Summer 6-15-2016

TRANSFERRING CONTINUOUS AUDITING TO THE DIGITAL AGE – THE KNOWLEDGE BASE AFTER THREE DECADES OF RESEARCH

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Research

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Abstract

Financial auditing is faced with an intensified regulatory framework and an increasing volume of accounting-relevant data. In order to address these challenges, information technology (IT) and corresponding information systems (IS) are implemented to improve the effectiveness and efficiency of audit services. In this context, continuous auditing (CA) is defined as an approach to deliver audit assurance in terms of an audit subject in real-time or almost real-time. Although CA is discussed in literature for more than thirty years, fully implemented CA systems are still exceptional cases in practice. The aim of this paper is to structure the relevant CA literature and to discuss insights in order to derive major challenges of CA adoption. To do so, we followed a structured literature review approach including backward search and forward search according to Webster and Watson (2002). Consequently, we transform insights and trends of CA research into a conceptual model by describing a scenario of a cloud-based service provider. Our results have a number of implications for both researchers and practitioners. Foremost, we suggest researchers and practitioners to direct their attention on the changes of traditional paradigms and focus on the digitization of the economy.

Keywords: Continuous Auditing, Literature Review, Conceptual Modeling, Digitization of Audit

1 Introduction

The domain of financial auditing is faced with an intensified regulatory framework and increasing volume of accounting-relevant data. Particularly in the *European Union* (EU), the upcoming reform of the audit market will have tremendous impact on audit firms because key measures relating to mandatory rotation of audit firms, promotion of market diversity, and enhanced supervision of the audit sector (European Parliament, 2014a, 2014b). This situation in Europe is comparable to the commencement of the Sarbanes-Oxley Act of 2002 (SOX, U.S. House of Representatives, 2002), when the upcoming regulatory requirements increased the demand for innovative solutions to ensure the efficient and high-quality auditing of financial statements and internal control.

In this context, *information technology* (IT) and corresponding *information systems* (IS) are implemented to improve the effectiveness and efficiency of audit services related to internal control (Arnold et al., 2007; Janvrin et al., 2008; Masli et al., 2010). For this reason, monitoring tools serve as major facilitators for *continuous auditing* (CA), which is defined as an approach to deliver audit assurance in terms of an audit subject in real-time or almost real-time (Alles et al., 2005; CICA/AICPA, 1999). Although CA is discussed since the 1970s (Kunkel, 1974; Perry, 1975), fully implemented CA systems are still exceptional cases in practice. Particularly, external auditors state that the widespread adoption and propagation of CA is associated with significant challenges as well as technical and organizational barriers (Byrnes et al., 2012). Hence, this area requires sound exploration and needs further attention in audit practice research (Chiu et al., 2014).

Our overall research goal is to create and evaluate innovative IT artifacts according to Hevner et al. (2004) to achieve prevalence of CA in practice and, hence, to reach the next evolution step of auditing. In this context, it is crucial to keep the overview of CA literature up-to-date because CA is settled in an environment which is characterized by extensive organizational, regulatory, and technological changes referring to a perpetually increasing knowledge base (vom Brocke et al., 2009). Moreover, reviewing the literature is necessary for justifying innovative design ideas and identifying existing artifacts which can contribute to the design process (vom Brocke et al., 2015). Therefore, the aim of this paper is not only to present relevant literature in the field of CA. Its main purpose is to examine and critically assess existing knowledge in the field of CA to establish a basis for investigating areas of improvement and overcoming identified weaknesses of hitherto proposed CA-concepts (Boell and Cecez-Kecmanovic, 2014). To do so, we followed a structured literature review approach including backward search and forward search according to Webster and Watson (2002). We retrieved a selection of 94 articles between 1989 and 2015, which includes CA concepts, research approaches, and evaluation methods. Finally, the review was completed by further analysis considering external factors and upcoming trends in IT, which have influenced CA research.

Anticipatory, we found that literature deals mainly with conceptual CA models (e.g., Debreceny et al., 2005; Vasarhelyi et al., 2004) and individualized implementation scenarios (e.g., Alles et al., 2008; Shin et al., 2013). However, the reviewed literature neglects investigating the coherence between CA and supply chains, mandatory auditor rotation, and independence of external auditors. In this context, we believe that our findings contribute to the knowledge base by a sound exploration of CA research. Moreover, we present an expansion of existing CA concepts by introducing a cloud-based audit service support and its related propositions. In this way, we believe that our paper enables academics as well as practitioners to extent research in this field and, therefore, can significantly improve the outcome of future CA projects.

In order to represent our findings, the remainder of our paper is structured as follows: The design of the review considering the applied method and existing boundaries are described in Section 2. Afterwards, we present the results of the review by a classification considering CA-key concepts and research approaches in Section 3. Additionally, further analysis of the literature and upcoming research trends are shown in Section 4. A conceptual model with supporting propositions is presented in Section 5. Implications and the outline for future research are discussed in Section 6. In Section 7, we point out limitations and conclude our work.

