regarding the CA adoption rate of known subjects (i.e. risks, controls, data), so specific hypotheses can be developed. Also, information will be collected to detect further CA subjects and to substantiate the nature of seldom CA subjects (i.e. projects, third parties).
3) Alongside the level of regulation and the degree of IT expertise within the internal audit function, the preliminary research will try to identify further company-specific or internal audit function-specific parameters the CA adoption rate depends upon.

The outcome of the preliminary research will include a distinct definition of CA. Also, results will help to phrase further hypotheses to validate research questions Q_2 and Q_3. The preliminary research itself comprises three research questions:

Q_{P1}: How is CA understood in the practical field?

Q_{P2}: What subjects is CA being used for?

Q_{P3}: What company-specific or internal audit function-specific parameters can CA best be applied under?

The research design will be based on these research questions. In contrast to the research process described in chapter 2, particular hypotheses for this preliminary researched are not being set up.

5.2.2 Research design

As previously discussed, internal auditors represent the primary user group of CA. Therefore, internal auditors are chosen as target group for this preliminary research. Data will be collected via qualitative interviews with members of the internal audit functions from eight German companies from five industries (3x Information and communication, 2x Finance and insurance, 1x Manufacturing, 1x Trade, and 1x Other services) located across Germany. Based on a convenience sampling approach, these companies have been in regular contact with the researcher on a professional level and were addressed directedly by the researcher to verify their willingness to participate in the study.

The interviews will be carried out in an open format, meaning that only the three research questions will be communicated to the interviewees in a straightforward manner. Other questions posed by the researchers will be a spontaneous result out of the discussions with the interviewees. Due to its qualitative nature, a questionnaire with a set of specific questions is not being applied.

The interviews will be carried out by two interviewers, with the lead interviewer managing the discussion and the assistant interviewer taking notes. The interviews are planned to last approximately one hour each and will be conducted at the premises of the companies.

5.2.3 Research conduction and results

As preparation for the interviews, an interview guideline was developed and discussed between the lead researcher and the assistant researcher to have a common understanding about the setup of the interviews and the division of roles (i.e. interview is led by lead researcher, notes are taken by assistant researcher). The interview guideline established the structure for the interviews and included the three research questions as well as several other elements. The full guideline is provided in appendix 2. A trial run was performed between the lead researcher, the assistant researcher, and a third person (acting as interviewee) before the interviews.

The interviews were conducted over a total time period of nine weeks in accordance with a previously establish time plan. The researchers paid careful attention to using the same wording in all eight interviews in order to prevent distortions. For the same reason, the concept of CA

was not introduced to the interviewees before the interviews. However, a brief introduction about the nature and the intent of the interview was given at the beginning of each interview.

In each of the eight companies, an internal audit function was in place as a separate unit and was headed by one manager acting as CAE. Of these eight companies, three companies claimed to make full or partial use of CA, while the five other companies claimed not to have implemented CA. In two cases, the interviews were carried out with the CAE alone and in six cases with the CAE and an additional senior internal auditor.

Responses to the three research questions provided by the interviewees are summarised below:

Responses to Q_{P1}: Understanding of CA

The interviews brought to light that CA is understood in very different ways. Although all eight respondents understand it as a form of auditing technique, the provided explanations varied significantly and hardly matched the academic definitions mentioned above. None of the respondents was able to summarise the definition of CA in one sentence. Instead, all of them quoted elements of CA (e.g. automated journal entry tests, tool-assisted analyses of authorisations in IT systems, automated status updates of companies' projects) without explicitly referring to CA as an independent discipline. Five of them (62.5%) also noted that single elements of CA had been known to them or had even been in place in their organisations for several years, but have not been understood as being part of CA. Two respondents (25%) saw CA as part of related meta topics (i.e. big data and digitalisation) and understood the latest growth in popularity of CA as a side effect of the meta topics' hype.

For six respondents (75%), IT plays an essential role when it comes to the application of CA with four respondents (50%) seeing IT as the central element of the methodology and two respondents (25%) understanding IT as a significant, but not yet a mandatory part of CA. One respondent (12.5%) considers CA as "the sum of tools used to analyse data on an ongoing basis". For this respondent, CA is seen as a means of technical assistance for a given (i.e. traditional) audit methodology. Yet, another respondent (12.5%) sees CA as a means of assisting in gathering information, not so much as sole methodology or combination of tools.

All respondents consider CA as a supplement to their current audit approach. A willingness to fully rely on CA as a one and only audit approach was not shown by any of the respondents.

While six respondents (75%) consider the importance of CA for their organisation to remain at a similar level as today or to even increase over the next five to ten years, two respondents (25%) expect the importance of CA for their company to decrease over the next five to ten years. One of these two respondents considers CA as "a trend which will come and go as many other data-related topics have before".

Responses to Q_{P2}: Audit subjects

Seven respondents (87.5%) consider finance as the primary field of application due to the high importance of this field to their companies. Also, the fields of purchasing, sales, human resources and IT are considered suitable for being monitored by CA. The respondents argued that these fields were considered as standardised and thus easy to oversee and/or that they exhibited a broad understanding of these fields from previous audit activities.

Four respondents (50%) think of CA as an approach which assists them in their risk management-related activities (i.e. identifying risks and input for audit universe, assessing changes to present risks, finding the right response to risks). Three respondents (37.5%) find CA suitable for evaluating the design and/or the proper functioning of controls (i.e. monitoring performance of controls in finance and human resources, assigning responsibility to control owners). Data (i.e. transactions, journal entries, incident tickets, IT authorisations) was mentioned by five respondents (62.5%) to be analysed by CA.

Two respondents (25%) also mentioned that they see CA as a means to monitor progress during the implementation of projects within their companies (i.e. status of milestones, completion rate of work activities). One respondent (12.5%) also finds that CA is a useful methodology on a program management level (in this case program is understood as the sum of all corporate projects).

Other CA subjects were not mentioned explicitly. Third parties as another subject was neither mentioned by anyone, nor did respondents confirm this subject's applicability to CA upon the lead researcher's explicit request.

Responses to Q_{P3}: Internal audit function-specific or company-specific parameters

A range of internal audit function-specific or company-specific parameters were mentioned by the respondents.

Internal audit function-specific parameters

Five respondents (62.5%) claimed that the experience of the internal auditor is of significant importance. Out of these five respondents, three (37.5%) said that internal auditors needed to be knowledgeable about the subject to be analysed by CA, four (50%) said internal auditors needed to have sufficient IT skills, and one (12.5%) said that internal auditors needed to be methodologically strong.

Five respondents (62.5%) see CA as a totally new methodology and assume the introduction of CA to be a very complex undertaking. They emphasised that monetary funds needed to be provided to bring CA into life. Two out of these five respondents (25%) see an additional need for freeing up capacities (i.e. time, personnel resources) within the IA function.

Two respondents (25%) mentioned that the comparably small size of their audit department increased the need for CA, implying that they regard CA as an audit approach which is more efficient than their current one. Contradictorily, two other respondents (25%) made it clear that CA cannot be successfully implemented if the size of the department was too small to guarantee a minimum level of support.

Company-specific parameters

One respondent (12.5%) commented that the size of the companies was a decisive factor. He pointed out that a specific size had to be reached before CA provided any benefits. Smaller companies were too unstable and subject to unforeseen changes too frequently and thus not capable of running a CA system which requires a solid design of organisational structures and processes. Similarly, but without explicit reference to the company's size, three other respondents (37.5%) stated that the internal environment of the company needed to be flexible and supportive. Management needed to assist during the implementation and ongoing maintenance of CA models. Also, corporate structures needed to be stable over time and responsibilities needed to be clearly assigned.

The same respondent (12.5%) also noted that the level of internationalisation triggers the usage of CA. He thereby assumed that companies active in a range of countries with responsibility spread across the globe (in comparison to companies which are active in only one regional market) were more difficult to oversee from an audit perspective. He reasoned that geographical distances were far and cultural difference were large. Thus, CA enabled audit departments to

identify deviations from regulations more easily and to better obtain assurance across several locations. This view was shared by another respondent (12.5%) who said that she intended to use CA for monitoring activities in other subsidiaries due to her limited travel budget.

Two respondents (25%) stressed the importance of IT and noted that the company needed to be positive towards IT. While one respondent reasoned that IT systems needed to be in place to enable CA, the other stated that the company as a whole needed to be culturally open towards IT.

One respondent (12.5%) also mentioned that CA was most appropriate for companies that are subject to increased regulatory requirements as it helps to streamline auditors' activities during the process of fulfilling requirements imposed by the Sarbanes-Oxley Act, the ISO 31000 norm as well as by other industry-specific regulations (e.g. BAIT).

5.2.4 Conclusions from preliminary research and hypotheses

The findings from the preliminary research reveal the following conclusion:

Regarding Q_1, answers given to Q_{P1} show that CA is a topic difficult to narrow down to a succinct definition. The interviews showed uncertainty among respondents whether they had CA in place or not. This circumstance creates a risk for the main research A and main research B when it comes to collecting data to evaluate the CA adoption rate. Due to an unclear understanding of CA, there is the risk that respondents (to be addressed during later research activities) provide incorrect replies. To mitigate this risk, two aspects will be incorporated into the designs of both main research A and main research B:

1. A comprehensible explanation of CA will be provided to all respondents. Also, wherever possible, the authors own definition of CA (see chapter 4.1) will be presented to respondents to ensure that a common understanding is present.
2. Examples and elements of CA will be used increasingly when respondents are being interviewed.

$H_{1\text{-}1}$ will remain as formulated above.

Regarding Q_2, answers to Q_{P2} support findings by other researchers that 'risks', 'controls', and 'data' can be considered as prime CA subjects. Additionally, results show that 'projects' can be considered as a further CA subject which is in line with statements made by Sharbatoghlie and Sepehri (2009). Interestingly, this subject addresses an area hardly mentioned in any of the other articles discussed above. As this subject is unexplored to a large extent, it will be covered in the further progress of this research.

However, the preliminary research did not provide any further insight regarding the popularity of single subjects and the extent to which they are being applied. Thus, it is difficult to bring forward a specific assumption regarding the level of adoption when it comes to single subjects (e.g. high adoption rate vs. low adoption rate). Yet, the preliminary research makes clear that CA is regarded in a more differentiated way in the practical field. Not only does the preliminary research show that the adoption rates of single CA subjects most likely vary from the overall CA adoption rate, it also provides an indication that the adoption rates of single CA subjects vary among each other. For Q_2 it can therefore be hypothesised that:

> ***$H_{2\text{-}1}$**: The adoption rates of CA subjects 'risks', 'controls', 'data', and 'projects' significantly differ from the overall CA adoption rate.*

Regarding Q_3, replies to Q_{P3} back up the previous discussion surround company-specific or internal audit function-specific parameters. They provide support that increased regulation relates to an increased usage of CA. Also, the need for a high IT affinity mentioned in the preliminary research is in line with the aforementioned findings from theory. Moreover, the given answers to Q_{P3} shed light on three further parameters:

The ***size of the internal audit department*** is found to be related to the degree of CA adoption. However, results from the preliminary research are ambiguous. On the one hand, small internal audit departments with only few auditors feel pressure to use CA as a result of scarce personnel resources. Thus, companies with small internal audit departments preferably make use of CA. On the other hand, a critical size of the internal audit department is required to conduct CA efficiently. This assumption results in high CA adoption in firms with many internal auditors. Yet, the preliminary research also indicates that experience among auditors and available resources are necessary for successful CA adoption. Both paraments are present in larger internal

audit departments. Therefore, it can be concluded that CA is preferably used by larger internal audit departments.

Similar to the size of the internal audit department, CA also corresponds with the ***size of the company***. For this parameter, however, provided answers clearly point out that the usage of CA is more likely when the company is larger.

Results from the preliminary research show that the need to govern and control business activities increases with the increasing ***geographical expansion of a company***. Therefore, it is assumed that there is a positive relationship between the degree of internationalisation and the adoption of CA. This finding is backed up by the findings of Consider (2011) who concludes that there is an increased need for CA-based monitoring of decentralised units due to an increased risk of fraud.

Combining gained insights from the literature review and the preliminary research, the following company-specific and internal audit function-specific parameters were identified:

Company-specific parameters

- Level of regulation a company is exposed to
- Size of a company
- Geographical expansion of a company

Internal audit function-specific parameters

- Degree of IT expertise within the internal audit function
- Size of the internal audit department

As a result, the following two hypotheses are postulated:

> ***$H_{3\text{-}1}$:*** *The CA adoption rate is significantly influenced by the company-specific parameters 'level of regulation', 'size of company', and 'geographical expansion'.*

> ***$H_{3\text{-}2}$:*** *The CA adoption rate is significantly influenced by the internal audit function-specific parameters 'degree of IT expertise within IT audit function' and 'size of internal audit department'.*

Although not explicitly addressed by any of the research questions, the preliminary research backed up findings from the preliminary research discussed under dilemma 4. Three internal auditors quoted that the initial implementation of CA required a high level of cost and time. Also, two auditors mentioned that digitalisation of their structures and processes had not advanced far enough to enable data to be provided on an ongoing basis. Two companies lacked the necessary monetary funds to finance the acquisition or development of an IT system to support CA. In one case the auditor saw the internal audit function of his company as not experienced and knowledgeable enough to tackle the challenges accompanying the implementation and maintenance of CA (e.g. lacking experience with specialised IT systems). Due to these findings, $H_{4\text{-}1}$ will remain unchanged.

In conclusion, a total of five hypotheses was developed to answer four research questions (allocated to main research A and main research B). These are shown in the following table:

Table 7: Dilemmas, research questions, and hypotheses

Main Research A - Current status of CA adoption
Dilemma 1: No clear indication regarding level of CA adoption in practice
Q_1: What is the overall CA adoption rate among German internal audit departments?
H_{1-1}: The overall CA adoption rate among German internal audit departments is low.
Dilemma 2: No scientific findings covering subject-specific levels of CA adoption
Q_2: In how far does the CA adoption rate differ among different CA subjects?
H_{2-1}: The adoption rates of CA subjects 'risks', 'controls', 'data', and 'projects' significantly differ from the overall CA adoption rate.
Dilemma 3: No scientific findings regarding the effect of company-specific or internal audit function-specific parameters on CA adoption
Q_3: In how far is the CA adoption rate influenced by company-specific or internal audit functi-on-specific parameters?
H_{3-1}: The CA adoption rate is significantly influenced by the company-specific parameters 'level of regulation', 'size of company', and 'geographical expansion'.
H_{3-2}: The CA adoption rate is significantly influenced by the internal audit function-specific parameters 'degree of IT expertise within IT audit function' and 'size of internal audit department'.
Main Research B - Current status of CA adoption
Dilemma 4: No scientific findings regarding strength of factors compromising the application of CA in practice
Q_4: What factors primarily cause companies to refrain from adopting CA?
H_{4-1}: Factor groups 'framework conditions', 'skills', 'results', 'resources', and 'support' have a significantly negative influence on the adoption of CA.

Source: Own resource

The hypotheses were tested in accordance with the research design described in the next sub-chapter.

5.3 Research design

As discussed above, the overall research approach covers two areas of research. Main research A can be considered as qualitative, confirmatory research. Data was collected via a questionnaire which was distributed among internal auditors of German companies who form the main target group of CA. The questionnaire covers a total of 25 closed-ended questions and is split into three parts.

The first part has 17 questions which, in sum, address $H_{1\text{-}1}$ and thus aim to find out the overall degree of CA adoption. To allow a distinct testing of hypothesis $H_{2\text{-}1}$, each question is allocated to a group corresponding to the CA subjects (i.e. ‘controls’, ‘risks’, ‘data’, ‘projects’) or to a fifth group called ‘general’. The allocation to the CA subject’s groups occurred evenly as all four groups include three questions each. The group ‘general’ holds five questions. In line with the findings from the preliminary research, single questions do not address CA explicitly, but pick up characteristics of CA.

In order to avoid distortion effects as outlined in chapter 2.3, questions are positioned in an alternating order on the survey form. Yet, the questions of group ‘general’ are mentioned first to be in line with the principle “from most general to most specific”.

All questions of the first part are multiple-choice questions and are answered by picking one out of four predefined answer options. Selecting multiple answers is not possible. The answer options correspond to the characteristics of the four phases in the CA maturity model by Vasarhelyi, Alles, Kuenkaikaew, Littley (2012, pp. 267-281). For each question, the four answer options range from traditional to fully continuous. Respondents therefore need to decide on those options which best reflect the level of CA adoption for the respective CA subject.

To identify the level of CA adoption, single questions of groups ‘general’ (survey questions 1 to 5), ‘controls’ (survey questions 6 to 8), ‘risks’ (survey questions 9 to 11), and ‘projects’ (survey questions 15 to 17) are derived from the maturity criteria mentioned in the CA maturity

model by Vasarhelyi, Alles, Kuenkaikaew, Littley (2012, pp. 267-281) (e.g. degree of automation, frequency, extent of coverage, extent of usage of indicators). Questions in group 'data' (survey questions 12 to 14) refer to popular examples of application in the area of data and transactions (i.e. journal entry testing, IT authorisation checks, data analytics).

The second part of the questionnaire contains six questions. These are designed to collect information about the previously discussed internal audit function-specific and company-specific parameters. Thus, they form the basis for testing hypotheses $H_{3\text{-}1}$ and $H_{3\text{-}2}$. Each question relates to one parameter, with annual turnover and amount of employees both relating to size of company. For each question of this part, the respondent can choose one answer out of a set of predefined answer options. The number of answer options varies per question. Multiple answer selections per question are not possible.

To test the effect of regulation on CA adoption, 21 industries (as listed by the International Standard Industrial Classification (United Nations, 2008)) are provided as answer options (survey question 18). In accordance with PwC (2017), industries 'Electricity, gas, steam and air conditioning supply' (d), and 'Financial and insurance activities' (k) are considered as highly regulated for the purpose of this research. The amount of IT auditors a company employs (survey question 19) is used to measure the degree of IT expertise within the internal audit function. The size of the internal audit department is measured by the number of auditors the company employs (either in a dedicated internal audit department or as part of another department) (survey question 20). Companies' annual turnover (survey question 21) and companies' average amount of employees (survey question 22) are chosen as figures to measure company size.[5] The area in which a company is predominantly active (survey question 23) is used as an indicator to measure companies' levels of geographical expansion.

The third part of the questionnaire covers the remaining two questions (survey questions 24 and 25) which aim to verify whether the respondent is active as an internal auditor or employed in internal audit activities in another way. Answers to these two questions will help the researcher to identify returned questionnaires which are deemed invalid. Only one answer per question can be chosen. Only if both questions are answered with 'yes' will the questionnaire be considered for further analysis.

[5] Size criteria in accordance with §267ff HGB (German commercial law)

Along with the three question parts, the questionnaire includes an introduction which describes the background of the research and provides an explanation of CA. The questionnaire also has a final passage to thank respondents for their participation on the survey. Also, respondents can provide their email addresses, if they wish to receive the results of the survey at a later point in time. The complete questionnaire can be found in appendix 3.

The survey was conducted shortly after the completion of the preliminary research and covered a time period of ten weeks. Via a judgmental sampling technique, the questionnaire was distributed among internal auditors and members from audit-like functions (e.g. risk managers, compliance managers, CFOs) known to the researcher from past cooperation, professional working associations, as well as from working groups and job-related conferences. Additionally, internal auditors were identified and addressed personally via several business networks. Respondents could either fill out a paper-based copy of the questionnaire and hand it back to the researcher or fill out an online questionnaire published on the researcher's own webpage.

Main research B can be considered as qualitative, confirmatory research. Data was collected via an online questionnaire. It covers a total of six survey questions. Five of these questions are rating questions, each of which covers one of the aforementioned factor groups. For each question, respondents were confronted with a statement about the factor group's effect on CA adoption. To answer, the respondents had to state to what extent they agreed with the statements. Each question offered five answer options to choose from. These are:

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Whether CA is in place or not in the corresponding company was deemed irrelevant. The sixth survey question is an open-ended question which enables respondents to state further restricting factors. However, a response to survey question 6 was optional. As respondents did not need to provide any personal information, replies are strictly anonymous. The questions are listed below:

Survey question 1: Framework conditions relevant to the adoption of CA (e.g. consistency in the internal and external corporate environment, stable processes) change too quickly.

Survey question 2: Necessary knowledge and skills for the adoption of CA among my company's internal auditors are not or insufficiently available.

Survey question 3: Results provided by CA are not precise enough, too extensive, or do not cover the desired information needs.

Survey question 4: The expenditures for the implementation, maintenance, and enhancement of CA (e.g. personnel costs, IT costs) are too high.

Survey question 5: The support from management or other departments (e.g. IT, Finance) necessary for the adoption of CA is not sufficiently ensured.

Survey question 6: Please list further reasons relevant to you in your decision not to adopt CA (optional).

Along with the six questions, the questionnaire includes an introduction proving general information about the background of the questionnaire as well as a final passage to thank respondents for their participation on the survey. The complete questionnaire can be found in appendix 4.

The link to this questionnaire was shared during a 1-hour long lecture about CA at an IT conference organised by the German chapters of the IIA and the ISACA taking place in Düsseldorf, Germany. According to the list of attendees, 72 internal auditors from German-based companies participated in this lecture. Participants were asked at the beginning of the lecture to complete the online questionnaire until the end of the conference. During this lecture, internal auditors were introduced to CA as well as to the setup, objectives, and purpose of the online questionnaire.

6 RESEACH RESULTS

This chapter covers the conduction of the research and explains how collected data was analysed. Also, it presents the research results split in accordance with the two main areas of research.

6.1 Results of main research A

A total of 81 questionnaires (in paper, by email, or via webpage) were returned. Out of these 81, three questionnaires turned out to be invalid as either survey question 24 or 25 (or both) were answered with 'no'. Answers provided on the remaining 78 questionnaires were assembled in a MS Excel-based spreadsheet (see appendix 5). For questions of the first part of the questionnaire (i.e. survey questions 1 to 17), each of the four answer options was assigned a number from 1 to 4, in accordance with the four phases of the CA maturity model by Vasarhelyi et al. (i.e. traditional, emerging, maturing, fully continuous). Answer options for survey questions 19 to 23 vary in number, but are ordinal in nature and were provided in ascending order. Thus, assigned numbers range from 1 to n. Answer options for survey question 18 (i.e. industry belonging) were not assigned a rank, as industries are of nominal nature and therefore cannot be ranked in an ascending or descending order. Instead, answer options were allocated to two groups: 'highly regulated industries' (1) and 'less regulated industries' (0). In line with the research design, the former group includes answer options 'Electricity, gas, steam and air conditioning supply' (d) and 'Financial and insurance activities' (k). The latter group covers all remaining answer options.