2 Research Method

Our literature review is based on the approaches introduced by Webster and Watson (2002) and vom Brocke et al. (2015). Consequently, the literature search was determined by a sequential, gradual, and systematic process (Webster and Watson, 2002). Initially, it was necessary to define a search scope, which has to provide *"an orienting framework for the search*" (vom Brocke, 2015). Therefore, we defined the following *research questions* (Step 1, see Table 1), which set the baseline for the search process and criteria for the relevance of publications:

RQ1	How is the scientific structure of CA research considering general research approaches?	RQ4	What is the outcome (i.e., artifacts) of design-oriented CA research works?
RQ2	Which technical concepts are prevalent in design-oriented CA research?	RQ5	What are major challenges of CA adoption?
RQ3	To what extent is external auditing addressed by design-oriented CA research?	RQ6	How to create an approach to overcome the identified barriers?

Table 1. Research Questions

The upcoming *literature search* (2) was built on three major steps (see also Appendix A). First, we started with a *keyword search* in six scientifically accepted bibliographic databases, which provide sophisticated functions for searching and identifying relevant literature (Step 2.1). The authors are aware that the terms {*Continuous Assurance*}, {*Continuous Auditing}*, and {*Continuous Monitoring* and *Audit}* are not superimposable and, therefore, cannot be synonymously used. Preliminary work, however, indicates that these search terms are useful to identify relevant concepts in CA research and contribute to a high coverage of literature. We focused on articles written in English and excluded titles that indicated another language. The result of this first step was an outcome of 593 articles. These articles have been screened for relevance by considering language, discipline, scope in the context of CA, and availability. Another serious challenge was the elimination of duplicates, which was solved by using text functions in Microsoft Excel as well as manual screening. Insights of further steps lead to refinement and updating of the screening process. Thus, we selected 52 articles, which were the basis for the next steps.

As a second step, we conducted a *backward references search* (Step 2.2) to collect articles, which are references of the articles yielded from the first step. The purpose of this step was to extend our knowledge on key concepts of CA. Moreover, we aimed to be able to find possible inconsistencies in literature as well as references and quotes, which might have been taken out of context (Levy and Ellis, 2006). We had a closer look on the articles of the first step and carved out the citations and references of these articles. Due to irregular citation styles and reference formats, we extracted and aggregated the references by author, the title of article and year of publication. For identifying relevant and useful literature in this list, we concentrated on literature that has been cited at least twice. Additionally, the relevance was appraised by screening title, author, citations, and, again, the language of the article. The backward search led to 11 relevant articles for the following Step 2.3, the forward search, and also for the final literature list.

Furthermore, a major aim of this literature review was evaluating novel concepts and trends in the CA research area. To do so, we processed the suggested *forward references search* by Webster and Watson (2002) and vom Brocke (2015) in the last Step 2.3. Therefore, we extended the search basis of 63 (52+11) articles by collecting publications, which cited these articles. In order to identify relevant literature addressing our research questions considering trends in CA research, we specified the scope on novel publications by searching for citing literature that was published from 2013 to 2015. For this step, we used GoogleScholar because it is connected to extensive literature databases and can therefore offer a large variety in the result. Again, after eliminating duplicates and screening the results for relevance, we identified further 31 articles, which we added to our review basis. Finally, we created a basis of 94 articles, which were subject matter of the following review (see also Appendix A).

The analysis of the knowledge base is the foundation for the further design process and the evaluation of created artifacts. In this context, reviewing the literature is an indispensable step in order to develop IT artifacts solving human purposes. Therefore, these considerations are mainly affected by design science theory (Hevner et al., 2004; March and Smith, 1995; Österle et al., 2011). Consequently, the *analysis of the literature* (3) was mainly driven by two overall goals. First, technical key concepts in CA research have to be identified and evaluated in terms of their feasibility and usefulness in practice. Second, prototypical instantiations of CA concepts have to be investigated in order to identify barriers and challenges, which have to be addressed to achieve the spread of CA in practice. Additionally, a major aim of our work is the *identification of upcoming research trends* (4) in CA research and for what extent these trends address the so far identified barriers.

In order to complete the research paper at hand, the major findings of the analysis have to be repatriated into the knowledge base. Therefore, significant insights are condensed into a conceptual model with supporting propositions, which are introduced and discussed at the end of this paper. This theoretical development aims to be the key contribution of this work (5). Our method is shown in Figure 1.