6.1.1 Continuous Auditing adoption levels

To determine the CA adoption levels as laid out in $H_{1\text{-}1}$ and $H_{2\text{-}1}$, mathematical averages were calculated on the basis of the MS Excel spreadsheet in two separate steps.

Step 1: For each of the 78 respondent (i), the following figures were determined:

- an overall CA adoption level for each respondent, calculated by

$$AL_i = \frac{1}{n} \sum x_i$$

with n = the number of questions answered by respondent i (in this case: 17, namely survey questions 1 to 17)
x_i = any value for a single response by respondent i

- a CA adoption level for group ‘general’ for each respondent, calculated by

$$AL_{gi} = \frac{1}{ng} \sum x_{gi}$$

with n_g = the number of questions in group ‘general’ answered by respondent i (in this case: 5, namely survey questions 1 to 5)
x_{gi} = any value for a single response to a question in group ‘General’ by respondent i

- a CA adoption level for group ‘controls’ for each respondent, calculated by

$$AL_{ci} = \frac{1}{nc} \sum x_{ci}$$

with n_c = the number of questions in group ‘controls’ answered by respondent i (in this case: 3, namely survey questions 6 to 8)
x_{ci} = any value for a single response to a question in group ‘Controls’ by respondent i

- a CA adoption level for group ‘risks’ for each respondent, calculated by

$$AL_{ri} = \frac{1}{nr} \sum x_{ri}$$

with n_r = the number of questions in group ‘risks’ answered by respondent i (in this case: 3, namely survey questions 9 to 11)
x_{ri} = any value for a single response to a question in group ‘Risks’ by respondent i

- a CA adoption level for group ‘data’ for each respondent, calculated by

$$AL_{di} = \frac{1}{nd} \sum x_{di}$$

with n_d = the number of questions in group ‘data’ answered by respondent i (in this case: 3, namely survey questions 12 to 14)
x_{di} = any value for a single response to a question in group ‘Data’ by respondent i

- a CA adoption level for group ‘projects’ for each respondent, calculated by

$$AL_{pi} = \frac{1}{np} \sum x_{pi}$$

with n_p = the number of questions in group ‘projects’ answered by respondent i (in this case: 3, namely survey questions 15 to 17)

x_{pi} = any value for a single response to a question in group ‘Projects’ by respondent i

The full results of these calculations can be found in appendix 5, first and second table, columns B to G.

Step 2: Average CA adoption rates were calculated over all 78 respondents. The following six figures were calculated:

- an overall CA adoption level over all respondents, calculated by

$$AL = \frac{1}{78} \sum AL_i$$

- a CA adoption level for group ‘general’ over all respondents, calculated by

$$AL_g = \frac{1}{78} \sum AL_{gi}$$

- a CA adoption level for group ‘controls’ over all respondents, calculated by

$$AL_c = \frac{1}{78} \sum AL_{ci}$$

- a CA adoption level for group ‘risks’ over all respondents, calculated by

$$AL_r = \frac{1}{78} \sum AL_{ri}$$

- a CA adoption level for group ‘data’ over all respondents, calculated by

$$AL_d = \frac{1}{78} \sum AL_{di}$$

- a CA adoption level for group ‘projects’ over all respondents, calculated by

$$AL_p = \frac{1}{78} \sum AL_{pi}$$

The full results of these calculations can be found in appendix 5, in the bottom line of the second table. The descriptive statistics (as summary of the results) of these calculations are shown below:

Table 8: Descriptive statistics of CA adoption levels

	AL	AL_g	AL_c	AL_r	AL_d	AL_p
Valid (n)	78	78	78	78	78	78
Missing	0	0	0	0	0	0
Mean	2.33	2.40	2.50	1.93	2.57	2.21
Std. deviation	0.35	0.41	0.51	0.58	0.48	0.55
Minimum	1.6	1.8	1.3	1.0	1.3	1.0
Maximum	3.3	3.4	4.0	3.3	3.3	3.7
Spread	1.7	1.6	2.7	2.3	2.0	2.7
25th Percentile	2.1	2.0	2.3	1.7	2.3	1.7
50th Percentile	2.3	2.4	2.5	2.0	2.7	2.3
75th Percentile	2.5	2.7	2.7	2.3	3.0	2.7

Source: Own calculation (n = 78)

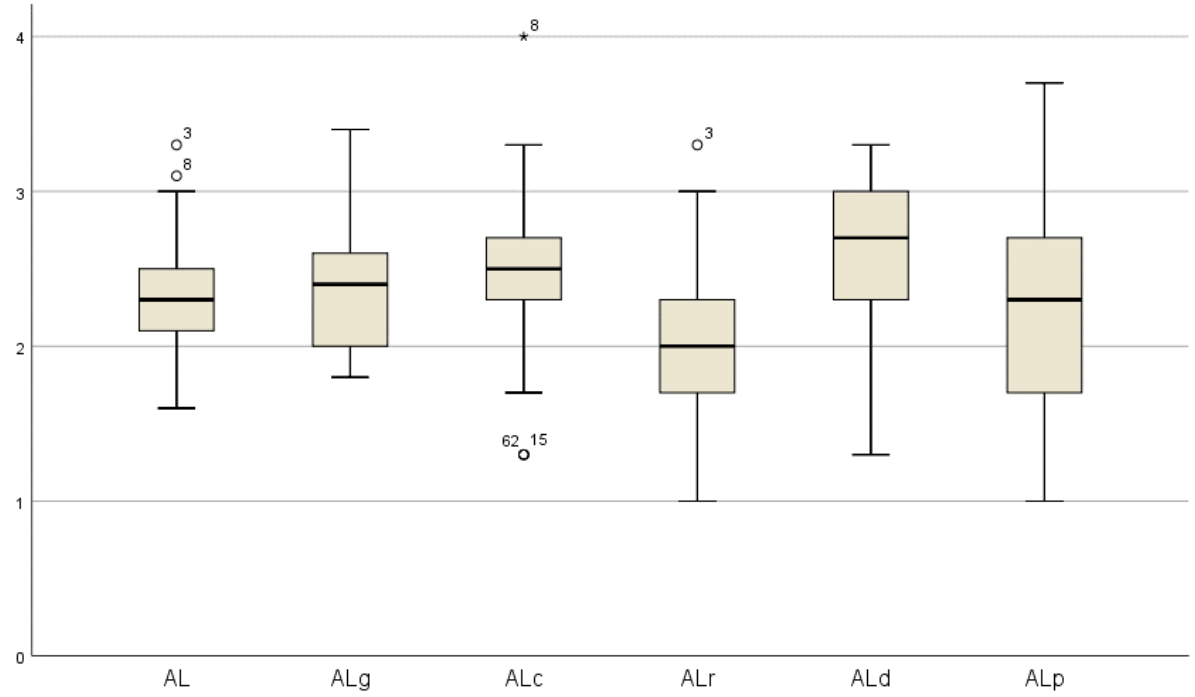
Overall CA adoption level

The table reveals an overall adoption rate of 2.33 with a standard deviation of 0.35 and a spread of 1.7. Similarly, the average adoption rate for group ‘general’ amounts to 2.40 with a standard deviation of 0.41 and a spread of 1.6. In terms of the CA maturity model, internal audit departments of German companies are therefore found to be located between phases ‘2-emerging’ and ‘3-maturing’. This implies that CA adoption is at a medium level.

CA subject-specific adoption levels

The box plots below depict the adoption rates of the overall CA adoption level as well as the CA subject-specific adoption levels.

Figure 6: Box plots for CA adoption levels



Source: Own calculation (n = 78)

Similar to the overall adoption rate, German companies find themselves between phases '2-emerging' and '3-maturing' when it comes to groups 'controls' and 'data'. Yet, the adoption rates of these two groups (2.50 and 2.57) exceed the overall average rate of 2.33 and can thus be considered closer to the maturing stage. This implies that Continuous Controls Monitoring and Continuous Data Assurance are comparably popular among German internal audit departments.

In contrast, group 'risks' is far less implemented, featuring an average adoption rate of only 1.93. In this field, German companies rank between phases '1-traditional' and '2-emerging' and adoption of CA is only at a low level. Thus, Continuous Risk Management and Assessment is found to be less popular in practice.

With an average adoption rate of 2.21, group ‘projects’ finds itself somewhere in the middle of the other groups and ranks just below the overall adoption rate of 2.33. CA adoption in this field has passed the emerging stage, but requires a lot more uptake before it can be considered as maturing.

In conclusion, results show a very differentiated picture. Groups ‘controls’ and ‘data’ significantly exceed the overall CA adoption rate, while group ‘risk’ significantly falls below the overall CA adoption rate. Although the adoption rate of group ‘projects’ is similar the overall CA adoption rate, its standard deviation and spread are both higher than the overall figures.

6.1.2 Company-specific and internal audit function-specific parameters

To verify how far company-specific parameters ($H_{3\text{-}1}$) or internal audit function-specific parameters ($H_{3\text{-}2}$) relate to the extent of CA usage, several statistical tests were carried out.

As first step, the Kolmogorow-Smirnow test and the Shapiro-Wilk test were used to determine whether the company-specific and internal audit function-specific parameters (in this case used as independent variables) are normally distributed. Also, the Levene test was carried out to assess the equality/homogeneity of variances among the single groups (i.e. the answer options) of each independent variable.

Based on the outcome of these tests, the Kruskal–Wallis test and the Mann-Whitney U test were applied to analyse how far single groups (of one independent variable) show a difference in the degree of CA adoption. Finally, the Spearman rank correlation analysis was carried out to validate how far changes in company-specific or internal audit function-specific parameters lead to a change in CA adoption levels.

During all tests, the significance level was set to 0.05 which allows an error tolerance of 5%. Descriptive statistics and graphical diagrams were used as supportive measures. The descriptive statistics and statistical tests are described in detail below:

Descriptive statistics

The descriptive statistics for the six independent variables are shown below:

Table 9: Descriptive statistics of company-specific and internal audit function-specific parameters

	Amount of auditors	Size of internal audit department	Annual turnover	Amount of employees	Degree of internationalisation	Industry
Valid (n)	78	78	78	78	78	78
Missing	0	0	0	0	0	0
Mean	1.99	1.78	3.31	2.41	2.72	0.24
Std. deviation	0.55	0.98	0.94	1.17	0.94	0.43
Minimum	1	1	1	1	1	0
Maximum	5	4	5	6	4	1
Skewness	2.442	1.058	-0.279	0.650	-0.369	1.218
Kurtosis	13.973	0.044	-0.398	-0.013	-0.670	-0.530
Spread	4	3	4	5	3	1

Source: Own calculation (n = 78)

Due to their binary nature, additional analytical steps were carried out for variable ‘industry’. Based on figures provided in the MS Excel spreadsheet, the average CA adoption rate per industry was calculated. The results are shown in the diagram in appendix 6. Responses covered eleven out of 21 provided industries, leaving nine industries not being picked by any of the respondents. Out of the eleven industries, four feature an above-average adoption rate. Industries ‘Electricity, gas, steam and air conditioning supply’ (d) and ‘Financial and insurance activities’ (k), which make up group 1, clearly stand out in comparison to others. While industries ‘Electricity, gas, steam and air conditioning supply’ features an adoption rates of 2.78, industry ‘Financial and insurance activities’ (k) ranks at 2.67.

The adoption rates of the remaining industries (making up group 0) are considerably lower than the aforementioned ones. The average adoption rates of industries ‘Wholesale and retail trade; repair of motor vehicles and motorcycles’ (g) and ‘Other service activities’ (s) amount to 2.35 each and therefore just surpass the overall adoption rate of 2.33. The industries ‘Information

and communication' (j), 'Water supply; sewerage, waste management and remediation activities' (e), and 'Professional, scientific and technical activities' rank in the middle of the scale with average adoption rates of 2.21, 2.12, and 2.02 respectively. Industry 'Real estate activities' (l) features a rate of 1.71, industry 'Construction' (f) amounts to a rate of 1.76, and industry 'Public administration and defence; compulsory social security' (o) totals to a rate of 1.94. The lowest average adoption rate of 1.65 is found for industry 'Education' (p).

Test for normal distribution of variables

To validate how far a variable is normally distributed, both the Kolmogorow-Smirnow test and the Shapiro-Wilk test can be applied. Although both tests share the same aim, the Shapiro-Wilk test is found to be more robust than the Kolmogorow-Smirnow test. As null hypothesis, both tests assume that the population is normally distributed.

The tests were carried out for the following independent variables. The number of groups (i.e. answer options) per variable are given in parentheses:

- Amount of auditors (5)
- Size of internal audit department (4)
- Annual turnover (5)
- Amount of employees (6)
- Degree of internationalisation (4)
- Industry (2)

The table below shows the results for both tests:

Table 10: Results of Kolmogorow-Smirnow test and Shapiro-Wilk test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Amount of auditors	.439	78	.000	.487	78	.000
Size of internal audit department	.301	78	.000	.760	78	.000
Annual turnover	.230	78	.000	.893	78	.000
Amount of employees	.227	78	.000	.889	78	.000
Degree of inter-nationalisation	.259	78	.000	.866	78	.000
Industry	.470	78	.000	.533	78	.000

Source: Own calculation (n = 78)

All results indicate a significant test statistic of 0.000 which clearly ranks below 0.05 for all six variables. This means that the null hypothesis is rejected and the alternative hypothesis (the population is not normally distributed) is assumed in each case.

These results are backed up by the kurtosis statistics. In literature, a kurtosis of 3 is considered typical for a normal distribution. In this research, all variables expect ‘amount of auditors’ feature a kurtosis smaller than 3 (‘size of internal audit department’: 0.044; ‘annual turnover’: -0.398; ‘amount of employees’: -0.013; ‘degree of internationalisation’: -0.670; ‘industry’: -0.530) and are thus considered platykurtic. Variable ‘amount of auditors’ (13.973) clearly surpasses 3 and is therefore leptokurtic.

A similar picture is presented by looking at the skewness of the variables’ distributions. Variables ‘amount of auditors’ (2.442), ‘industry’ (1.218), and ‘size of internal audit department’ (1.058) are positively skewed. Variable ‘amount of employees’ (0.650) features a positive skew as well, however to a weaker extent. Variables ‘annual turnover’ (-0.279) and ‘degree of internationalisation’ (-0.369) are negatively skewed to a weak extent.

The distributions of the variables are depicted in histograms. The divergence of the variables' distributions from their normal distributions are depicted in Q-Q plots. Both histograms and Q-Q plots can be found in appendix 7.

These results have implications for the test for variance homogeneity, the analysis of variance, and the correlation analysis. Standard variants of these test require a normal distribution of single variables to be present. As this is not the case, other variants will have to be applied.

Test for variance homogeneity

Literature mentions several tests to determine the homogeneity of variances within given variables (e.g. F-test of equality of variances, Levene test). Given that variables of this research are not normally distributed, the comparably robust Levene test was applied. Specifically, it was used to validate how far variances of single groups within one population (i.e. variable) are equal (Datatab, 2021). As null hypothesis, it assumed that all variances within a population are equal and homogeneity is therefore given.

The test was carried out for the following independent variables. The amount of groups (i.e. answer options) per variable are given in parentheses:

- Amount of auditors (5)
- Size of internal audit department (4)
- Annual turnover (5)
- Amount of employees (6)
- Degree of internationalisation (4)
- Industry (2)

AL_i (i.e. the overall adoption level) was used as dependent variable.

The Levene test incorporated four different variants by which homogeneity was calculated (mean, median, median and adjusted df, as well as trimmed mean). Results were consistent across these four variants.

The test brought forward significance levels of above 0.05 for variables 'amount of auditors', 'size of internal audit department', 'annual turnover', 'amount of employees', and 'industry'.

Due to these insignificant results, the null hypothesis cannot be rejected, i.e. the groups' variances are homogeneous for the aforementioned variables. For variable 'degree of internationalisation', the significance levels are below 0.05, i.e. the null hypothesis is rejected and variances of this variable's groups are heterogenous.

The full results as well as the descriptive statistics for this test (covering the number of groups per variable, the amount of items per group, as well as the groups' means, standard deviations, and confidence intervals) are provided in appendix 8.

Analysis of variance

The analysis of variance (ANOVA) is a statistical test to analyse differences between different groups of observations for a specific variable. This comparison is based on the empirical mean of single groups as well as on their variances, i.e. deviations from the overall mean of all considered observations.

The ANOVA is based on the equation

$$X_{ij} = \mu_i + \epsilon_{ij}$$

which assumes that the random variable (X_{ij}) is due to a fixed cause (μ_i) on the one hand and a disturbance/error variable (ϵ_{ij}) on the other. As null hypothesis, the ANOVA assumes that this fixed cause (μ_i) is always constant and that the variation in the random variable is solely due to the disturbance variable/error variable.

In practical terms, an ANOVA first calculates the mean value of each group as well as the mean value over all observations regardless of group membership. Then, both the variance of the individual observations with their respective group's mean (within-group variation) and the variance of the individual group's mean with the overall mean (between-group variation) are determined. The variance quotient F to be calculated subsequently relates the systematic variance (between-group variation) to the unsystematic variance (within-group variation). More precisely, the variance generated by the experimental treatment of the different groups is compared to the variance resulting from errors or differences within a group. The greater the value of F, the more the measured differences can be attributed to the experimental treatment, i.e. the greater the probability that the examined groups differ significantly.

The ANOVA can be applied if at least two groups are present and thus is an extension of the t-test, which allows a maximum of two groups only. Therefore, the use of the ANOVA makes sense when at least 3 groups are being compared. The ANOVA can be used for analyses comprising exactly 2 groups, however in this case results will be identical to those of the t-test.

To apply the standardised form of the ANOVA, several preconditions need to be met:

1) The object of the analysis is the difference between individual groups
2) The mean of at least two groups is available or can be calculated on the basis of the available information
3) There is exactly one dependent variable, which is at least interval-scaled
4) All independent variables are at least categorical
5) Analysed groups are normally distributed
6) Variance homogeneity among the individual groups is present

While preconditions no. 1 to 4 are met, the results from the Kolmogorow-Smirnow tests and the Shapiro-Wilk test as well as from the Levene tests show that preconditions no. 5 and 6 are not met. Variables ‘amount of auditors’, ‘size of internal audit department’, ‘annual turnover’, ‘amount of employees’, ‘degree of internationalisation’, and ‘industry’ are all not normally distributed. On top of this, variable ‘degree of internationalisation’ holds heterogeneous variances among its groups. Thus, the Kruskal–Wallis test (as non-parametric alternative of the standard ANOVA) was carried out for variables ‘amount of auditors’, ‘size of internal audit department’, ‘annual turnover’, ‘amount of employees’ and ‘degree of internationalisation’. Variable ‘industry’ possess only two groups, therefore the Mann-Whitney U test (as non-parameterised alternative of the t-test) was carried out. Both the Kruskal–Wallis test and the Mann-Whitney U test use ranks (instead of exact data), making them more robust than t-tests or standardised ANOVAs.

For all tests, AL_i (i.e. the overall adoption level) functioned as dependent variable.

The results of the Kruskal-Wallis test are shown in the following table:

Table 11: Results of Kruskal-Wallis test

	Amount of auditors	Size of internal audit department	Annual turnover	Amount of employees	Degree of internatio-nalisation
Krus-kal-Wallis-H	10.997	12.643	34.202	44.255	23.872
df	4	3	4	5	3
Asymp. Sig.	0.027	0.005	0.000	0.000	0.000

Source: Own calculation (n = 78)

The results for all five variables are significant, i.e. below the significance level of 0.05. This implies that the null hypothesis is rejected and the alternative hypothesis (variances of groups within one variable vary from each other) is assumed.

Also the Mann-Whitney U test brings forward a significance level of below 0.05, indicating that the null hypothesis is rejected and the alternative hypothesis is assumed.

Table 12: Results of Mann-Whitney U test

	Industry
Mann-Whitney U test	121
Wilcoxon-W	1891
Z	-5.141
Asymp. Sig.	0.000

Source: Own calculation (n = 78)

As shown by the results of these two tests and the detailed overviews of the mean ranks for each variable (see appendix 9), the extent to which companies employ CA varies with the form of the company-specific and internal audit function-specific factors. It is important to note that the tests above do not provide details about the exact strength of the difference. Nor do they

deliver further information about a pair-wise comparison of single groups. Post-hoc tests which could have closed this gap were not carried out due to relevance reasons. Instead, a correlation analysis was performed to further investigate the relationship of company-specific and internal audit function-specific factors (independent variables) on the degree of CA adoption (dependent variables).

Correlation analysis

A correlation analysis is a statistical method used to identify whether there is a relationship between data sets. Building upon the results of the ANOVA, such correlation analyses were conducted to validate how far there is a relationship between each of the company-specific/internal audit function-specific parameters (as investigated by survey questions 18 to 23) and the CA adoption rate. This form of analysis not only determines the existence of a relationship, but also provides information about the strength of the relationship of the two variables. However, it does not deliver any proof for causation. Thus, statements regarding the direction of the relationship (i.e. whether a change in parameters leads to a change in the adoption level or the other way around) will not be given.

The nature of the relationship between two variables is expressed by the correlation coefficient ρ which can take any number between +1 and -1. A positive coefficient indicates that a positive change in one variable leads to a positive change in the other variable and vice versa. If the coefficient results in a negative value, a positive change in one variable leads to a negative change in the other variable and vice versa. A value of exactly +1 (or -1) indicates a perfect linear relationship between the two variables. A value of 0 indicates an absence of any relationship (Griesel, Postel, 2000, pp. 27-32). The correlation coefficient can be interpreted as follows:

Table 13: Interpretations of correlation values

Correlation coefficient	Interpretation
0.000	No correlation
0.001 – 0.200	Very weak correlation
0.201 – 0.400	Weak correlation
0.401 – 0.600	Medium correlation
0.601 – 0.800	Strong correlation
0.801 – 0.999	Very strong correlation
1.000	Perfect correlation

Source: Own resource, based on Griesel, Postel, 2000, pp. 27-32

Correlation analyses were performed among the following variables:

- Dependent variables: AL_i; AL_{gi}; AL_{ci}; AL_{ri}; AL_{di}; AL_{pi}
- Independent variables: ‘amount of auditors’, ‘size of internal audit department’, ‘annual turnover’, ‘amount of employees’, ‘degree of internationalisation’, ‘industry’

Multiple variants of correlations analyses are discussed in theory (e.g. Pearson, Spearman). Due to the abnormally distributed independent variables, Spearman rank correlation analyses were performed in all cases as this form of correlation analysis is more robust, accounts better for outliers, and was found to be more suitable when data is of ordinal nature (as in the case of variable ‘industry’) (Statistik-Nachhilfe, 2019).

The correlations table with the results of the analyses can be found in appendix 10. As shown, CA adoption (indicated by AL_i) correlates at a 0.05 significance level with ‘the size of the internal audit department’, ‘the annual turnover’, ‘the amount of employees’, ‘the degree of internationalisation’ and ‘industry’. The correlation between all four variable pairs is positive,

indicating that all company/internal audit function-specific parameters increase with an increase in the CA adoption level. The correlation coefficient for the pair ‘CA adoption’ and ‘annual turnover’ as well as for the pair ‘CA adoption’ and ‘amount of employees’ results in figures of 0.638 and 0.666 respectively. The correlation for both pairs can therefore be considered as strong. The correlation for the pair ‘CA adoption’ and ‘industry’ amount to 0.568 and is therefore at a medium level. The correlation for the pairs ‘CA adoption’ and ‘size of internal audit department’ as well as ‘CA adoption’ and ‘degree of internationalisation’ can be considered as week, as corresponding coefficients amount to only 0.352 and 0.365 respectively. A significant correlation between ‘CA adoption’ and ‘amount of IT auditors’ could not be found. The scatter plots in appendix 11 provide a detailed picture of how data pairs are aligned and how the single variables develop with a corresponding growth in the CA adoption level.

These findings are supported by the correlation coefficients of variable AL_{gi}. Medium strong correlation coefficients could be found for the pairs AL_{gi} and ‘annual turnover’ (0.500) as well as AL_{gi} and ‘amount of employees’ (0.454). For the pairs AL_{gi} and ‘size of internal audit department’ as well as AL_{gi} and ‘industry’ only weak correlations were determined (0.238 and 0.311). Results found for pairs AL_{gi} and ‘degree and internationalisation’ as well as AL_{gi} and ‘amount of IT auditors’ are statistically insignificant.

When looking at the other four CA groups (i.e. AL_{ci}, AL_{ri}, AL_{di}, AL_{pi}), the picture is similar. Variables ‘annual turnover’, ‘amount of employees’, and ‘industry’ each correlate at a medium or weak level with all four CA groups. The variable ‘degree of internationalisation’ correlates weakly with $AL_{ci,}$ AL_{ri} and AL_{pi}, however it does not correlate with AL_{di}. Variable ‘size of internal audit department’ correlates weakly with $AL_{ci,}$ AL_{ri} and AL_{di}, however it does not correlate with AL_{pi}. Variable ‘amount of IT auditors’ does not correlate significantly with any of the four CA groups.

Looking at only pairs of company/internal audit function-specific variables, the ‘amount of employees’ and ‘annual turnover’ feature a weak correlation. The same is true for the pairs ‘degree of internationalisation’ and ‘annual turnover’, ‘degree of internationalisation’ and ‘amount of employees’, ‘annual turnover’ and ‘size of internal audit department’, ‘industry’ and ‘amount of IT auditors’, as well as ‘industry’ and ‘annual turnover’. The pair ‘industry’ and ‘amount of employees’ features a medium strong correlation.

The CA adoption rate variables (i.e. AL_i, AL_{gi}, AL_{ci}, AL_{ri}, AL_{di}, AL_{pi}) significantly correlate with each other. AL_i correlates strongly with all five CA groups. The groups correlate weakly or medium strongly with each other. Given that these variables are linked with each other and/or build upon each other, the found correlations are not surprising.

In regard to the company-specific and internal audit function-specific parameters, the result can be summarised as follows:

Company size

The variables 'annual turnover' and 'amount of employees' were used to represent company size. As shown by the Kruskal–Wallis test, the single groups of both variables significantly differ from each other and both variables feature a strong correlation (coefficient of 0.600 and higher) with the overall CA adoption level (AL_i). They also correlate at a medium or weak level with all four CA subjects (AL_{ci}, AL_{ri}, AL_{di}, AL_{pi}) as well es with the general group (AL_g). Consequently, company size is found to have a positive connection to CA adoption.

Industry

As indicated by the descriptive statistics and substantiated by the Mann-Whitney U test, the two groups of variable 'industry' (i.e. companies from highly regulated industries and companies from less regulated industries) are found to differ significantly from each other. This finding is backed up by the descriptive statistics and the corresponding histogram. The correlation analysis shows that the variable correlates with the overall CA adoption level as well as with all five subgroups. In contrast to variables 'annual turnover' and 'amount of employees', the correlations are less strong however. Yet, the results show that companies from highly regulated industries (banks and other financial institutions as well as energy companies) make use of CA to a larger extent than companies from other industries. As a result, level of regulation is found to have a positive connection to CA adoption.

Degree of internationalisation

The variable 'degree of internationalisation' correlates weakly with the overall CA adoption level (AL_i) and with groups 'controls' (AL_{ci}), 'risks' (AL_{ri}), and 'projects' (AL_{pi}). However, significant correlations with groups 'general' (AL_g) and 'data' (AL_{di}) were not identified. Despite a significant Kruskal–Wallis test showing that single groups of this variable differ from

each other, results remain inconsistent. Thus, the degree of internationalisation is found to not have a connection to CA adoption.

Amount of IT auditors

Despite a significant result in the Kruskal–Wallis test, the correlation analysis shows that the variable ‘amount of IT auditors’ does not correlate with CA adoption, neither at a general level, nor in combination with one of the five CA groups. Consequently, the amount of auditors is found not to have a connection to CA adoption.

Size of internal audit department

The groups of variable ‘size of internal audit department’ significantly differ from each other. Moreover, the variable correlates with the overall CA adoption rate as well as with groups ‘controls’ (AL_{ci}), ‘risks’ (AL_{ri}), and ‘projects’ (AL_{pi}). However, all correlation coefficients rank below 0.400, indicating a weak or even very weak correlation. Significant correlations with groups ‘general’ (AL_{g}) and ‘data’ (AL_{di}) were not identified. In contrast to the other four independent variables, the ‘size of internal audit department’ holds heterogeneous variances among its group as found out by the Levene test. As a result, the ‘size of internal audit department’ is found not to have a connection to CA adoption.

6.2 Results of main research B

The questionnaires of main research B were filled out during the conference and analysed afterwards. Only fully completed questionnaires (i.e. answers were provided for all five obligatory questions) were considered. Provided answers were allocated to a number according to their rank (strongly disagree = 1; somewhat disagree = 2; neither agree nor disagree = 3; somewhat agree = 4; strongly agree = 5). Based on these numbers, average agreement rates were calculated per question. An average agreement rate of 3.0 or higher was considered as significant.

A total of 22 questionnaires were completed, one of which did not hold answers to all obligatory questions. Thus, the average agreement rates were calculated on the basis of 21 complete questionnaires. In relation to the 72 participants who signed up for the lecture, the return rate amounts to 29.2%. The results are shown in the following table:

Table 14: Results of main research B

	Frame-work conditions		Skills		Results		Resources		Support	
Strongly disagree (1)	3	14.3%	3	14.3%	2	9.5%	0	0,0%	0	0,0%
Somewhat disagree (2)	12	57.1%	5	23.8%	4	19.0%	3	14.3%	5	23.8%
Neither agree nor disagree (3)	3	14.3%	6	28.6%	9	42.9%	2	9.5%	6	28.6%
Somewhat agree (4)	2	9.5%	6	28.6%	6	28.6%	10	47.6%	7	33.3%
Strongly agree (5)	1	4.8%	1	4.8%	0	0.0%	6	28.6%	3	14.3%
Sum	21	100.0%	21	100.0%	21	100.0%	21	100.0%	21	100.0%
Average		**2.3**		**2.9**		**2.9**		**3.9**		**3.4**

Source: Own calculation (n = 21)

Factor group ‘frameworks conditions’ holds an average agreement rate of 2.3 which is below the significance level of 3.0 and thus considered low. 71.4% of all respondents strongly or somewhat disagree to ‘framework conditions’ having a negative impact on CA adoption, while only 14.3% strongly or somewhat agree. Therefore, conditions in the internal or external environment of a company are not found to impair internal auditors in their decision to adopt CA.

The average agreement rate for factor group ‘skills’ ranks just below the significance level at 2.9. Six out of 21 respondents selected ‘neither agree nor disagree’, the remaining responses are split almost evenly between agree (7) and disagree (8). This almost even distribution implies the absence of a tendency in either direction. Consequently, these results do not clearly identify a significant negative impact on CA adoption arising from lacking auditors’ skills. Therefore, missing skills are not found to impair internal auditors in their decision to adopt CA.

As for factor group ‘skills’, the average agreement rate for factor group ‘results’ ranks at 2.9 and thus below the significance level of 3.0. Nine out of 21 respondents (and thus almost 43%) selected ‘neither agree nor disagree’. Each six respondents selected either agree or disagree which shows that distribution of responses is even. In contrast to factor group ‘skills’, the distribution of responses for factor group ‘results’ is even more centre-based. Consequently, these results do not identify a significant negative impact on CA adoption arising from improper results of CA activities. CA’s shortage in delivering inaccurate results is therefore not found to impair internal auditors in their decision to adopt CA.

The average agreement rate of 3.9 for factor group ‘resources‘ is clearly above the significance level of 3.0 and is therefore considered high. 76.2% of all respondents indicated that limits in their cost and time budgets make them reluctant to introduce or enhance CA activities in their company. Only 14.3% of the respondents did not see a lack of resources as having an impact on CA adoption. With only 9.5% opting for ‘neither agree nor disagree’, respondents show a very clear opinion, compared to the other questions. Consequently, the lack of proper resources is found to be one major weakness when it comes to the adoption of CA.

Factor group ‘support’ features an average agreement rate of 3.4 which is above the significance level of 3.0. 47.6% of all respondents ‘somewhat agree’ or ‘strongly agree’ that missing support from management or other departments impacts their decision on adopting CA. Only 23.8% do not see that the missing support has a significantly negative impact on CA adoption. These results underline the significance of CA failing if proper support is missing. Thus, missing support is found to impair internal auditors in their decision to adopt CA.

The detailed results can be found in appendix 12.

Alongside these findings, survey question 6 provided further factors impairing companies in their CA efforts. These are listed below:

- Lack of resources among auditors to approach CA (2 replies).
- Internal audit function fears to approach something new (1 reply).
- Senior management wants internal audit function to focus on efficiency. CA does not match this focus (1 reply).

- CA is not seen as a strategic internal audit topic. Instead, responsibility for CA is understood to rest with first line or second line departments (1 reply).

The first reason ('lack of resources') corresponds to factor group 'resources' (survey question 4). The fact that two respondents explicitly mentioned this reason under survey question 6 indicates the importance of this issue and thus reinforces internal auditors' view that a shortage in resources prevents them from fostering CA.

As second reason, 'fear to approach something new' was mentioned by one respondent correspondents. The fact that this reason was explicitly mentioned under survey question 6 implies that internal auditors consider CA as a new methodology which substantially diverges from their established practices. However, as this reason was mentioned by only one respondent, its value is small.

The third reason and the fourth reason ('missing relevance of CA to internal audit function' and 'efficiency focus') are each mentioned by one respondent. They do not fit in any of the five factor groups and are thus considered as new insights of why internal auditors refrain from using CA. Similar to reason 'fear to approach something new', these two reasons are only of small value as they were mentioned only once.

6.3 Summary of results

The empirical research presented in this thesis covered two areas of research, main research A and main research B.

Main research A identified the overall CA adoption rate among German internal audit departments as well as the adoption rate for the CA subjects 'risks', 'controls', 'data', and 'projects'. It also covered several statistical tests to validate how far the CA adoption rate is significantly related to the company-specific parameters 'level of regulation', 'size of company', and 'geographical expansion' as well as to the internal audit function-specific parameters 'degree of IT expertise within IT audit function' and 'size of internal audit department'.

The overall CA adoption rate was found to be 2.33, the adoption rate for group 'general' amounts to 2.40. In terms of the CA maturity model, these two averages show that internal audit

departments of German companies are located between phases ‘2-emerging’ and ‘3-maturing’ and are therefore at a medium level. H_{1-1} assumes that the overall CA adoption rate among German internal audit departments is low and that German internal audit departments are in a stage not higher than ‘2-emerging’. H_{1-1} is therefore rejected.

In regard to the CA subject-specific analyses, results show a very differentiated picture. Groups ‘controls’ and ‘data’ significantly exceed the overall CA adoption rate, while group ‘risk’ significantly falls below the overall CA adoption rate. Although the adoption rate of group ‘projects’ is similar the overall CA adoption rate, its standard deviation and spread are both higher than the overall figures. Results are thus heterogenous. H_{2-1} assumes that the adoption rates of CA subjects ‘risks’, ‘controls’, ‘data’, and ‘projects’ significantly differ from the overall CA adoption rate. As the results show, this is clearly the case. H_{2-1} is therefore confirmed.

H_{3-1} states that the CA adoption rate is significantly influenced by the company-specific parameters ‘level of regulation’, ‘size of company’, and ‘geographical expansion’. The results from the correlation analysis, however, do not provide an unambiguous picture. Parameters ‘level of regulation’ and ‘size of company’ are found to have positive correlation to CA adoption and therefore do affect the adoption of CA in German internal audit departments. In contrast, the ‘degree of internationalisation’ is found to not have a connection to CA adoption and therefore does not influence the adoption of CA. Due to this lack of clarity, H_{3-1} is rejected.

H_{3-2} states that the CA adoption rate of CA is significantly influenced by the internal audit function-specific parameters ‘degree of IT expertise within the IT audit function’ and ‘size of internal audit department’. However, for both variables a significant correlation to CA adoption could not be found. Neither parameters therefore affect the adoption of CA. Thus, H_{3-2} is rejected as well.

Main research B covered an analysis on the extent to which factor groups ‘framework conditions’, ‘skills’, ‘results’, ‘resources’, and ‘support’ have a significantly negative influence on the adoption of CA. As shown above, results are ambiguous. While factor groups ‘resources’ and ‘support’ are found to impair internal auditors in their decision to adopt CA, factor groups ‘framework conditions’, ‘skills’, and ‘results’ are found not to have a significantly negative influence on the adoption of CA. H_{4-1} assumes that all five factor groups have a significantly negative influence on the adoption of CA. As this is not the case, H_{4-1} is rejected.

An overview of the results of both main research A and main research B is shown in the following table:

Table 15: Summary of results

Main Research A - Current status of CA adoption		
Dilemma 1: No clear indication regarding level of CA adoption in practice		
Q_1: What is the overall CA adoption rate among German internal audit departments?		
Hypothesis H_{1-1}: The overall CA adoption rate among German internal audit departments is low.	**Findings:** The overall CA adoption rate among German internal audit departments is at a medium level (2.33).	**Result:** Rejected
Dilemma 2: No scientific findings covering subject-specific levels of CA adoption		
Q_2: In how far does the CA adoption rate differ among different CA subjects?		
Hypothesis H_{2-1}: The adoption rates of CA subjects 'risks', 'controls', 'data', and 'projects' significantly differ from the overall CA adoption rate.	**Findings:** The adoption rates of CA subjects 'risks' (1.93), 'controls' (2.50), 'data' (2.57), and 'projects' (2.21) significantly differ among each other and from the overall CA adoption rate (2.23).	**Result:** Confirmed
Dilemma 3: No scientific findings regarding the effect of company-specific or internal audit function-specific parameters on CA adoption		
Q_3: In how far is the CA adoption rate influenced by company-specific or internal audit function-specific parameters?		
Hypothesis H_{3-1}: The CA adoption rate is significantly influenced by the company-specific parameters 'level of regulation', 'size of company', and 'geographical expansion'.	**Findings:** Parameters 'level of regulation' and 'size of company' are found to have a significant influence on CA adoption. Parameter 'geographical expansion' is found not to have a significant influence on CA adoption.	**Result:** Rejected
Hypothesis H_{3-2}: The CA adoption rate is significantly influenced by the internal audit function-specific parameters 'degree of IT expertise within IT audit function' and 'size of internal audit department'.	**Findings:** Both parameters 'degree of IT expertise within IT audit function' and 'size of internal audit department' are found not to have a significant influence on CA adoption.	**Result:** Rejected
Main Research B – Reasons behind current CA adoption level		
Dilemma 4: No scientific findings regarding strength of factors compromising the application of CA in practice		
Q_4: What factors primarily cause companies to refrain from adopting CA?		
Hypothesis H_{4-1}: Factor groups 'framework conditions', 'skills', 'results', 'resources', and 'support' have a significantly negative influence on the adoption of CA.	**Findings:** Factor groups 'resources' and 'support' are found to have a significantly negative influence on the adoption of CA. Factor groups 'framework conditions', 'skills', and 'results' are found not to have a significantly negative influence on the adoption of CA.	**Result:** Rejected

Source: Own resource

7 DISCUSSION

This chapter includes a detailed discussion on the results of main research A and main research B. It elaborates on the implications to both the academic and the practical field. Also, the chapter details the novelty of this research as well as its limitations. The chapter also provides recommendations for further academic research.

7.1 Conclusions

This research provides further insights of where German internal audit departments stand on their way to a more progressive auditing methodology. The determined results add a significant resource to the academic discussion around the topic of CA. They not only supplement existing findings, but also enrich the field of CA by new insights.

Discussion on research question Q_1

This research discovered that, on average, German internal audit departments find themselves between stages '2-emerging' and '3-matruing'. The overall CA adoption rate can therefore be considered as medium. In comparison to many findings of research articles mentioned in chapter 4, this finding is surprising. Only the findings of Grant Thornton of 2011 and KPMG of 2011 are in line with this research as only these conclude that CA adoption is at the medium level. Five out of nine research articles mentioned in chapter 4 present results which are below the level of CA adoption identified in this research. In particular, the divergence from the most recent findings of Vasarhelyi, Kuenkaikaew, Littley, and Williams of 2015 is unexpected as their research features a comparable approach (i.e. use of the CA adoption levels). This difference may be explicable by methodological reasons (e.g. a time gap between the two investigations, samples which differ in nature and size, or research instruments which differ in detail). However, differences may also stem from the nature of the respondents in this research. Given that respondents were addressed via dedicated auditing networks, it can be assumed that auditors actively engaging in these networks show an increased interest in enhancing their audit activities (in comparison to auditors not being active in these networks).

Another reason why German internal audit departments feature a medium maturity level could be based on the highly regulated environment in which German companies are active. Increased regulatory pressure (compared to other countries) forces German audit departments to gear their

audit activities towards compliance aspects. In this context, CA is used to better facilitate this alignment.

Discussion on research question Q_2

This research provides an in-depth picture of the degree of CA adoption on several CA subjects. Controls and data are likely to be covered by CA activities, while the coverage of projects is slightly less popular among internal auditors. Risks are found to be of subordinate interest for CA purposes.

As discussed in chapter 3, auditing controls is a prime task of the internal audit function. The finding that internal auditors are likely to include controls as part of CA is therefore not surprising. Since the introduction of the Sarbanes-Oxley Act in the year 2002, a lot of research has been performed on internal controls and multiple frameworks (e.g. COSO) have been established. When implementing internal controls, companies are able to refer back to these frameworks as well as existing guidelines, interpretations, and practice aids. Due to extended availability of best practices and master control descriptions, the steps towards CA in the field of controls is small (compared to risks or projects).

The comparably high adoption rate for data may be based on the growing popularity of data analytics among German internal auditors. These allow internal auditors to evaluate large data volumes which bring forward insights into areas not auditable before (Audicon, 2021). As discussed in chapter 4, CA supports these developments. Also, sophisticated tools to analyse data (e.g. IT authorisations or journal entries) have been available for approx. 20 years, giving this subject an advantage over subjects such as projects or risks.

As companies become more and more flexible, an increasing number of corporate undertakings are organised as projects. Due to this increase in importance, projects more and more affect internal auditors in their professional activities. Internal auditors increasingly have to evaluate projects retrospectively or in real time and provide an opinion on their effectiveness. The results of this research provide evidence that internal auditors apply CA during their evaluation of projects. However, the extent of these CA-based activities is not as extensive as for controls and data. One reason why projects are not on the same level as controls or data could be due to a lower degree of standardisation of projects. Although projects follow a common structure, the

content of each projects differs. Designing appropriate KPIs therefore represents a major challenge to internal auditors and requires from them an increased effort.

Risk management is central to companies. Corporate scandals such as Enron and Parmalat approx. 20 years ago have shown that the identification and proper handling of risks are of essential importance when it comes to preventing fraud or financial misstatements. Since then, companies have been asked to implement solid risk management systems which are supposed to prevent them from facing severe damage. Also, regulations have been introduced which impose fines on senior management if risks are not properly managed. It is therefore all the more surprising that the subject 'risks' ranks lowest among all CA subjects in this research. These results do not necessarily prove that companies do not account for risk management, but that CA is not applied in the field of risk management by internal auditors. This could be based on the fact that Continuous Risk Management and Assessment primarily relies on KRIs (instead of KPIs used for other subjects) and that the applicability of KRIs in practice is not as straightforward as KPIs. Recent corporate scandals (e.g. Wirecard) and the debate around the role of auditors in this context nourishes the assumption that risk management is in fact not of prime concern among auditors (against public belief). This can be another reason for the low adoption rate of CA subject 'risks'.

Discussion on research question Q_3

CA is more likely to be applied by some companies than others. This research identified a significantly positive relationship between the degree of CA adoption and 'company size' as well as between the degree of CA adoption and the 'level of regulation'. Thus, larger companies and companies from industries with a higher level of regulation increasingly use CA. Both findings do not come as a surprise.

As argued above, a critical company size is recommended to ease the resource-intense implementation of CA. Costs apply not only for personnel who take over tasks such as defining the CA model (i.e. the audit subject, the KPIs/KRIs, frequencies, target values) and acquiring a CA software, but also for ongoing functional support and technical maintenance. Given these required investments, the break-even point of using CA lies multiple years ahead which can cause smaller companies without a strong financial background to refrain from applying CA. To overcome this limitation, companies need to refrain from the implementation of CA in a big bang approach. Instead, it is highly advisable to start off with a few, but manageable audit subjects.

Also, if the acquisition of CA-specific software is beyond reach, standard software (e.g. MS Office) may help during early CA endeavours.

In this research, CA is found to be used to a larger extent in companies from highly regulated industries. As hypothesised, industries ‘Electricity, gas, steam and air conditioning supply’ (d) and ‘Financial and insurance activities’ (k), which were assumed as highly regulated, feature a comparably high adoption rate. As discussed in chapter 3.5, internal audit departments are increasingly confronted with regulatory requirements in two ways. Not only do they need to validate compliance of their companies with rules and regulations, they also need to ensure that their own work occurs in line with requirements imposed on the internal audit function itself. CA proves helpful to address these regulatory requirements due to its strong focus on high risk areas. This finding is in line with the findings of Khargi of 2010 and KPMG of 2011. As a consequence for the practical field, affected companies (e.g. banks) need to carefully consider the many benefits of implementing CA and evaluate how far CA can help them achieve compliance with regulations.

The three other company-specific or internal audit function-specific parameters (‘size of internal audit department’, ‘IT expertise among internal auditors’, and ‘degree of geographical expansion’) were found not to be correlate with the extent of CA usage.

As discussed in the preliminary research, the relationship between ‘size of the internal audit department’ and CA usage is not entirely clear and in parts even contradictory. While some respondents argued that the internal audit department needed a critical size (similar to company size), others argued that CA compensates for a lack of personnel. The fact that the size of the internal audit department was found not to correlate with the CA adoption rate may be a result of this unclear situation.

The missing correlation between CA and ‘IT expertise’ is surprising. Given that CA is closely connected to IT (i.e. higher efficiency, better applicability when audit subject is of digital nature), it is not too far-fetched to assume a correlation between these two variables. As shown by the results, companies do apply CA, even in the absence of dedicated IT auditors. This implies that major challenges during the usage of CA are not of a technological nature. Another explanation could be that CA is used to compensate for a lack of skilled IT auditors.

In the preliminary research one respondent mentioned that the degree of geographical expansion has an impact on the usage of CA. Not having found a strong correlation between this variable and the CA adoption rate in main research A shows that this response was subjective and not representative for the 78 companies covered.

Discussion on research question Q_4

This research found out what two factors influence companies in their decision to refrain from applying CA, namely the lack of resources as well as lacking proper support from management and other departments.

The need for proper support is of central importance for the application of CA, especially during the introduction phase. CA represents a major divergence from traditional auditing and will crease noise within the organisation. Management's main responsibility is to assist the internal audit function in promoting the new approach and ensuring that doubts and obstacles are removed. If this form of support is missing, the introduction of CA is most likely to fail. Also, other departments need to provide support as well. E.g., the accounting departments must consent to providing raw data for CA purposes in due time and the IT department needs to ensure the availability of the technical infrastructure for CA analyses. A suitable and well-phrased methodology to align tasks and responsibilities needs to be in place and understood by all involved parties. This finding is in line with findings by Vasarhelyi, Kuenkaikaew, and Romero (2010) as well as by Khargi (2010) who point out that support provided by management and the organisation as a whole is of great importance for the adoption of CA.

Similar to the results of main research A, main research B provides evidence that having an adequate number of resources available is a decisive factor when it comes to the adoption of CA. This finding is in line with findings by Tumi (2013), Taylor and Murphy (2004), as well as of Baksa and Turoff (2010) who all believe that a CA introduction comes with major costs. Also, it supports the discussion on research question Q_3 and demonstrates the importance of having adequate resources available during all CA stages.

One respondent did not understand CA to fall under the responsibility of the internal audit departments. Instead, he saw the responsibility for CA as resting with first line or second line departments. As discussed in chapter 4.2, there is a close connection between CA and CM, the

latter one of which is primarily applied by management and other functional departments. Confusion around the definitions of these disciplines in practice may have caused this reason to come up in this research. Yet, understanding CA as a discipline primarily performed by departments of the first and second line is inconsistent with CA definitions provided in chapter 4 and gives rise to a fundamental discussion about the ownership of CA.

Moreover, evidence was found that providing assurance is not the ultimate objective of the internal audit function. Instead, auditors' focus rests with efficiency of operations. This shift of the internal audit function's objectives towards efficiency (and thus away from effectiveness) is comprehensible from a management perspective, but is inappropriate regarding the internal audit function's primary objective to provide assurance. It can even be considered as risky, when it goes hand in hand with internal audit departments sacrificing their independence. Yet, this notion may be a result of the respondent's unclear understanding of CA, CM, and related terms. As this reason was provided by one respondent only, its explanatory power is limited.

Fear to approach something new was mentioned as another reason to refrain from CA by one respondent. It is in line with Hoffer (2007, pp. 1-19) who finds that auditors fear disruption of the audit plan and with Vasarhelyi, Teeter, and Krahel (2010, pp. 405-423) who believe that internal auditors fear a loss of independence when traditional auditing is superseded by CA. Fear, in this case, can also imply that auditors are afraid of becoming obsolescent (although this opinion is unfounded as CA does not aim to abolish internal auditors). Yet, also this reason possesses limited explanatory power.

Weak framework conditions, such as high technical or structural boundaries, instable processes, or rapidly changing environments do not have a negative impact on a company's decision to implement CA. Thus, CA is considered strong enough to overcome these obstacles.

A low level of technical and functional knowledge or other forms of missing experience among auditors does not discourage internal auditors from adopting CA. This implies that internal auditors are positive towards CA and do not fear to approach challenging tasks such as the definition of suitable KPIs/KRIs or the implementation of CA tools.

Moreover, auditors do not worry that CA delivers impressive results, at least this fear is not severe enough to make them refrain from CA. This implies that internal auditors lay trust in

CA. The findings of main research B support the discussion on research question Q_1 and provide further proof that German internal auditors are willing to undertake small steps towards more progressive auditing methodologies.

7.2 Novelty of research

The research at hand yields benefits to both the scientific field and the practical community.

Benefits to the scientific field

This research adds value to the academic discussion around CA in multiple ways.

As there has been little research regarding the adoption rate of CA, this research primarily delivers further insights into the degree companies utilise CA. The main novelty is that this research not only considers the discipline of CA as one object. It goes beyond this high-level perspective by splitting CA down into its disciplines and accounting for its subjects ‘controls’, ‘risks’, ‘data’, and ‘projects’. As a result, this research provides a differentiated, in-depth picture of the degree of CA adoption on several dimensions which marks a strong contrast to existing research.

Existing literature has brought forward several factors influencing the usage of CA. However, the strength of single reasons for the adoption of CA had been unexplored in science. By empirically investigating the strength of single influencing factors, this research goes beyond the current state of research.

As most CA studies, and especially those centring around the adoption level of CA, are based on samples from the U.S.A., this research delivers insights on how CA is applied in another country, namely Germany, which has not been the exclusive subject to any CA adoption level studies before.

Yet, the academic discussion around CA yields further unexplored fields. Future research therefore should aim to identify further factors which prevent CA from reaching an even higher adoption rate. Further analyses about the strength of single factors would deliver additional help for practitioners during the prioritisation of obstacles. Moreover, the discussion about CA sub-

jects has not reached its limits and researchers should focus on identifying other subjects besides ‘risks’, ‘controls’, ‘data’, and ‘projects’. For the practical field it would be of help if specific implementation guidelines were developed. These would ease companies’ efforts during early CA stages. Sharing success stories that point out the benefits of CA and convince yet more companies to adopt CA will be of great additional value as well.

Benefits to the practical community

Alongside the academic benefits, this research yields several benefits for the academic community as well.

Results provided by this research add a small piece of knowledge and help practitioners before and during the implementation of CA. Insights gained can be used as a starting point for further, even more detailed analysis or may be reframed into practical guidelines. Also, this research provides a more practically oriented explanation of CA which helps internal auditors to outline CA more specifically.

The level of adoption to be identified by this research will provide a benchmark for internal auditors to orientate themselves. It will give them a considerable amount of security and confidence regarding their standpoint and their prospects. Also, it will enhance their understanding about the definition and the elements of CA.

The reasons for a specific adoption rate to be identified by this research can be used to determine and counteract potential hurdles during the implementation of CA. They can also be used during the auditors’ evaluation of how far a CA implementation is feasible.

7.3 Limitations

Both main research A and main research B hold limitations. The limitations of main research A are listed below:

- As indicated in chapter 2, hypotheses represent different alternatives to address the research questions. The tested hypotheses represent the best options in the author’s opinion, although other hypotheses are theoretically possible.
- The primarily aim of the preliminary research was to collect further information to specify the hypotheses for main research A. It only covers eight respondents. Also, the extent

of questions covered in the preliminary research is limited to three. Despite all care taken, the risk of distortion in results due to these limitations cannot entirely be ruled out.

- Main research A covers a total of 78 valid responses. Results and conclusions generated from this comparably small number must therefore be handled with care. Expressiveness is only limited. Also, due to the unknown total population (i.e. the exact number of addressed individuals), a response rate cannot be determined. Thus, the representativeness of main research A is unclear.
- As responses were provided anonymously, it is possible that not all respondents act as internal auditors.
- Questions used in the survey aimed to collect data about the current status of CA adoption as best as possible. As these questions were limited in number, the questionnaire did not account for elements of minor importance.
- The overall CA adoption level comprised the CA adoption levels of four CA subjects (plus group ‘general’). While doing so, it was assumed that the four CA subjects held equal shares of the total CA adoption (i.e. three questions each). Whether this even distribution is a fair representation remains uncertain.
- Questions covering the company-specific and internal audit function-specific parameters provided predefined answer options which are of ordinal (in one case nominal) nature. Also, as answer options only provided ranges (instead of exact figures), respondents could not provide exact answers or provide individual responses. Also, it was assumed that the chosen variables best reflect the parameters. Due to these shortages and assumptions, results could be distorted to a minor extent.
- The correlation analyses assumed that the relationship between the variables is strictly linear. However, even if analyses did not identify a significant relationship, it is possible that a relationship between two variables could be present in a non-linear (e.g. exponential, quadratic) form.

Main research B holds the following limitations:

- Given a total of 21 valid questionnaires returned and a return rate of 29.2%, participation can be regarded as relatively low. Thus, results are not as representative as other investigations featuring a higher return rate.

- Also, this research focused on restricting factors only. Reasons supporting the adoption of CA were not analysed. Thus, results are not entirely free from bias.
- Main research B featured different participants than main research A. In how far or to what level participants of main research B have adopted CA (in comparison to participants of main research A) is unknown. A direct link between main research A and main research B is not present. This limits the explanatory power of conclusions drawn from the combination of both areas of research.
- As main research B occurred in an anonymous manner, it is unknown whether respondents were, in fact, internal auditors. Although the conference was addressed primarily to internal auditors, it cannot be ruled out that members of other professions (e.g. scientists, external auditors, risk managers, compliance managers, general managers) were part of the audience and thus part of the survey.
- The questionnaire only consisted of six questions which can be regarded as a comparably small figure. Answers are thus subject to sampling error.
- Newly identified reasons (from survey question 6) were not analysed in further detail. Representativeness of findings generated from this question is therefore uncertain.
- Respondents to the survey were offered a comparably small timeframe to answer the questions. If they had been provided with more time, then the level of thought that they put into the answers may have been more reflective and thus more representative.

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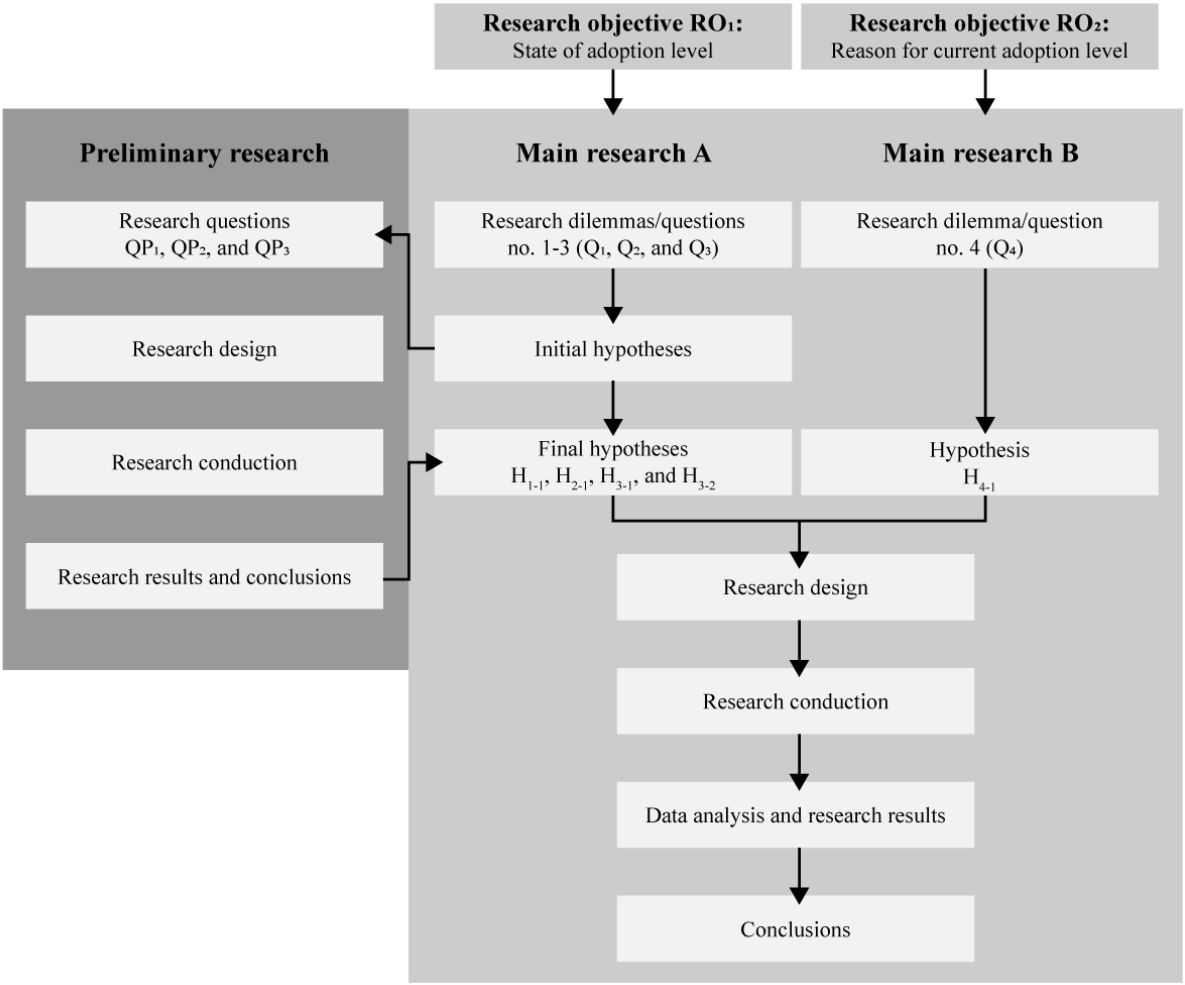
Appendix 1: Overview of research



Appendix 2: Interview guideline

Agenda item	Performed by
Welcome	CAE
Personal introduction of interview participants: • Name • Role • Experience in the field of internal auditing / past positions	All
Explanation of objectives and background of interview: • Interview is part of a research about the adoption rate of CA • Research is used for doctoral thesis • Interview aims to obtain further information to sharpen understanding of CA, its elements, and its characteristics • Whole research aims to provide further insights into the academic and practical field	Lead researcher
Introduction to CA: • Scientific definitions of CA • Own interpretation of definitions	Lead researcher
General questions: • What are your roles? (if not stated during personal introduction) • How is your internal audit department structured? (if not stated during personal introduction)	Lead researcher Notes taken by assistant researcher
Research questions: • QP1: How is CA understood in the practical field? • QP2: What subjects is CA being used for? • QP3: What company-specific or internal audit function-specific conditions can CA best be applied under?	Lead researcher Notes taken by assistant researcher
Acknowledgements: • Thank participants for their help • Ask participants whether they are interested in receiving results from this research	Lead researcher
Farewell	CAE

Appendix 3: Questionnaire of main research A

Dear internal auditors!

Today I would like to invite you to participate in my study covering the degree of adoption of Continuous Auditing.

Continuous Auditing is a risk-oriented, systematic auditing methodology (assisted by using IT tools) which aims to provide real-time information on the selected audit subjects by using KPI-based target-performance comparisons. It strives for a more efficient audit process and redirects the focus of audit procedures to the most critical audit subjects.

As doctoral student, I am currently working on an in-depth analysis of the topic of Continuous Auditing on a scientific level. The objective of this study is to analyse the degree of adoption of different CA subjects in internal audit departments of German companies. Doing so, I aim at gaining useful insights into the extent to which German auditors harness the benefits of this new methodology. Therefore, your participation in the study forms the basis for an important contribution to the scientific development of the topic.

The study consists of 25 questions and participation will only take 15 minutes. It goes without saying that your participation is anonymous and in compliance with legal data protection requirements.

If you are interested in the results of the study, I will gladly send you the results by email after completion. In addition to the overall results (broken down by CA subject), you will receive a detailed information of the maturity level your company ranks in and the corresponding rank of your peer group (same industry, similar company size) which you may refer to as a benchmark.

The questionnaire is attached to this cover letter! If you have any questions, please do not hesitate to contact me. Thank you very much for your participation!

Best regards,
Johannes Martin Wagner

Questionnaire

'Adoption of continuous auditing among German internal audit departments'

Part I: Continuous Auditing in your company (17 questions)

[Q1] Which situation best describes the objectives of your internal audit function?

a) Audit activities exclusively aim to validate financial reporting. Only auditing activities are performed.
b) Audit activities primarily aim to validate financial reporting, but also cover other corporate areas. Alongside audit activities, occasional consulting activities are performed.
c) A balanced mix of audit and consulting activities aim to validate and support a range of different corporate areas.
d) A risk-based, integrated set of audit and consulting activities aims to validate all significant corporate areas.

[Q2] Which situation best describes the process of planning your audit activities?

a) An annual audit plan is prepared. Audit engagements are performed in strict adherence to the plan.
b) An annual audit planned is prepared. This plan is supplemented by occasional, unscheduled audit engagements. Indicators (e.g. KPIs/KRIs) are not or only rarely used during the planning process.
c) Audit planning is largely flexible and demand-oriented. Alongside other methods, indicators are used frequently to identify demand for audit activities.
d) Exclusive (or almost exclusive) reliance on indicators to identify abnormalities and need to perform in-depth audit activities.

[Q3] Which situation best describes the process of obtaining data stored in IT systems required for your audit activities?

a) Relevant data is provided on explicit request only.
b) Relevant data is provided without request.
c) Access to systems holding relevant data is granted for a limited time period.
d) Access to systems holding relevant data is granted for an unlimited time period.

[Q4] Which situation best describes the extent to which you make use of sophisticated audit software for your audit activities?

a) Audit activities are entirely or almost entirely manual. Sophisticated audit software is not in use.
b) Audit activities are primarily manual. Standard software (e.g. MS Excel) is used for simple data analyses.
c) Audit activities are primarily manual. Sophisticated audit software (e.g. ACL, IDEA) is used irregularly.
d) Audit activities are automated to a significant extent. Sophisticated audit software is used on a regular or ongoing basis. Software is connected to email client to enable alerts being sent automatically to auditors.

[Q5] Which situation best describes the extent to which you take input from management or other audit-like functions (e.g. compliance, IT security, data protection, risk management) into account in your audit planning?

a) Input from management or other audit-like functions is not considered for the audit planning.
b) Input from management or other audit-like functions is rarely considered for the audit planning.
c) Input from management or other audit-like functions is mostly considered for the audit planning.
d) Input from management or other audit-like functions is always considered for the audit planning.

[Q6] Which situation best describes the extent of formalisation of your company's internal controls?

a) Formalised control descriptions are not available. Control ownership is not entirely defined.
b) Formalised control descriptions are available. Control ownership is largely defined.
c) Formalised control descriptions are available. Control ownership is fully defined. Internal controls are overseen and managed by a dedicated function independent from functional departments.

d) Formalised control descriptions are available. Control ownership is fully defined. Internal controls are overseen and managed by a dedicated function independent from functional departments. Additionally, internal controls are subject to regular audit engagements by other audit-like functions (e.g. compliance, IT security, data protection, risk management).

[Q9] Which situation best describes the extent to which your audit activities cover risk management?

a) Risk management is not subject to internal audit activities.
b) Single elements of risk management (e.g. review of risk assessments, review of risk processes, review of risk reporting) are accessed by the internal audit function in an informal manner (i.e. without adherence to formalised audit procedures).
c) Risk management and risk management elements are extensively accessed by the internal audit function. Audit activities are included in a yearly audit plan. Formalised audit procedures are applied when audit activities are performed.
d) Risk management or risk management elements are continuously monitored and accessed by the internal audit function with support of specialised software.

[Q12] Which situation best describes your procedure when auditing journal entries?

a) Journal entries are not subject to audit activities.
b) Journal entries are assessed manually.
c) Journal entries are assessed in regular or irregular intervals by using specialised software.
d) Journal entries are assessed continuously by using specialised software.

[Q15] Which situation best describes the extent to which audit activities cover corporate projects?

a) Projects are not subject to internal audit activities.
b) Retrospective reviews of project documentation are performed for selected projects.
c) The internal audit function is partially involved in major projects and audit activities are performed when milestones are reached.
d) The internal audit function is fully involved in all projects and continuously performs audit activities.

[Q7] Which situation best describes the extent to which internal controls are covered by your audit activities?

a) Internal controls are not subject to any audit activity.
b) Internal controls are occasional reviewed as part of other audit engagements.
c) Internal controls are reviewed at intervals as part of independent audit activities.
d) Internal controls are continuously monitored. If feasible, indicators (e.g. KPIs) are calculated and IT tools are used as support.

[Q10] Which situation best describes the frequency of your audit activities covering risk management or risk management elements?

a) Risk management or risk management elements are not accessed at all.
b) Risk management or risk management elements are accessed irregularly.
c) Risk management or risk management elements are accessed regularly.
d) Risk management or risk management elements are accessed continuously.

[Q13] Which situation best describes your procedure when auditing user authorisations in IT systems?

a) The assessment of user authorisations is not subject to audit activities.
b) User authorisations are assessed manually.
c) User authorisations are assessed at regular or irregular intervals by using specialised software.
d) User authorisations are assessed continuously by using specialised software.

[Q16] Which situation best describes the procedure of assessing corporate projects?

a) Projects are informally assessed (i.e. without applying formalised audit procedures).
b) Projects are assessed with adherence to formalised audit procedures and standardised work programs.
c) Projects are assessed with adherence to individualised work programs. Audit activities are adjusted throughout the project, if necessary.
d) The internal audit function’s assessment is based on an ongoing calculation of project-related indicators (e.g. KPIs) to allow risk-based adjustments of audit activities throughout the project.

[Q8] Which situation best describes your approach to assess the effectiveness of controls?

a) Little or no documentation of controls and control performances is available in digitalised form. Controls are either not checked or are only checked manually by the internal audit function (e.g. by inspecting of paper-based documents, questioning control owners).
b) Little or no documentation of controls and control performances is available in digitalised form. The effectiveness of controls is occasionally assessed by using audit software.
c) Documentation of controls and control performances is mostly available in digitalised form. The effectiveness of controls is mostly assessed by using audit software.
d) Documentation of controls and control performances is fully available in digitalised form. Effectiveness of controls are exclusively or almost exclusively assessed by using audit software.

[Q11] Which situation best describes the extent to which you apply indicators (e.g. KRIs) during your assessment of your company's risk management activities?

a) Indicators are not used at all.
b) Indicators are rarely used (i.e. for only few audit subjects in the risk management environment).
c) Indicators are mostly used (i.e. for most audit subjects in the risk management environment).
d) Indicators are always used (i.e. for all audit subjects in the risk management environment).

[Q14] Which situation best describes the extent to which your audit activities include data analytics (e.g. trend analyses, time series analyses, correlation or regression analyses, etc.) to access data?

a) Audit activities do not include data analytics.
b) Data analytics are performed irregularly and with standard tools (e.g. MS Excel)
c) Data analytics are performed regularly (e.g. at period end) and with support of specialised software.
d) Data analytics are performed continuously with support of specialised software.

[Q17] Which situation best describes the extent to which audit software is used for the assessment of corporate projects?

a) Audit software is not used for the assessment of projects.
b) Audit software is used to a limited extent and only for the assessment of certain projects or the performance of certain audit activities.
c) Audit software is used frequently for the assessment of projects.
d) Audit software is a central part of project-related audit activities and used for the assessment of (almost) all projects.

Part II: Information about your company and your internal audit department (6 questions)

[Q21] How high was the annual turnover of your company in the last financial year?

a) < €1 million
b) €1 million - €10 million
c) €10 million - €100 million
d) €100 M million - €1 billion
e) > €1 billion

[Q22] How many employees work in your company?

a) 1 – 100
b) 101 – 1,000
c) 1,001 – 5,000
d) 5,001 – 10,000
e) 10,001 – 50,000
f) 50,001 – 100,000
g) > 100,000

[Q18] Which industry does your company belong to?

a) Agriculture, forestry and fishing
b) Mining and quarrying
c) Manufacturing
d) Electricity, gas, steam and air conditioning supply
e) Water supply; sewerage, waste management and remediation activities
f) Construction

g) Wholesale and retail trade; repair of motor vehicles and motorcycles
h) Transportation and storage
i) Accommodation and food service activities
j) Information and communication
k) Financial and insurance activities
l) Real estate activities
m) Professional, scientific and technical activities
n) Administrative and support service activities
o) Public administration and defence; compulsory social security
p) Education
q) Human health and social work activities
r) Arts, entertainment and recreation
s) Other service activities
t) Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
u) Activities of extraterritorial organisations and bodies

[Q23] Where is your company mainly active?

a) predominantly regional
b) predominantly national
c) predominantly Europe-wide
d) predominantly worldwide

[Q20] How many employees work in your company's internal audit department or are primarily engaged with internal audit activities?

a) 1 - 10
b) 11 - 25
c) 26 - 50
d) 51 - 100
e) > 100

[Q19] How many internal IT auditors does your company employ?

a) 0
b) 1 - 10

c) 11 - 25

d) 26 - 50

e) > 50

Part III: Information about your company and your internal audit department (2 questions)

[Q24] Are you currently working in the internal audit department of your company?

a) Yes

b) No

[Q25] Are you primarily performing internal audit activities?

a) Yes

b) No

Thank you very much for participating in my study!

If you wish to receive the results of my study, please leave your email address below:

_____

Appendix 4: Questionnaire of main research B

Questionnaire
'Reasons for low adoption rate of continuous auditing among German internal audit departments'

Dear internal auditors!

Continuous Auditing is a risk-oriented, systematic auditing methodology (assisted by using IT tools) which aims to provide real-time information on the selected audit subjects by using KPI-based target-performance comparisons. It strives for a more efficient audit process and redirects the focus of audit procedures to the most critical audit subjects.

As doctoral student, I am currently working on an in-depth analysis of the topic of Continuous Auditing on a scientific level. The objective of this study is to analyse the reasons for the low adoption of continuous auditing among internal audit departments of German companies. Doing so, I aim at gaining useful insights into the extent to which German auditors harness the benefits of this new methodology. Therefore, your participation in the study forms the basis for an important contribution to the scientific development of the topic.

For each of the following questions, please indicate which answer option best fits the quoted statement in regard to your company!

Survey question 1: Framework conditions relevant to the adoption of CA (e.g. consistency in the internal and external corporate environment, stable processes) change too quickly.

1) Strongly disagree
2) Somewhat disagree
3) Neither agree nor disagree
4) Somewhat agree
5) Strongly agree

Survey question 2: Necessary knowledge and skills for the adoption of CA among my company's internal auditors are not or insufficiently available.

1) Strongly disagree

2) Somewhat disagree
3) Neither agree nor disagree
4) Somewhat agree
5) Strongly agree

Survey question 3: Results provided by CA are not precise enough, too extensive, or do not cover the desired information needs.

1) Strongly disagree
2) Somewhat disagree
3) Neither agree nor disagree
4) Somewhat agree
5) Strongly agree

Survey question 4: The expenditures for the implementation, maintenance, and enhancement of CA (e.g. personnel costs, IT costs) are too high.

1) Strongly disagree
2) Somewhat disagree
3) Neither agree nor disagree
4) Somewhat agree
5) Strongly agree

Survey question 5: The support from management or other specialist departments (e.g. IT, Finance) necessary for the adoption of CA is not sufficiently ensured.

1) Strongly disagree
2) Somewhat disagree
3) Neither agree nor disagree
4) Somewhat agree
5) Strongly agree

Survey question 6 (optional): Please list further reasons relevant to you in your decision not to adopt CA.

_____

Thank you very much for participating in my study!

Appendix 5: Spreadsheet with results from main research A

Data in the spreadsheets is based on 78 valid answers received (n = 78). The first table shows the answers of respondents 1 to 39 to the questions of the first part of the questionnaire (question 1 to question 17).

Element	AL	ALg	ALc	ALr	ALd	ALp	General 1 (Q1)	General 2 (Q2)	General 3 (Q3)	General 4 (Q4)	General 5 (Q5)	Control 1 (Q6)	Control 2 (Q7)	Control 3 (Q8)	Risk 1 (Q9)	Risk 2 (Q10)	Risk 3 (Q11)	Data 1 (Q12)	Data 2 (Q13)	Data 3 (Q14)	Project 1 (Q15)	Project 2 (Q16)	Project 3 (Q17)
1	2.9	3.0	3.0	3.0	2.7	3.0	3	3	3	3	3	3	2	4	4	3	2	2	3	3	3	3	3
2	3.0	3.2	3.0	3.0	3.0	2.7	3	3	3	3	4	3	3	3	3	3	3	3	4	2	3	3	2
3	3.3	3.2	3.3	3.3	3.0	3.7	4	3	3	3	3	4	3	3	3	4	3	3	3	3	4	3	4
4	2.9	3.4	2.7	2.3	3.3	2.3	4	3	3	3	4	3	3	2	2	2	3	4	3	3	2	2	3
5	2.9	3.0	3.3	3.0	2.7	2.7	3	3	3	3	3	3	3	4	2	3	4	3	2	3	2	3	3
6	2.9	2.8	2.7	3.0	3.3	3.0	2	3	3	3	3	2	3	3	3	3	3	3	4	3	3	3	3
7	2.6	2.8	3.3	2.7	2.3	2.0	2	3	2	4	3	3	4	3	3	2	3	2	3	2	2	2	2
8	3.1	3.0	4.0	2.3	3.3	2.7	3	3	2	3	4	4	4	4	3	2	2	4	3	3	3	3	2
9	2.6	2.6	3.3	2.3	2.3	2.7	3	2	2	2	4	4	3	3	2	3	2	1	3	3	3	3	2
10	2.5	2.2	3.0	2.0	2.3	3.0	3	2	2	2	2	3	3	3	2	2	2	2	3	2	3	3	3
11	2.6	2.8	2.3	2.3	2.7	2.7	2	3	3	2	4	3	2	2	2	3	2	3	2	3	3	3	2
12	2.8	2.8	3.0	2.7	3.0	2.3	2	2	3	4	3	2	4	3	2	3	3	2	4	3	2	3	2
13	2.4	2.0	2.7	2.3	3.0	2.3	1	2	3	2	2	3	3	2	3	2	2	3	3	3	2	2	3
14	2.5	2.8	2.3	2.3	2.7	2.3	2	3	3	3	3	2	2	3	2	2	3	4	2	2	3	2	2
15	2.1	2.4	1.3	2.0	2.0	2.3	3	2	2	2	3	1	2	1	2	2	2	2	2	2	2	2	3
16	2.5	2.6	2.3	2.0	2.7	2.7	2	2	3	3	3	2	3	2	3	2	1	3	3	2	3	2	3
17	2.8	2.0	3.3	2.0	3.3	3.7	1	2	2	3	2	3	4	3	2	2	2	3	3	4	4	3	4
18	2.3	2.2	2.3	2.0	2.0	3.0	2	2	3	2	2	2	3	2	2	2	2	2	3	1	4	3	2
19	2.5	2.6	2.3	2.3	2.3	2.7	3	3	2	2	3	3	2	2	2	3	2	3	2	2	3	3	2
20	2.9	3.4	3.3	2.0	3.0	2.3	3	3	3	4	4	4	3	3	2	2	2	2	4	3	2	3	2
21	2.2	2.8	2.3	1.0	2.7	2.0	4	3	3	2	2	2	3	2	1	1	1	3	2	3	2	3	1
22	2.3	2.0	3.0	1.7	2.7	2.3	2	2	2	2	2	3	3	3	2	2	1	3	3	2	3	2	2
23	2.4	2.2	2.7	2.0	2.7	2.7	2	2	2	2	3	3	3	2	2	2	2	2	3	3	3	3	2
24	1.9	2.0	2.0	1.7	2.3	1.7	2	2	2	2	2	2	2	2	2	2	1	2	2	3	2	2	1
25	2.2	2.2	2.7	2.0	2.0	2.0	1	3	3	2	2	3	2	3	2	2	2	3	1	2	2	3	1
26	2.1	2.2	2.3	1.7	2.3	2.0	2	3	2	2	2	2	2	3	2	2	1	3	2	2	2	2	2
27	2.1	2.4	2.7	1.0	2.7	1.7	3	2	3	2	2	3	3	2	1	1	1	2	3	3	2	2	1
28	2.4	2.6	2.3	2.0	3.0	1.7	3	2	3	2	3	2	2	3	2	2	2	3	3	3	2	2	1
29	2.4	2.2	2.7	2.0	2.7	2.3	2	1	3	1	4	3	3	2	2	2	2	3	3	2	3	3	1
30	2.1	2.2	2.0	2.0	2.3	2.0	3	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	1
31	2.6	2.6	2.3	2.0	3.3	2.7	2	3	3	3	2	2	2	3	3	2	1	3	3	4	4	3	1
32	2.5	2.8	2.7	2.3	3.0	1.7	3	3	3	3	2	3	2	3	2	3	2	2	4	3	2	2	1
33	2.4	2.4	2.3	2.0	2.7	2.3	2	4	3	2	1	2	2	3	2	2	2	3	3	2	3	2	2
34	2.2	2.8	2.0	1.0	2.3	2.7	4	4	2	2	2	3	1	2	1	1	1	3	2	2	3	2	3
35	2.6	2.6	2.7	2.0	3.0	2.7	3	3	2	3	2	2	3	3	2	2	2	4	2	3	4	3	1
36	2.5	2.6	2.7	2.3	3.0	2.0	2	2	3	3	3	3	3	2	2	3	2	2	3	4	3	2	1
37	2.5	2.8	2.3	2.3	2.3	2.7	2	3	3	3	3	3	2	2	2	3	2	2	1	4	3	2	3
38	2.4	2.6	2.3	2.0	2.7	2.0	3	2	2	3	3	2	2	3	2	2	2	3	1	4	3	2	1
39	2.3	2.4	2.3	2.7	2.7	1.3	3	3	1	2	3	2	2	3	3	3	2	3	2	3	2	1	1

The second table shows the answers of respondents 40 to 78 to the questions of the first part of the questionnaire (question 1 to question 17).

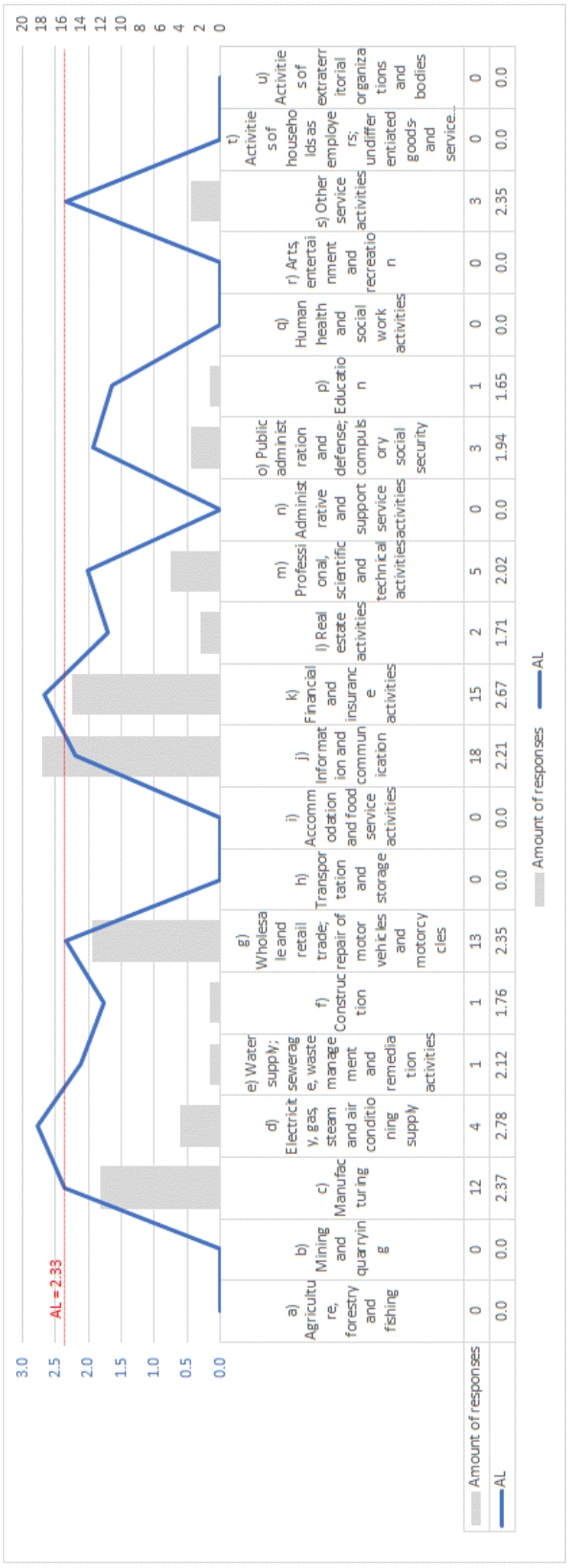
Element	AL	ALg	ALc	ALr	ALd	ALp	General 1 (Q1)	General 2 (Q2)	General 3 (Q3)	General 4 (Q4)	General 5 (Q5)	Control 1 (Q6)	Control 2 (Q7)	Control 3 (Q8)	Risk 1 (Q9)	Risk 2 (Q10)	Risk 3 (Q11)	Data 1 (Q12)	Data 2 (Q13)	Data 3 (Q14)	Project 1 (Q15)	Project 2 (Q16)	Project 3 (Q17)
40	2.1	1.8	2.3	2.3	2.3	1.7	2	2	1	2	2	2	3	2	3	2	2	2	2	3	2	2	1
41	2.0	2.0	2.0	2.7	1.7	1.7	2	1	3	2	2	2	2	2	3	3	2	2	1	2	2	2	1
42	2.3	1.8	2.7	2.3	2.3	2.7	2	2	2	1	2	2	3	3	2	3	2	3	2	2	3	3	2
43	2.6	3.0	2.3	2.0	3.3	2.3	3	3	3	3	3	3	2	2	2	2	2	4	3	3	3	3	1
44	2.4	2.4	2.3	2.3	3.0	1.7	3	3	1	2	3	2	2	3	2	3	2	3	3	3	2	2	1
45	1.9	1.8	2.3	1.0	2.7	1.7	1	2	2	2	2	2	2	3	1	1	1	3	3	2	2	2	1
46	2.3	2.0	2.7	2.0	2.7	2.3	1	2	3	2	2	3	3	2	2	2	2	3	2	3	2	3	2
47	1.9	2.4	2.3	1.0	1.7	2.0	2	2	3	2	3	2	3	2	1	1	1	2	1	2	3	2	1
48	2.2	2.4	2.7	2.3	1.7	2.0	3	1	4	2	2	3	3	2	2	3	2	1	2	2	2	2	2
49	2.4	2.0	2.7	2.3	2.7	2.3	2	2	2	2	2	3	2	3	2	3	2	3	3	2	3	2	2
50	2.2	1.8	2.7	2.0	2.3	2.7	2	1	3	1	2	3	3	2	2	2	2	2	3	2	3	3	2
51	2.5	2.6	2.0	2.0	3.3	2.7	3	1	3	4	2	2	2	2	2	2	2	4	3	3	4	3	1
52	2.3	2.0	2.7	1.7	2.3	3.0	2	1	3	2	2	2	3	3	2	2	1	2	2	3	2	4	3
53	2.1	2.0	2.7	1.0	2.7	2.3	2	2	2	2	2	3	2	3	1	1	1	3	3	2	3	2	2
54	2.1	1.8	2.7	2.0	2.3	1.7	1	2	3	1	2	2	3	3	2	2	2	2	3	2	2	2	1
55	2.4	2.6	2.3	1.7	2.3	2.7	3	2	4	1	3	3	2	2	2	2	1	3	2	2	3	2	3
56	2.4	2.6	2.3	2.0	2.7	2.3	2	3	4	2	2	2	3	2	2	3	1	3	2	3	3	3	1
57	2.5	2.8	2.7	2.3	2.7	2.0	3	3	4	1	3	3	2	3	2	3	2	3	2	3	2	2	2
58	1.8	2.0	2.7	1.7	1.7	1.0	1	3	3	1	2	2	3	3	2	2	1	2	1	2	1	1	1
59	2.4	2.2	3.3	1.7	2.7	2.3	2	2	2	3	2	3	4	3	2	2	1	3	2	3	3	3	1
60	2.2	2.2	2.7	1.3	2.7	2.0	3	2	2	2	2	3	3	2	1	1	2	3	2	3	3	2	1
61	2.5	2.2	2.7	2.0	3.3	2.7	2	2	2	3	2	3	3	2	3	2	1	4	3	3	4	3	1
62	1.9	2.6	1.3	1.0	1.7	2.3	3	3	3	2	2	1	2	1	1	1	1	2	1	2	3	2	2
63	2.2	2.2	2.7	1.7	2.3	2.3	2	2	2	3	2	2	3	3	2	2	1	3	2	2	4	2	1
64	2.7	3.0	3.0	2.3	3.0	2.0	2	3	3	4	3	3	3	3	2	3	2	4	3	2	2	3	1
65	2.2	2.0	2.3	2.3	2.3	2.3	2	3	2	1	2	3	2	2	2	3	2	3	2	2	3	3	1
66	2.0	2.0	2.3	2.0	2.0	1.7	2	3	1	1	3	3	2	2	2	3	1	2	3	1	2	2	1
67	2.2	2.2	2.3	1.7	3.0	2.0	2	2	2	2	3	2	2	3	2	2	1	4	3	2	2	2	2
68	1.8	2.2	1.7	1.7	2.3	1.0	3	2	3	1	2	2	1	2	2	2	1	3	2	2	1	1	1
69	2.3	2.4	2.3	2.3	2.3	2.0	2	3	3	2	2	3	1	3	2	3	2	2	2	3	2	2	2
70	1.6	1.8	2.0	1.0	2.0	1.3	1	1	3	2	2	3	2	1	1	1	1	3	1	2	2	1	1
71	1.8	2.2	2.0	1.0	1.7	2.0	2	2	4	1	2	2	2	2	1	1	1	2	2	1	2	2	2
72	1.9	2.2	3.3	1.0	1.3	1.7	1	2	3	3	2	3	4	3	1	1	1	2	1	1	2	2	1
73	2.2	2.4	2.7	1.0	3.0	2.0	2	2	2	3	3	3	2	3	1	1	1	3	4	2	2	2	2
74	1.9	2.6	1.7	1.0	2.7	1.3	3	3	2	2	3	2	2	1	1	1	1	2	3	3	1	1	2
75	2.0	2.2	1.7	1.0	3.3	1.7	2	2	3	2	2	2	2	1	1	1	1	3	3	4	2	1	2
76	1.6	2.0	1.3	1.0	1.7	1.7	2	2	2	2	2	1	2	1	1	1	1	2	2	1	2	1	2
77	1.8	1.8	2.0	1.0	2.7	1.3	2	1	2	2	2	2	2	2	1	1	1	3	2	3	2	1	1
78	1.8	1.8	1.7	1.7	2.7	1.0	2	2	1	2	2	2	2	1	2	2	1	3	3	2	1	1	1
Totals	**2.3**	**2.4**	**2.5**	**1.9**	**2.6**	**2.2**	**2.3**	**2.3**	**2.6**	**2.3**	**2.5**	**2.5**	**2.5**	**2.4**	**2.0**	**2.1**	**1.7**	**2.7**	**2.5**	**2.5**	**2.6**	**2.3**	**1.8**

The third table shows the answers of respondents 1 to 78 to the questions of the second part of the questionnaire (question 18 to question 23).

Element	Industry (Q18)	Amount of IT auditors (Q19)	Size of internal audit department (Q20)	Annual turnover (Q21)	Amount of employees (Q22)	Degree of internationalisation (Q23)
1	K	2	1	5	3	3
2	G	1	2	5	3	3
3	D	2	2	5	2	3
4	K	2	3	5	5	3
5	K	2	2	5	5	4
6	K	2	4	5	3	3
7	J	2	2	4	2	3
8	D	3	4	4	6	3
9	C	1	1	4	2	3
10	K	2	1	4	4	3
11	K	1	2	4	2	2
12	K	2	4	4	3	3
13	J	2	3	4	2	4
14	C	2	1	4	2	2
15	G	2	1	4	4	4
16	G	2	1	4	2	4
17	K	1	2	4	3	3
18	J	2	4	4	2	2
19	S	1	2	4	4	4
20	K	2	3	4	3	2
21	G	2	1	4	2	3
22	S	2	3	4	2	4
23	D	2	1	4	3	4
24	M	2	1	4	1	3
25	C	2	4	4	2	4
26	E	2	2	4	1	4
27	J	2	2	4	1	3
28	J	2	1	4	2	2
29	K	2	2	4	4	4
30	C	2	1	4	3	3
31	K	2	2	4	4	4
32	G	2	1	4	4	3
33	C	2	2	4	2	4
34	J	2	3	4	2	2
35	C	2	1	4	3	2
36	G	2	1	4	2	4
37	K	2	1	3	4	3
38	J	2	4	3	2	2
39	C	2	2	3	3	3
40	J	5	3	3	4	4
41	G	2	1	3	1	2
42	K	2	2	3	2	3
43	C	3	2	3	4	3
44	J	2	1	3	2	3
45	O	2	2	3	1	1
46	G	2	1	3	2	2
47	J	2	3	3	1	2
48	J	2	1	3	4	3
49	D	2	2	3	3	2
50	C	2	1	3	2	1
51	G	1	1	3	4	3
52	S	2	1	3	1	4
53	O	2	1	3	1	3
54	J	2	1	3	2	2
55	G	2	2	3	3	3
56	J	2	1	3	2	3
57	G	2	2	3	3	2
58	O	2	1	3	1	1
59	K	1	1	3	2	3
60	M	2	3	3	2	4
61	C	2	2	3	3	2
62	J	2	1	3	1	3
63	G	2	1	2	3	3
64	K	4	4	2	3	3
65	J	2	1	2	4	2
66	C	2	1	2	1	3
67	J	2	2	2	1	2
68	G	1	1	2	1	1
69	C	2	3	2	3	3
70	P	2	1	2	1	1
71	L	2	1	2	1	1
72	J	2	1	2	2	1
73	M	2	1	2	2	3
74	J	2	1	2	1	2
75	M	2	1	2	2	3
76	L	2	1	2	1	1
77	F	2	2	1	1	1
78	M	2	1	1	1	1

Appendix 6: Frequency distribution of variable ‘industry‘

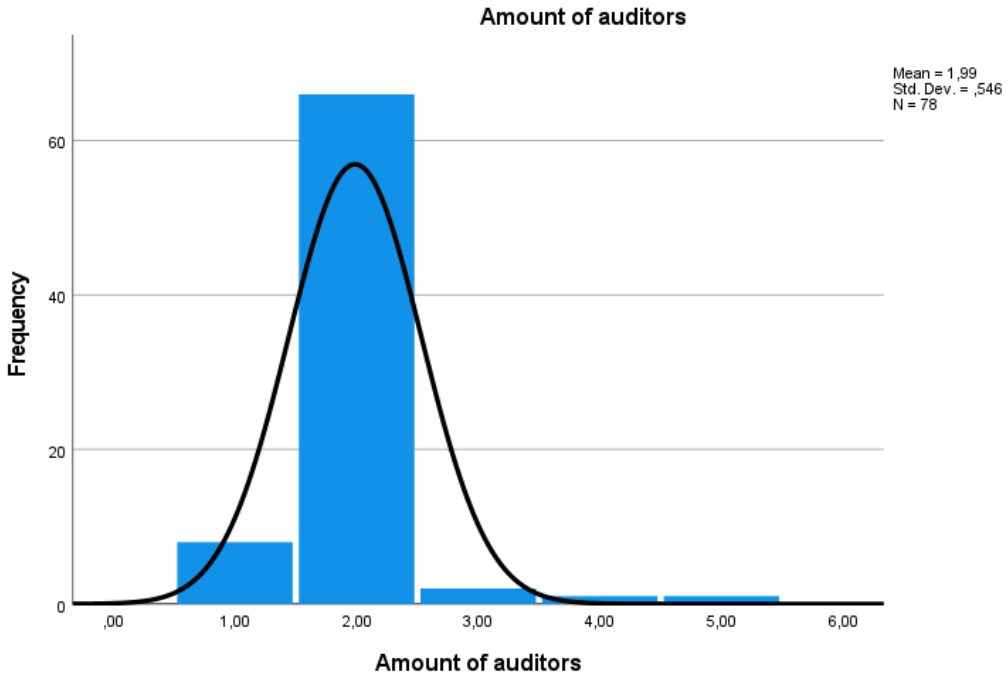
The diagram depicts the number of replies received for each industry. It is based on 78 valid answers (n =78).

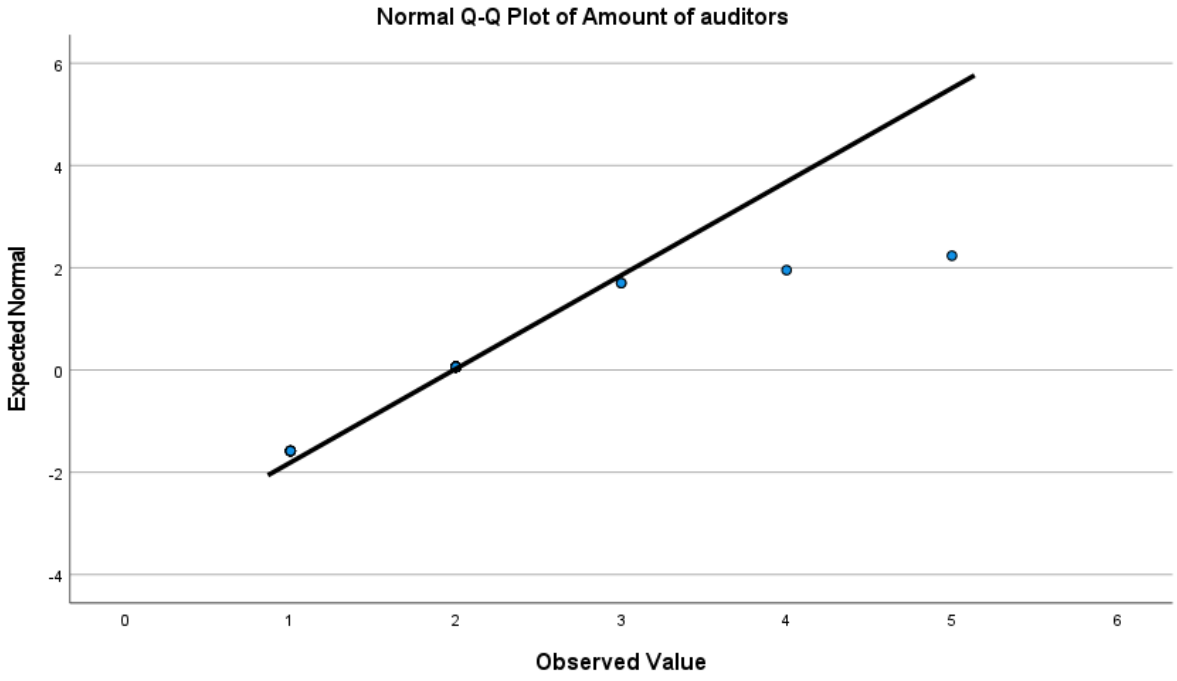


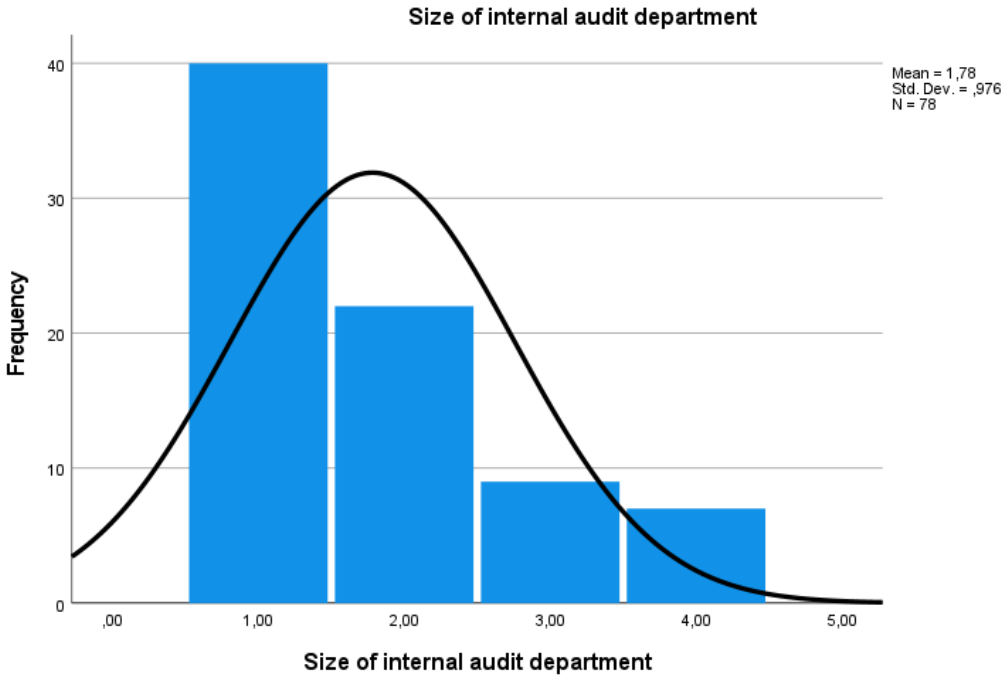
	a) Agriculture, forestry and fishing	b) Mining and quarrying	c) Manufacturing	d) Electricity, gas, steam and air conditioning supply	e) Water supply; sewerage, waste management and remediation activities	f) Construction	g) Wholesale and retail trade; repair of motor vehicles and motorcycles	h) Transportation and storage	i) Accommodation and food service activities	j) Information and communication	k) Financial and insurance activities	l) Real estate activities	m) Professional, scientific and technical activities	n) Administrative and support service activities	o) Public administration and defense; compulsory social security	p) Education	q) Human health and social work activities	r) Arts, entertainment and recreation	s) Other service activities	t) Activities of households as employers; undifferentiated goods- and services...	u) Activities of extraterritorial organizations and bodies
Amount of responses	0	0	12	4	1	1	13	0	0	18	15	2	5	0	3	1	0	0	3	0	0
AL	0.0	0.0	2.37	2.78	2.12	1.76	2.35	0.0	0.0	2.21	2.67	1.71	2.02	0.0	1.94	1.65	0.0	0.0	2.35	0.0	0.0

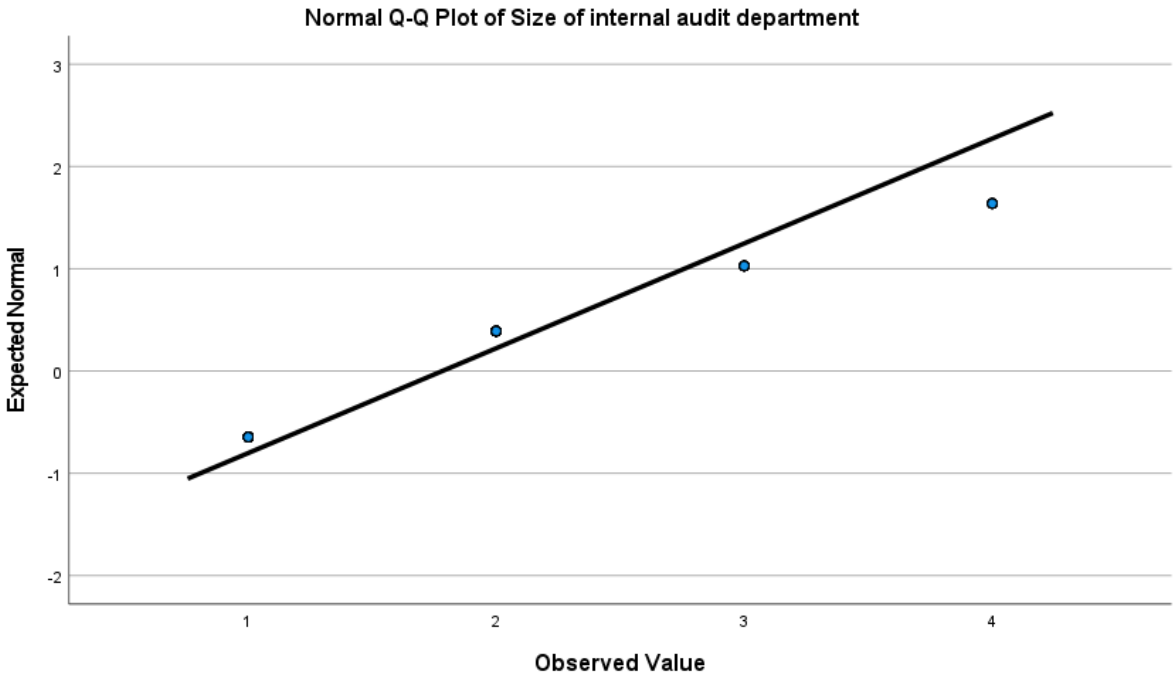
Appendix 7: Histograms and Q-Q plots of independent variables

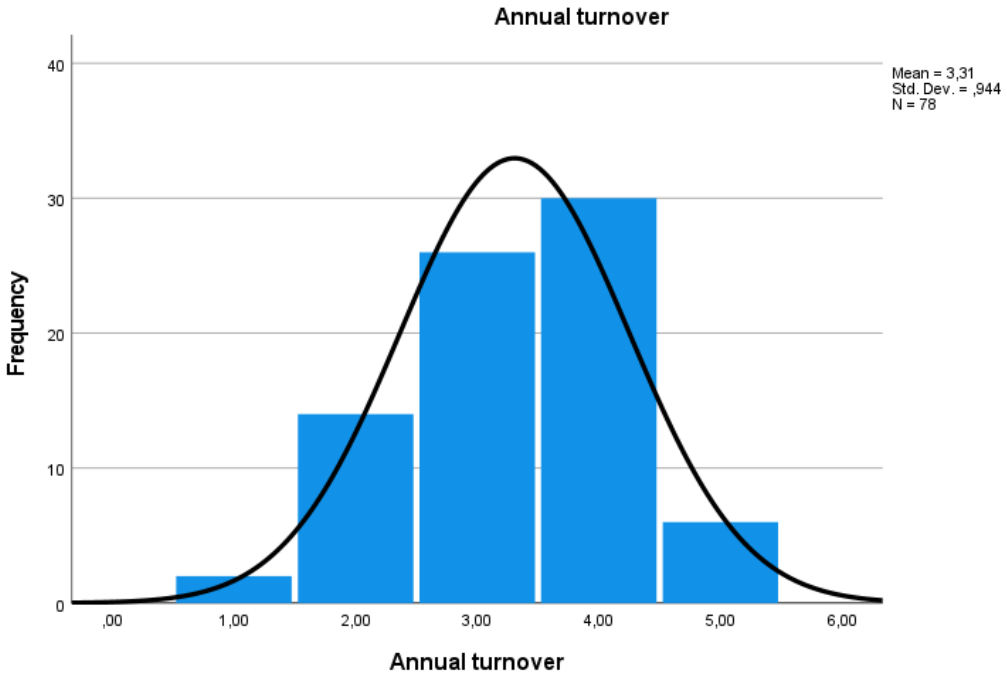
The histograms depict the number of replies per answer option for each independent variable. The divergence of the variables' distributions from their normal distributions are depicted in Q-Q plots. All diagrams are based on 78 valid answers (n =78).

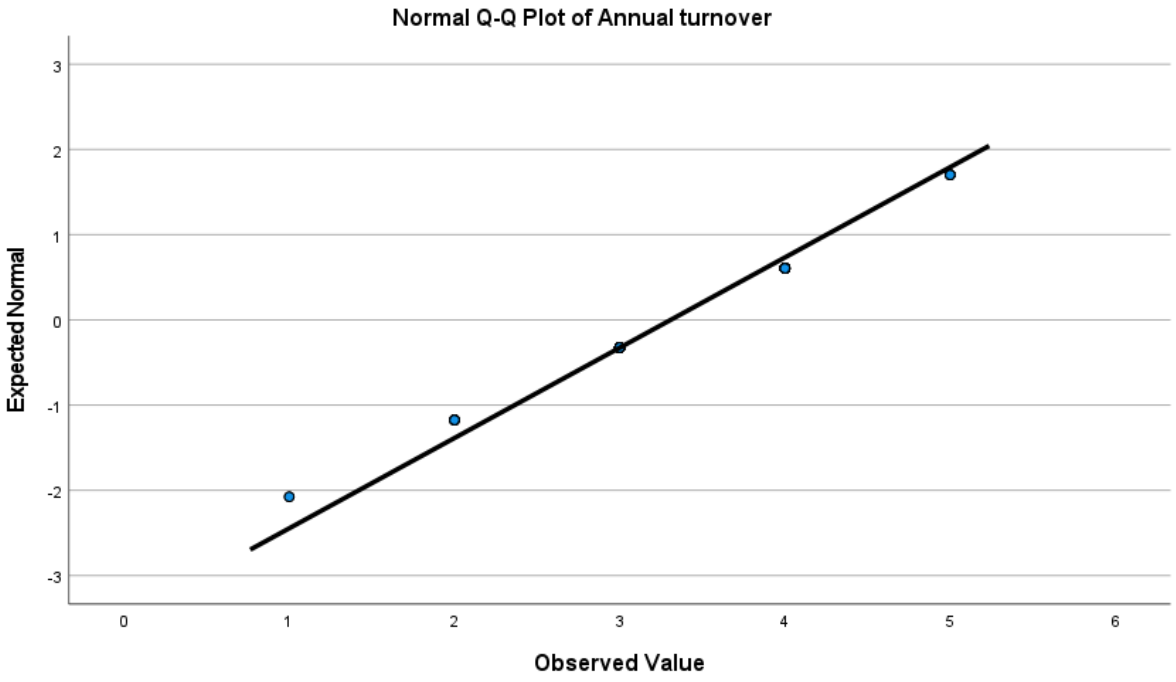


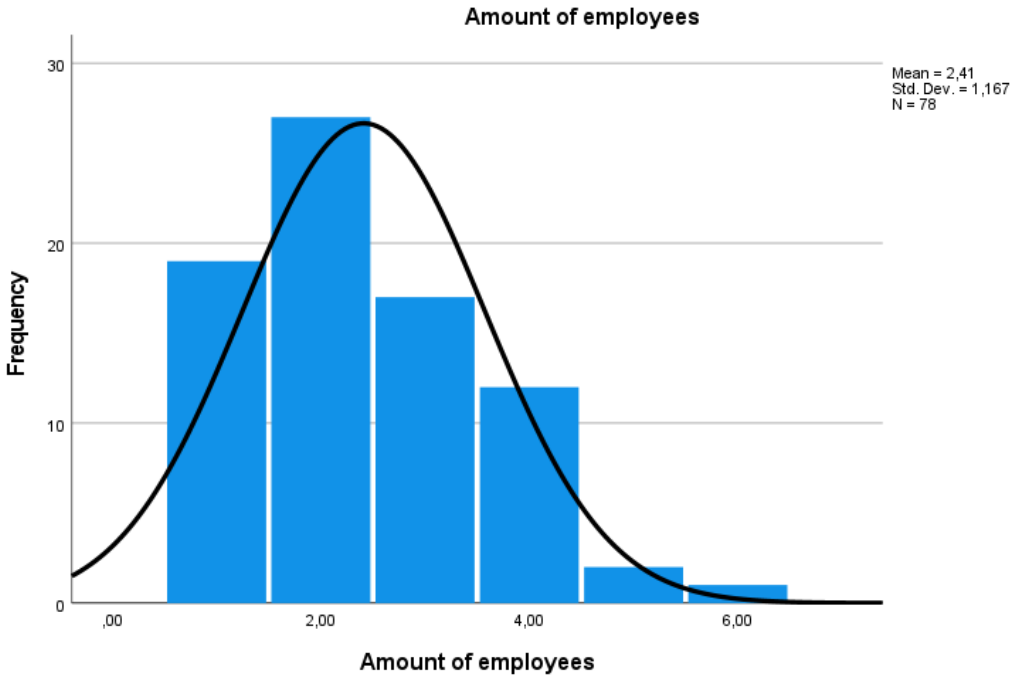


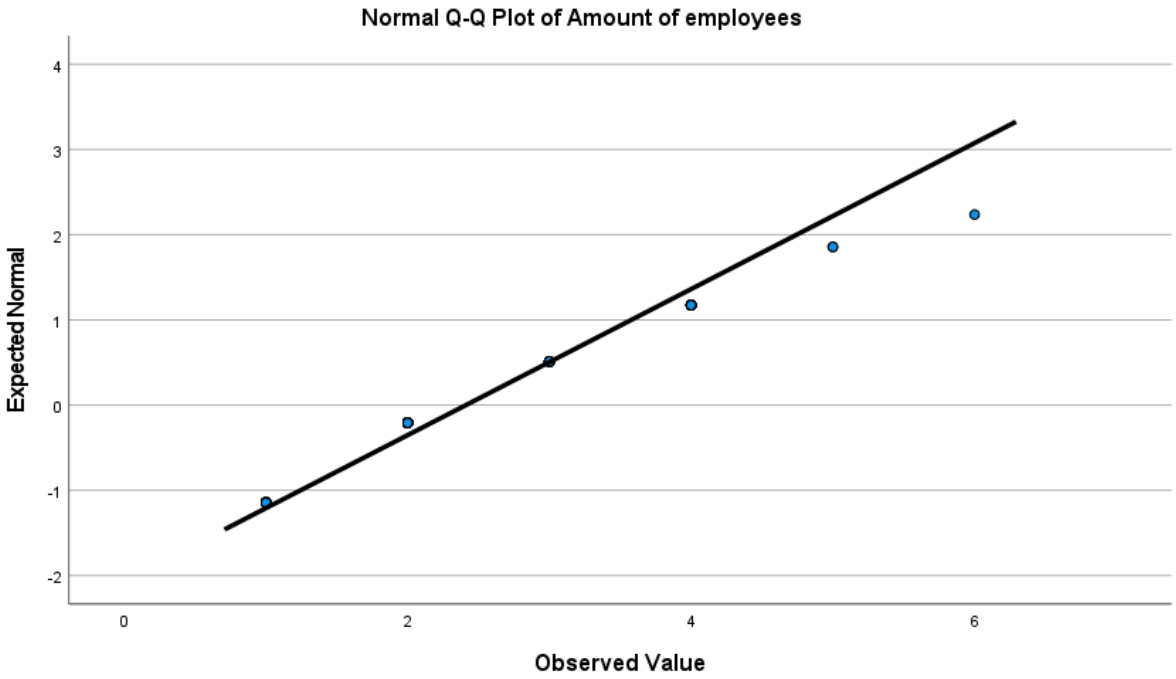

Size of internal audit department
Mean = 1,78
Std. Dev. = ,976
N = 78
Frequency
40
30
20
10
0
,00
1,00
2,00
3,00
4,00
5,00
Size of internal audit department

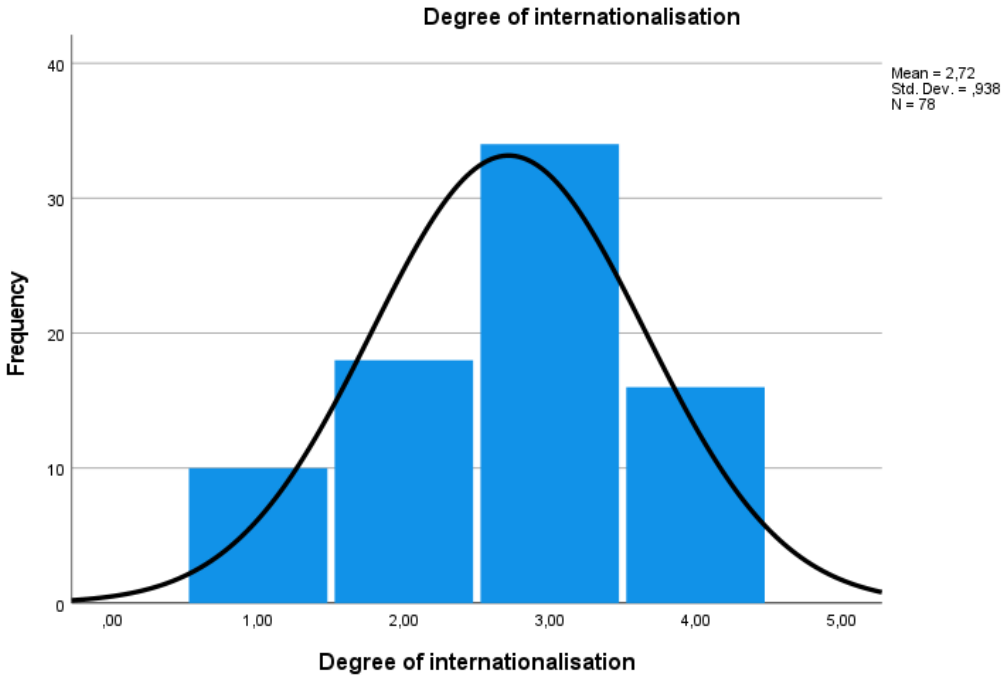

Normal Q-Q Plot of Size of internal audit department
Expected Normal
3
2
1
0
-1
-2
1
2
3
4
Observed Value

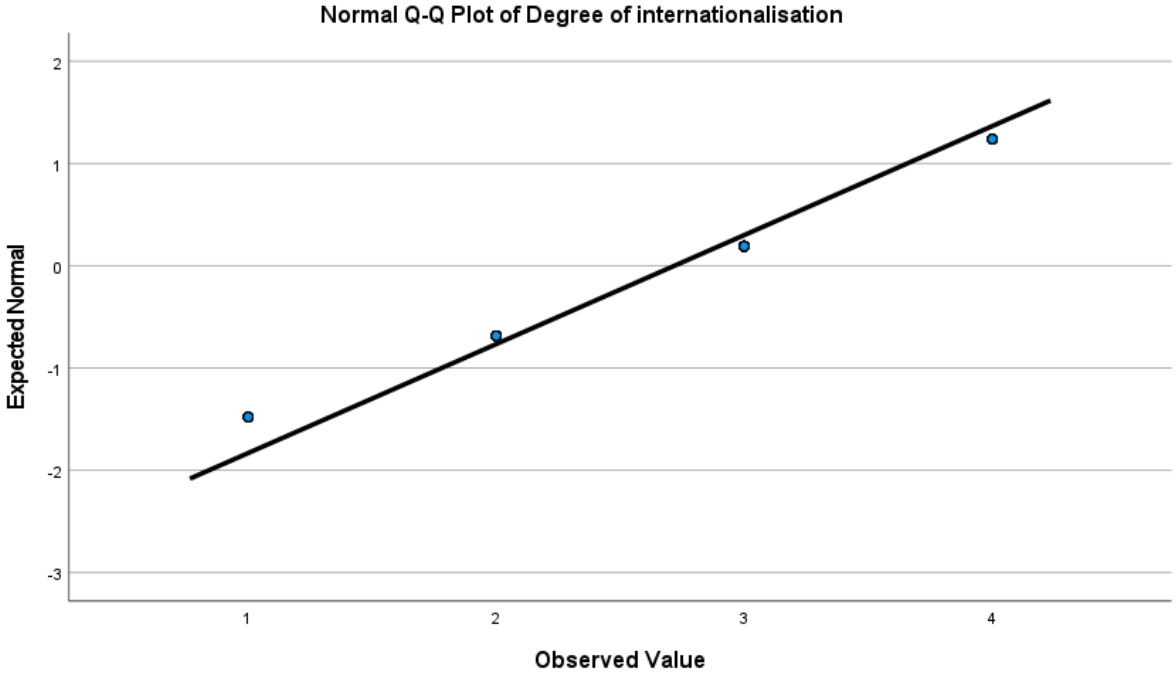

Annual turnover
Mean = 3,31
Std. Dev. = ,944
N = 78
Frequency
40
30
20
10
0
,00
1,00
2,00
3,00
4,00
5,00
6,00
Annual turnover

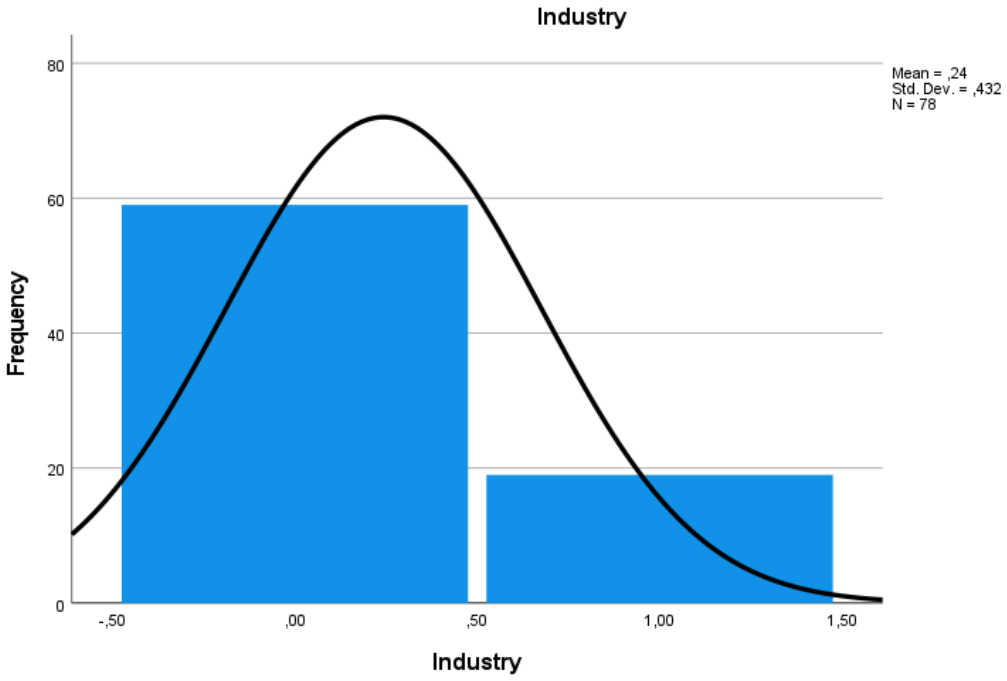

Normal Q-Q Plot of Annual turnover
Expected Normal
3
2
1
0
-1
-2
-3
0
1
2
3
4
5
6
Observed Value

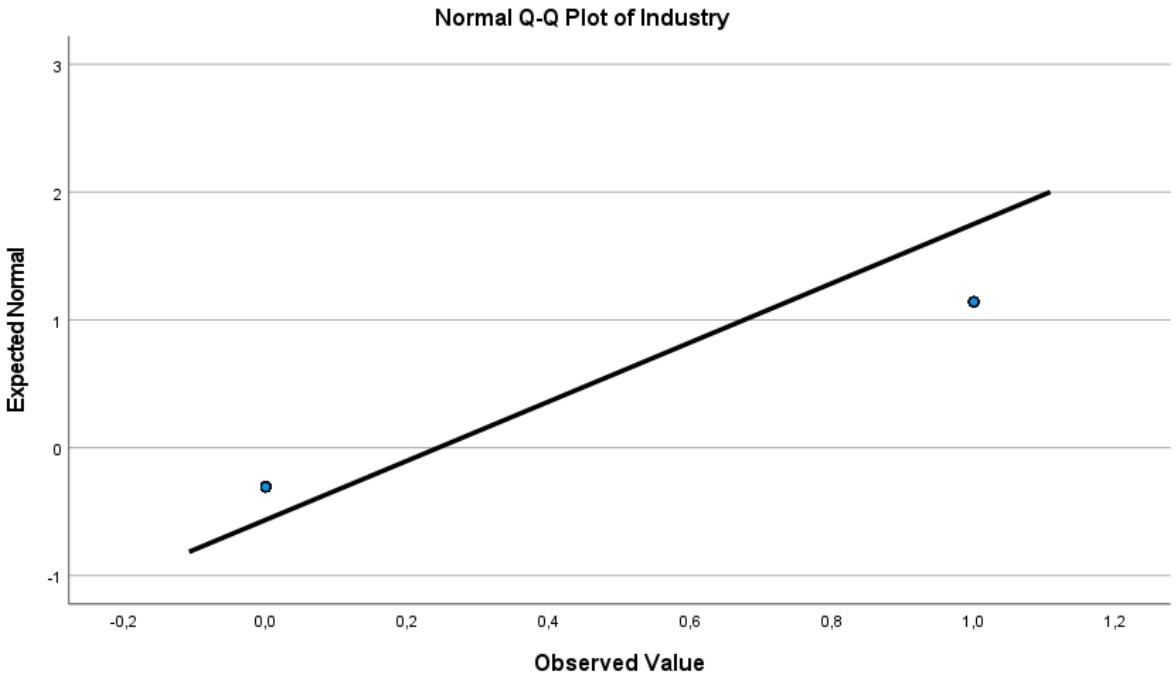

Amount of employees
Mean = 2,41
Std. Dev. = 1,167
N = 78
Frequency
30
20
10
0
,00
2,00
4,00
6,00
Amount of employees


Normal Q-Q Plot of Amount of employees
Expected Normal
4
3
2
1
0
-1
-2
0
2
4
6
Observed Value


Degree of internationalisation
Mean = 2,72
Std. Dev. = ,938
N = 78
Frequency
40
30
20
10
0
,00
1,00
2,00
3,00
4,00
5,00
Degree of internationalisation


Normal Q-Q Plot of Degree of internationalisation
Expected Normal
2
1
0
-1
-2
-3
1
2
3
4
Observed Value


Industry
Mean = ,24
Std. Dev. = ,432
N = 78
Frequency
80
60
40
20
0
-,50
,00
,50
1,00
1,50
Industry


Normal Q-Q Plot of Industry
Expected Normal
3
2
1
0
-1
-0,2
0,0
0,2
0,4
0,6
0,8
1,0
1,2
Observed Value

Appendix 8: Results of Levene test

The diagrams show the results of the Levene test for all five independent variables. The results are based on a total of 78 valid answers (n =78).

Amount of auditors								
	N	Mean	Standard deviation	Standard error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
1	8	2.53	0.35	0.12	2.23	2.82	1.80	3.00
2	66	2.29	0.33	0.04	2.20	2.37	1.60	3.30
3	2	2.85	0.35	0.25	-0.33	6.03	2.60	3.10
4	1	2.70	.	.	.	.	2.70	2.70
5	1	2.10	.	.	.	.	2.10	2.10
Total	78	2.33	0.35	0.04	2.25	2.41	1.60	3.30

Amount of auditors				
	Levene Statistic	df1	df2	Sig.
Base on Mean	0.079	2	73	**0.924**
Based on Median	0.074	2	73	**0.929**
Based on Median and with adjusted df	0.074	2	70.957	**0.929**
Based on trimmed mean	0.081	2	73	**0.922**

* Significant at the 0.05 level

Size of internal audit department								
	N	Mean	Standard deviation	Standard error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
1	40	2.20	0.30	0.05	2.10	2.29	1.60	2.90
2	22	2.46	0.35	0.07	2.31	2.62	1.80	3.30
3	9	2.36	0.34	0.11	2.09	2.62	1.90	2.90
4	7	2.63	0.34	0.13	2.32	2.94	2.20	3.10
Total	78	2.33	0.35	0.04	2.25	2.41	1.60	3.30

Size of internal audit department				
	Levene Statistic	df1	df2	Sig.
Base on Mean	0.072	3	74	**0.975**
Based on Median	0.060	3	74	**0.981**
Based on Median and with adjusted df	0.060	3	67.612	**0.981**
Based on trimmed mean	0.074	3	74	**0.974**

* Significant at the 0.05 level

Annual turnover								
	N	Mean	Standard deviation	Standard error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
1	2	1.80	0.00	0.00	1.80	1.80	1.80	1.80
2	14	2.03	0.30	0.08	1.86	2.20	1.60	2.70
3	26	2.25	0.22	0.04	2.16	2.34	1.80	2.60
4	30	2.44	0.26	0.05	2.34	2.54	1.90	3.10
5	6	2.98	0.16	0.07	2.82	3.15	2.90	3.30
Total	78	2.33	0.35	0.04	2.25	2.41	1.60	3.30

Annual turnover				
	Levene Statistic	df1	df2	Sig.
Base on Mean	1.633	4	73	**0.175**
Based on Median	1.695	4	73	**0.160**
Based on Median and with adjusted df	1.695	4	68.994	**0.161**
Based on trimmed mean	1.624	4	73	**0.177**

* Significant at the 0.05 level

Amount of employees								
	N	Mean	Standard deviation	Standard error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
1	19	1.92	0.18	0.04	1.83	2.01	1.60	2.30
2	27	2.36	0.26	0.05	2.26	2.46	1.90	3.30
3	17	2.57	0.28	0.07	2.43	2.71	2.10	3.00
4	12	2.39	0.19	0.05	2.27	2.51	2.10	2.60
5	2	2.90	0.00	0.00	2.90	2.90	2.90	2.90
6	1	3.10	.	.	.	.	3.10	3.10
Total	78	2.33	0.35	0.04	2.25	2.41	1.60	3.30

Amount of employees				
	Levene Statistic	df1	df2	Sig.
Base on Mean	1.890	4	72	**0.122**
Based on Median	1.528	4	72	**0.203**
Based on Median and with adjusted df	1.528	4	64.119	**0.205**
Based on trimmed mean	1.895	4	72	**0.121**

* Significant at the 0.05 level

Degree of internationalisation								
	N	Mean	Standard deviation	Standard error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
1	10	1.82	0.17	0.05	1.70	1.94	1.60	2.20
2	18	2.33	0.26	0.06	2.20	2.46	1.90	2.90
3	34	2.46	0.35	0.06	2.34	2.58	1.90	3.30
4	16	2.37	0.21	0.05	2.26	2.48	2.10	2.90
Total	78	2.33	0.35	0.04	2.25	2.41	1.60	3.30

Degree of internationalisation				
	Levene Statistic	df1	df2	Sig.
Base on Mean	3.803	3	74	**0.014***
Based on Median	3.509	3	74	**0.019***
Based on Median and with adjusted df	3.509	3	63.864	**0.020***
Based on trimmed mean	3.787	3	74	**0.014***

* Significant at the 0.05 level

Industry								
	N	Mean	Standard deviation	Standard error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
0	59	2.21	0.28	0.04	2.14	2.28	1.60	3.00
1	19	2.70	0.27	0.06	2.57	2.83	2.30	3.30
Total	78	2.33	0.35	0.04	2.25	2.41	1.60	3.30

Industry				
	Levene Statistic	df1	df2	Sig.
Base on Mean	0.040	1	76	**0.842**
Based on Median	0.049	1	76	**0.825**
Based on Median and with adjusted df	0.049	1	74.093	**0.825**
Based on trimmed mean	0.045	1	76	**0.833**

* Significant at the 0.05 level

Appendix 9: Mean ranks of independent variables

The diagrams show the mean ranks of single answer options per independent variable. In each case, a total of 78 valid answers were given (n =78).

Amount of auditors		
	N	Mean Rank
1	8	54.81
2	66	36.56
3	2	70.75
4	1	68.00
5	1	20.00
Total	78	

Size of internal audit department		
	N	Mean Rank
1	40	31.56
2	22	48.45
3	9	39.28
4	7	57.00
Total	78	

Annual turnover		
	N	Mean Rank
1	2	5
2	14	20.21
3	26	35.06
4	30	47.68
5	6	74.33
Total	78	

Amount of employees		
	N	Mean Rank
1	19	12.42
2	27	41.76
3	17	55.29
4	12	46.21
5	2	73
6	1	77
Total	78	

Degree of internationalisation		
	N	Mean Rank
1	10	7.75
2	18	40.28
3	34	46.96
4	16	42.63
Total	78	

Industry		
	N	Mean Rank
0	59	32.05
1	19	62.63
Total	78	

Appendix 10: Results from correlation analyses

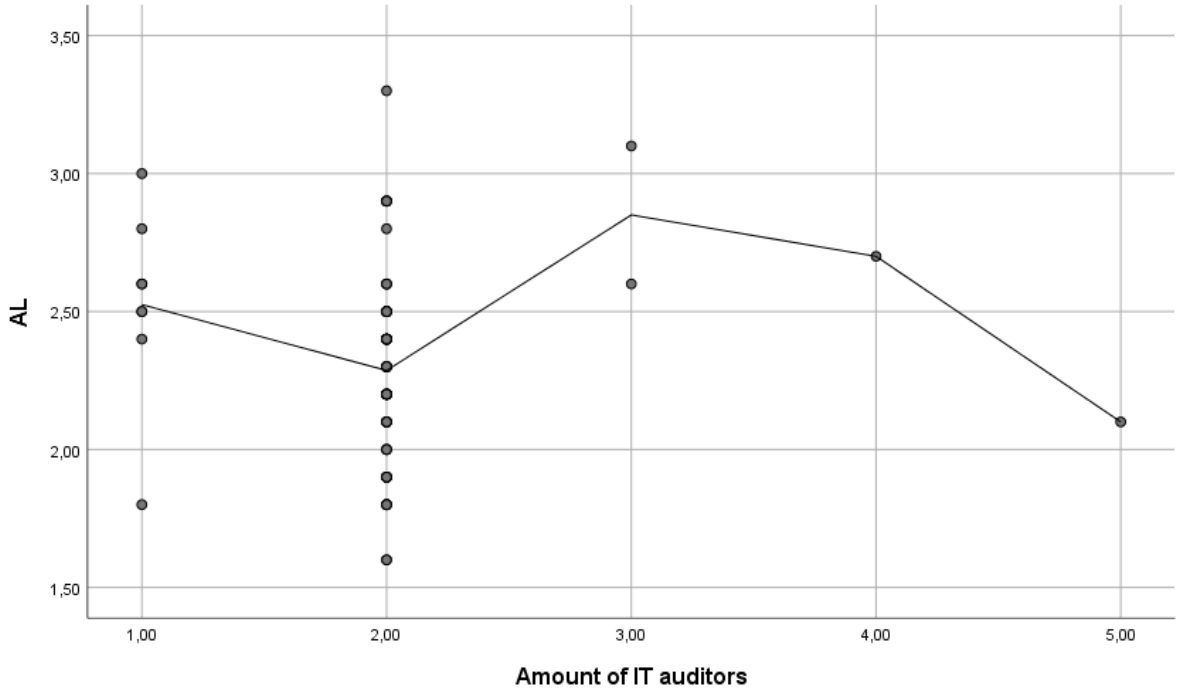
			AL	ALg	ALc	ALr	ALd	ALp	Amount of IT auditors	Size of internal audit department	Annual turnover	Amount of employees	Degree of internationali-sation	Industry
Spearman-Rho	AL	Correlation coefficient	1.000	.704**	.606**	.709**	.628**	.686**	-0.085	.352**	.638**	.666**	.365**	.586**
		Significance		0.000	0.000	0.000	0.000	0.000	0.457	0.002	0.000	0.000	0.001	0.000
		N	78	78	78	78	78	78	78	78	78	78	78	78
	ALg	Correlation coefficient	.704**	1.000	.228*	.417**	.413**	.347**	-0.001	.238*	.500**	.454**	0.207	.311**
		Significance	0.000		0.045	0.000	0.000	0.002	0.994	0.036	0.000	0.000	0.068	0.006
		N	78	78	78	78	78	78	78	78	78	78	78	78
	ALc	Correlation coefficient	.606**	.228*	1.000	.399**	.286*	.408**	-0.007	.264*	.404**	.349**	.240*	.483**
		Significance	0.000	0.045		0.000	0.011	0.000	0.951	0.020	0.000	0.002	0.034	0.000
		N	78	78	78	78	78	78	78	78	78	78	78	78
	ALr	Correlation coefficient	.709**	.417**	.399**	1.000	.253*	.357**	-0.005	.248*	.466**	.588**	.279*	.410**
		Significance	0.000	0.000	0.000		0.026	0.001	0.966	0.029	0.000	0.000	0.013	0.000
		N	78	78	78	78	78	78	78	78	78	78	78	78
	ALd	Correlation coefficient	.628**	.413**	.286*	.253*	1.000	.238*	0.026	.263*	.290*	.352**	0.191	.343**
		Significance	0.000	0.000	0.011	0.026		0.036	0.824	0.020	0.010	0.002	0.094	0.002
		N	78	78	78	78	78	78	78	78	78	78	78	78
	ALp	Correlation coefficient	.686**	.347**	.408**	.357**	.238*	1.000	-0.202	0.195	.541**	.475**	.340**	.499**
		Significance	0.000	0.002	0.000	0.001	0.036		0.077	0.087	0.000	0.000	0.002	0.000
		N	78	78	78	78	78	78	78	78	78	78	78	78
	Amount of IT auditors	Correlation coefficient	-0.085	-0.001	-0.007	-0.005	0.026	-0.202	1.000	0.216	-0.140	0.101	0.064	-0.007
		Significance	0.457	0.994	0.951	0.966	0.824	0.077		0.057	0.220	0.378	0.580	0.949
		N	78	78	78	78	78	78	78	78	78	78	78	78
	Size of internal audit department	Correlation coefficient	.352**	.238*	.264*	.248*	.263*	0.195	0.216	1.000	.283*	.234*	0.192	.286*
		Significance	0.002	0.036	0.020	0.029	0.020	0.087	0.057		0.012	0.039	0.092	0.011
		N	78	78	78	78	78	78	78	78	78	78	78	78
	Annual turnover	Correlation coefficient	.638**	.500**	.404**	.466**	.290*	.541**	-0.140	.283*	1.000	.375**	.477**	.380**
		Significance	0.000	0.000	0.000	0.000	0.010	0.000	0.220	0.012		0.001	0.000	0.001
		N	78	78	78	78	78	78	78	78	78	78	78	78
	Amount of employees	Correlation coefficient	.666**	.454**	.349**	.588**	.352**	.475**	0.101	.234*	.375**	1.000	.389**	.455**
		Sig. (2-seitig)	0.000	0.000	0.002	0.000	0.002	0.000	0.378	0.039	0.001		0.000	0.000
		N	78	78	78	78	78	78	78	78	78	78	78	78
	Degree of internationalisation	Korrelationskoeffizient	.365**	0.207	.240*	.279*	0.191	.340**	0.064	0.192	.477**	.389**	1.000	0.191
		Significance	0.001	0.068	0.034	0.013	0.094	0.002	0.580	0.092	0.000	0.000		0.094
		N	78	78	78	78	78	78	78	78	78	78	78	78
	Industry	Korrelationskoeffizient	.586**	.311**	.483**	.410**	.343**	.499**	-0.007	.286*	.380**	.455**	0.191	1.000
		Sig. (2-seitig)	0.000	0.006	0.000	0.000	0.002	0.000	0.949	0.011	0.001	0.000	0.094	
		N	78	78	78	78	78	78	78	78	78	78	78	78

** Correlation is significant at the 0.01 level (2-tailed).

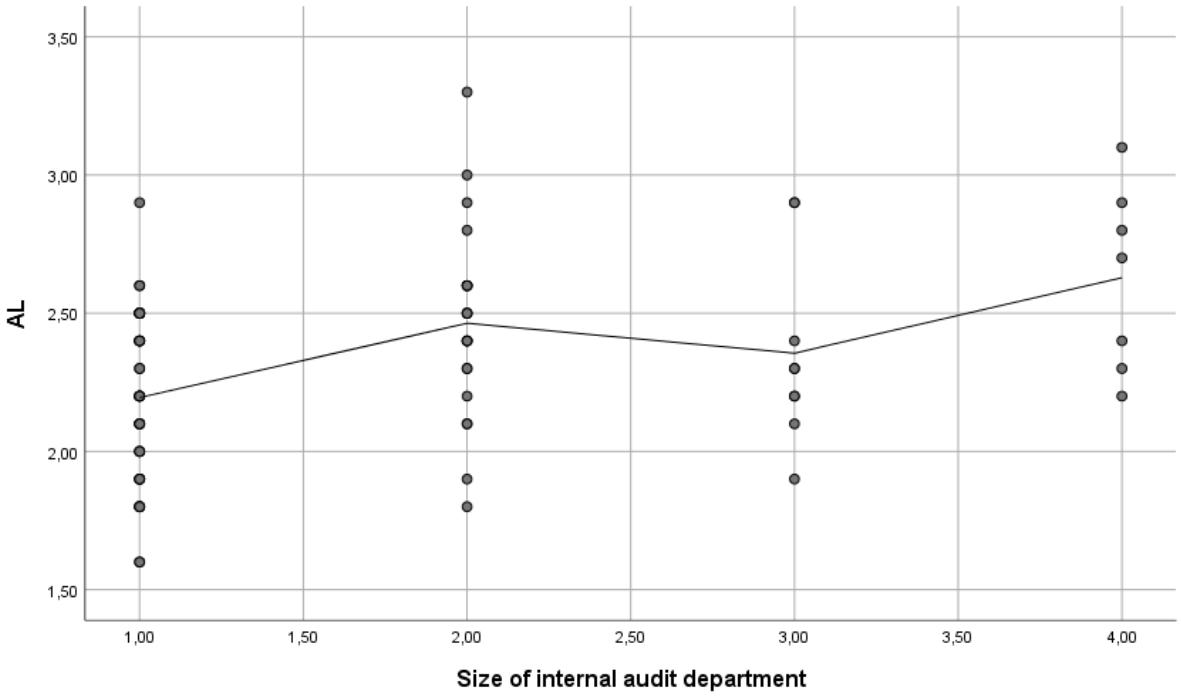
* Correlation is significant at the 0.05 level (2-tailed).

Appendix 11: Scatter plots

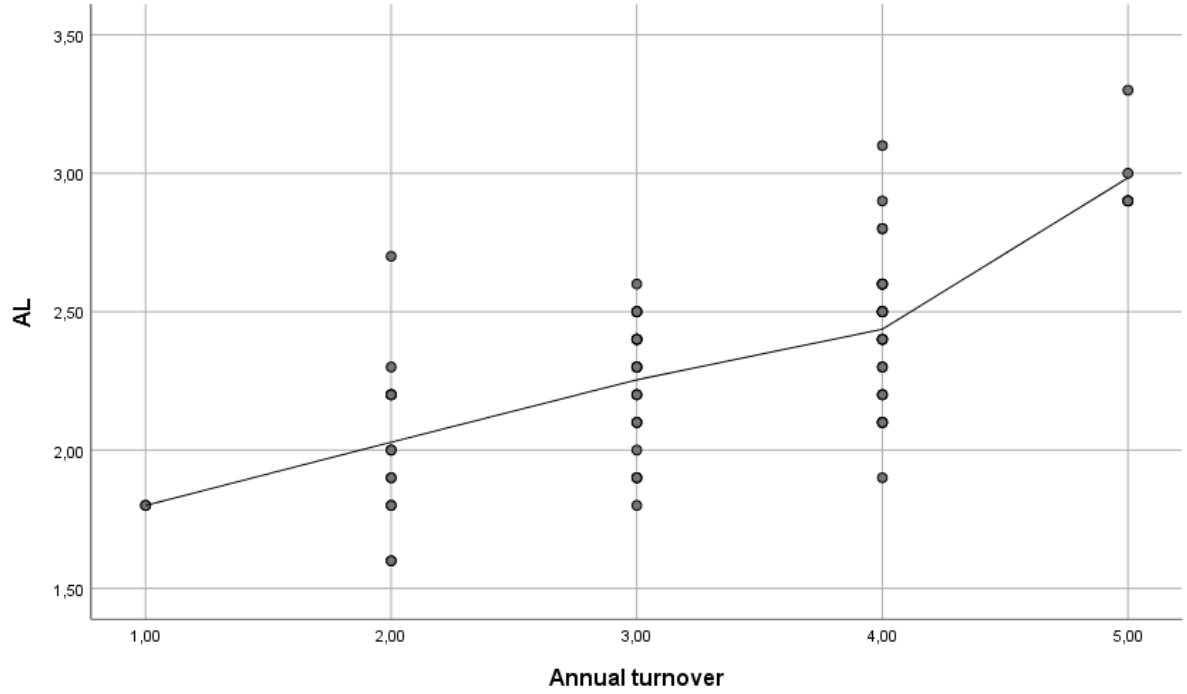
The scatter plots are based on 78 valid answers received (n =78). The first scatter plot depicts the values of variable ‘amount of IT auditors’ per CA adoption degree.



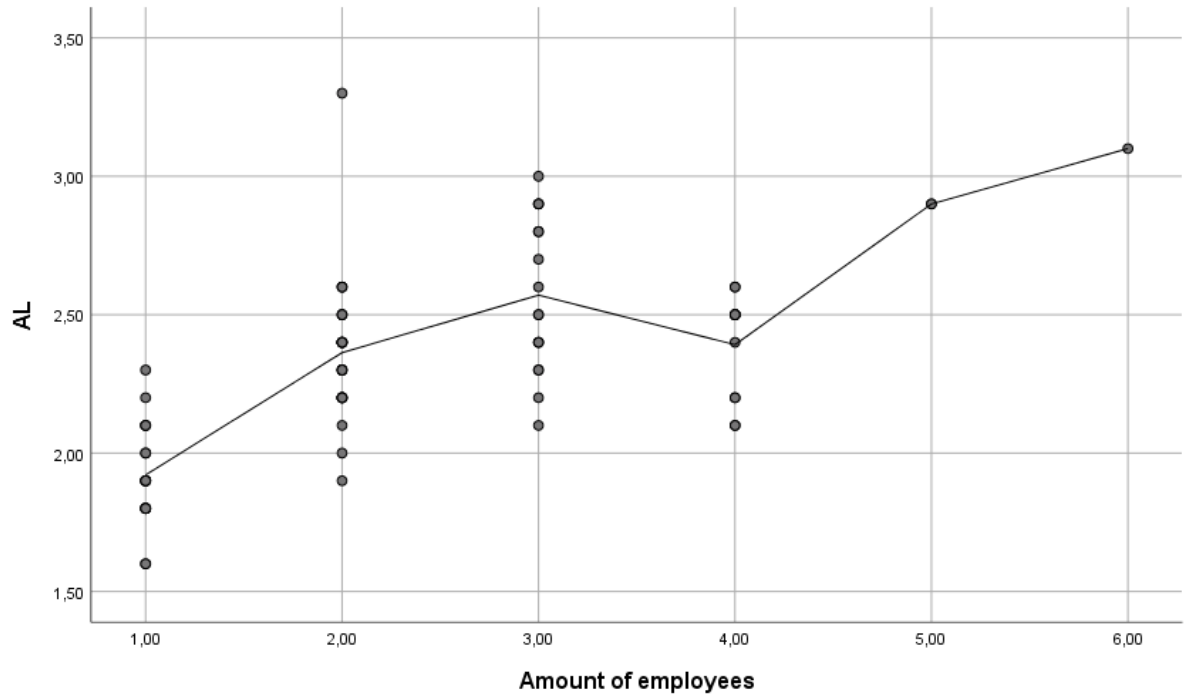
The second scatter plot depicts the values of variable ‘size of internal audit department’ per CA adoption degree.



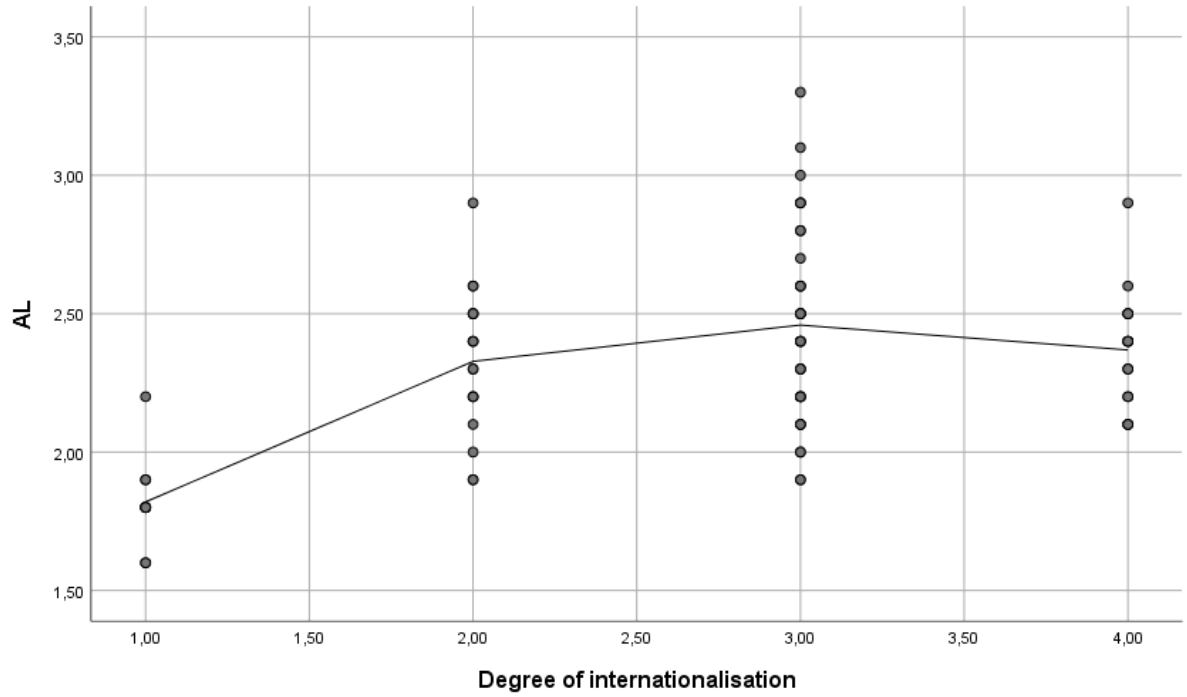
The third scatter plot depicts the values of variable ‘annual turnover’ per CA adoption degree.



The fourth scatter plot depicts the values of variable ‘amount of employees’ per CA adoption degree.

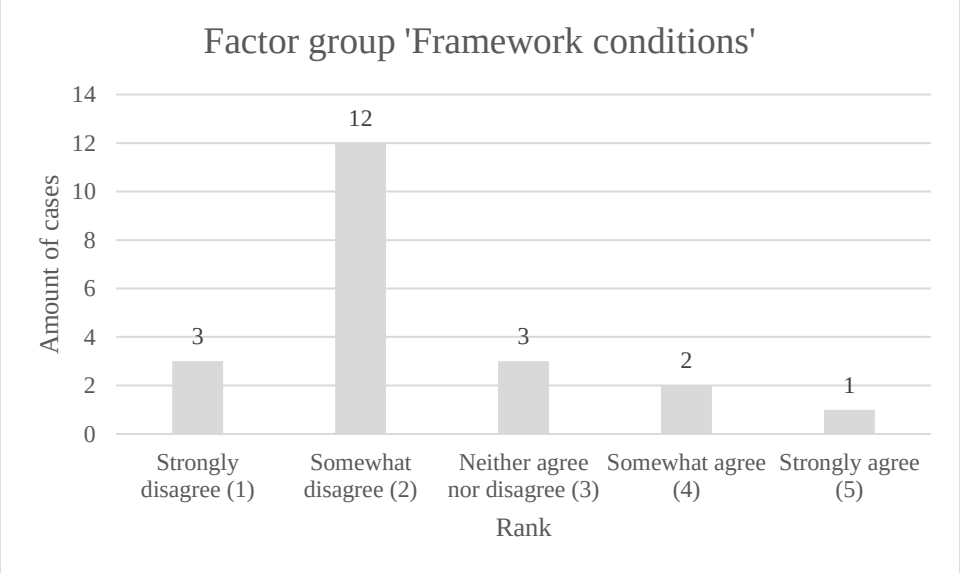


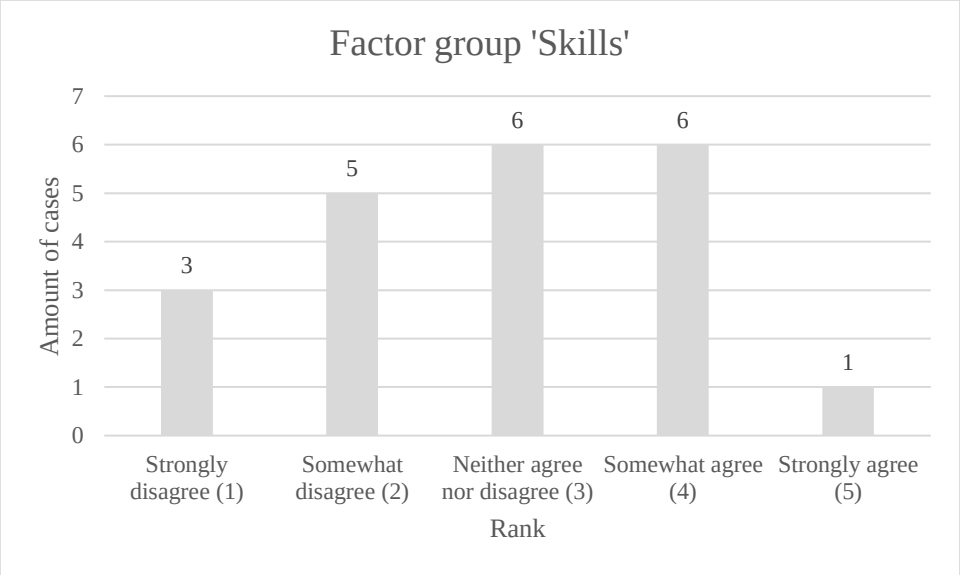
The fifth scatter plot depicts the values of variable ‘degree of internationalisation’ per CA adoption degree.

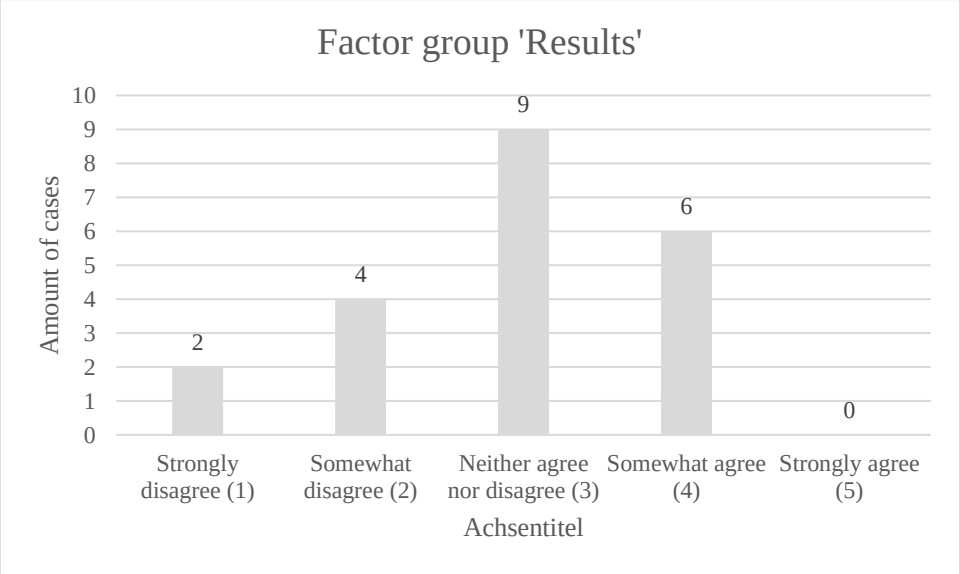


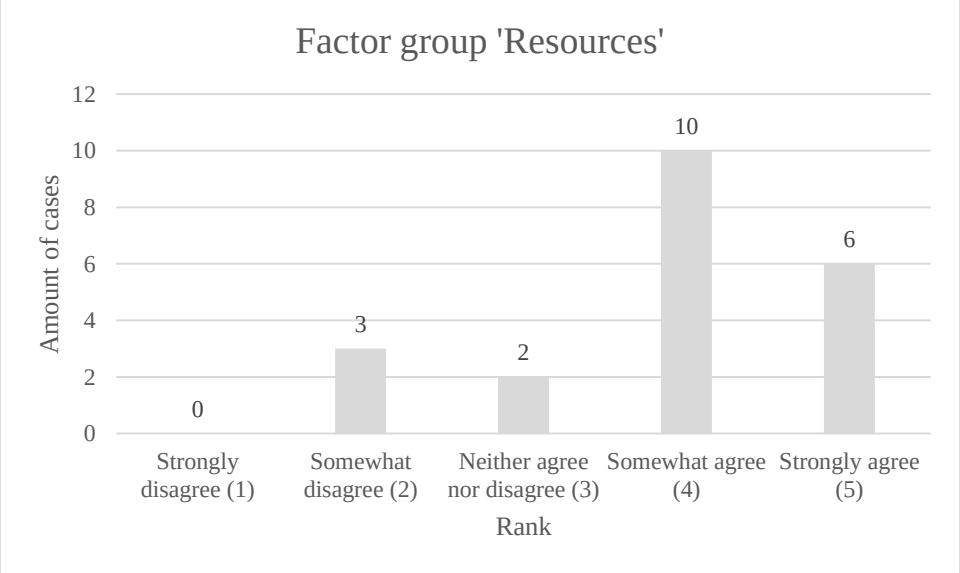
Appendix 12: Detailed results of main research B

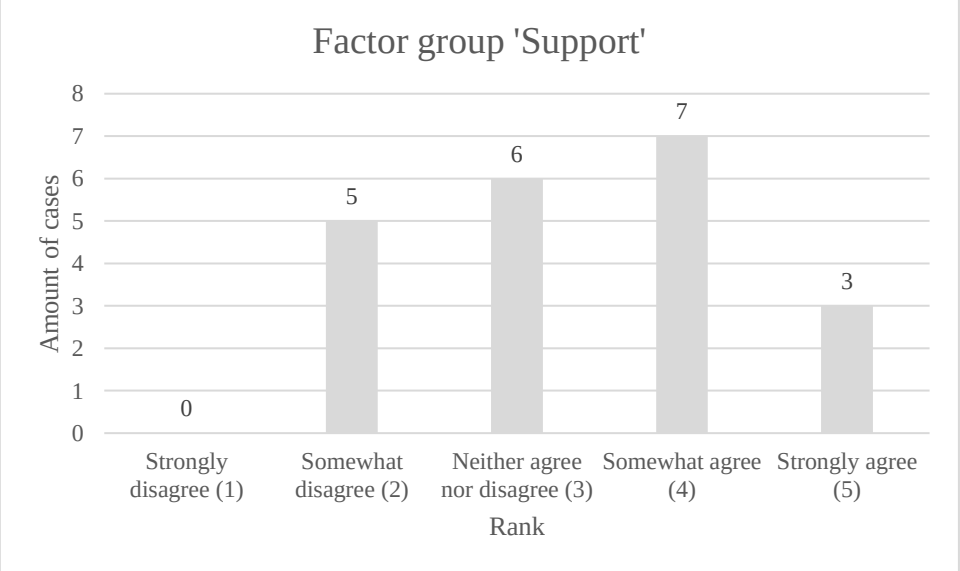
The following diagrams show the detailed results for each of the five factor groups. Data is based on 21 valid replies (n = 21).






Factor group 'Results'
Amount of cases
10
9
8
7
6
5
4
3
2
1
0
2
4
9
6
0
Strongly disagree (1)
Somewhat disagree (2)
Neither agree nor disagree (3)
Somewhat agree (4)
Strongly agree (5)
Achsentitel


Factor group 'Resources'
Amount of cases
12
10
8
6
4
2
0
0
3
2
10
6
Strongly disagree (1)
Somewhat disagree (2)
Neither agree nor disagree (3)
Somewhat agree (4)
Strongly agree (5)
Rank


Factor group 'Support'
Amount of cases
8
7
6
5
4
3
2
1
0
0
5
6
7
3
Strongly disagree (1)
Somewhat disagree (2)
Neither agree nor disagree (3)
Somewhat agree (4)
Strongly agree (5)
Rank

Appendix 13: Statement of authenticity

I, Johannes Martin Wagner, by signing this declaration declare that my PhD thesis is my own work. During the dissertation I complied with the LXXVI. and the rules of the doctoral dissertation prescribed by the Doctoral School, especially regarding references and citations.[6]

Furthermore, I declare that I did not mislead the supervisor or the programme leader with the dissertation.

By signing this declaration, I acknowledge that if it can be proved that the dissertation is not self-made or the author of a copyright infringement is related to the dissertation, the University of Sopron is entitled to refuse the acceptance of the dissertation. Refusing to accept a dissertation does not affect any other (civil, legal, criminal) consequences of copyright infringement.

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(PhD candidate)

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