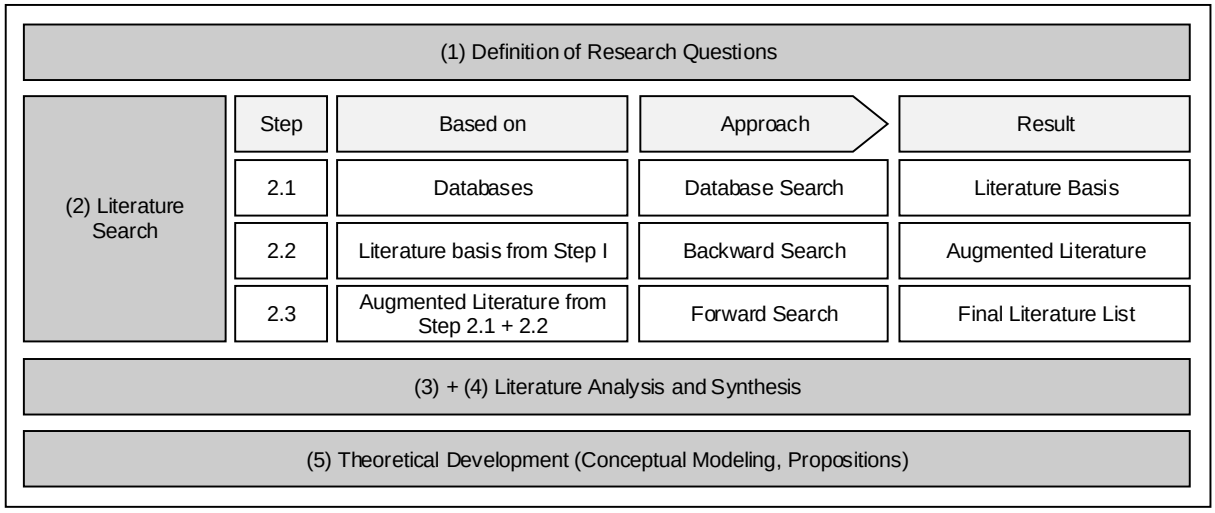


Figure 1. Structured Process of Literature Review (cf. Webster and Watson, 2002)

3 Appraising Continuous Auditing Literature

3.1 Analysis Criteria of Continuous Auditing Research

The analysis of the knowledge base requires the definition of appropriate criteria in order to draw reasonable implications for future research projects. Initially, we defined the *mode* as the first criteria in order to structure the identified literature (RQ1). This helped us to understand the methods, outcome, and directions of CA research. Moreover, we believe that the value and rigor of design-oriented work can be improved by expanding the scope on the different scientific modes of inquiry (Nunamaker and Briggs, 2011). These original modes are: *exploratory research*, *experimental research*, *theoretical research*, and *applied science/engineering*.

Generally, CA approaches consist of a combination of various technical constructs (i.e., concepts), which is the second criterion and refers to RQ2. CA literature provides several overviews of technical constructs (Brown et al., 2007; Chiu et al., 2014; Flowerday et al., 2006; Kuhn and Sutton, 2010). Many CA approaches are built up on *embedded audit modules* (EAM), which can be declared as the major construct of CA in its early days (Debreceny et al., 2003, 2005; Groomer and Murthy, 1989; Vasarhelyi and Halper, 1991). Further essential technical constructs are *general audit software* (GAS), and *systems control and review facility* (SCARF, Rezaee et al., 2002; Sun, 2012). Additionally, tools for the monitoring of accounting-relevant processes are discussed in literature (i.e., monitoring control layer, MCL,

Vasarhelyi et al., 2004). These technical constructs can be used to extract and analyze accounting-relevant data and, therefore, can be defined as can be defined as c*omputer-assisted audit tools and techniques* (CAATTs, Braun and Davis, 2003; Hall, 2011). A combination of rule-based detection by digital agents and web-based valuation sites are proposed by Woodroof and Searcy (2001). Finally, many publications discuss *extensible business reporting language* (XBRL) as a major technology in order to realize CA (e.g., Bovee et al., 2002; Pinsker, 2003; Shan and Troshani, 2014). All technical constructs, which are not fit in the definition of the constructs mentioned above, are categorized as *other*.

Basically, CA research focuses on both internal (e.g., Alles et al., 2008; Kogan et al., 2014; Vasarhelyi et al., 2012) and external auditors (Kuhn and Sutton, 2006; Murthy and Groomer, 2004; Searcy et al., 2003; Vasarhelyi and Alles, 2008). Both areas are faced with the essential challenges and barriers in introducing CA. However, we believe that it is essential to distinguish between internal and external auditing in CA research considering the different circumstances, issues, and progress in adopting CA in these areas (Byrnes et al., 2012). Thus, we defined auditing as a third criterion including the categories *internal* and *external* in order to address RQ3.

Alles et al (2013) state that the dominating research approach in the area of CA is design science research. According to March and Smith (1995), the products of design science are constructs, models, methods, and implementations. Therefore, we believe that the four types of design science products are appropriate to describe the *outcome* of CA research work, which is our final criterion in order to appraise CA literature and to draw implications for our work (RQ4). In the context of design science research, *models* are defined as combinations of constructs whereas *methods* are goal-directed activities. The oftentimes prototypical instantiation of technical artifacts is covered by the category *implementation*. Since *constructs* are characterized as the basic concepts and already addressed by a specific criterion, we passed on this category and, however, added the category *behavioral* to cover the variety of artificial types that are not fit into the definition design-oriented research.

We are aware that our list of criteria is not conclusively and several other aspects could be relevant in order to investigate the state of the art. However, we believe that the criteria (see Figure 2) are appropriate to answer the research questions and to draw implications for further research.

In order to analyze the identified literature regarding the selected criteria, we created a concept matrix in Excel according to Webster and Watson (2002). The final concept matrix encompasses 142 rows and 30 columns. Due to space limitations, we present this paper without this matrix and aggregated the results in manageable figures and tables instead.

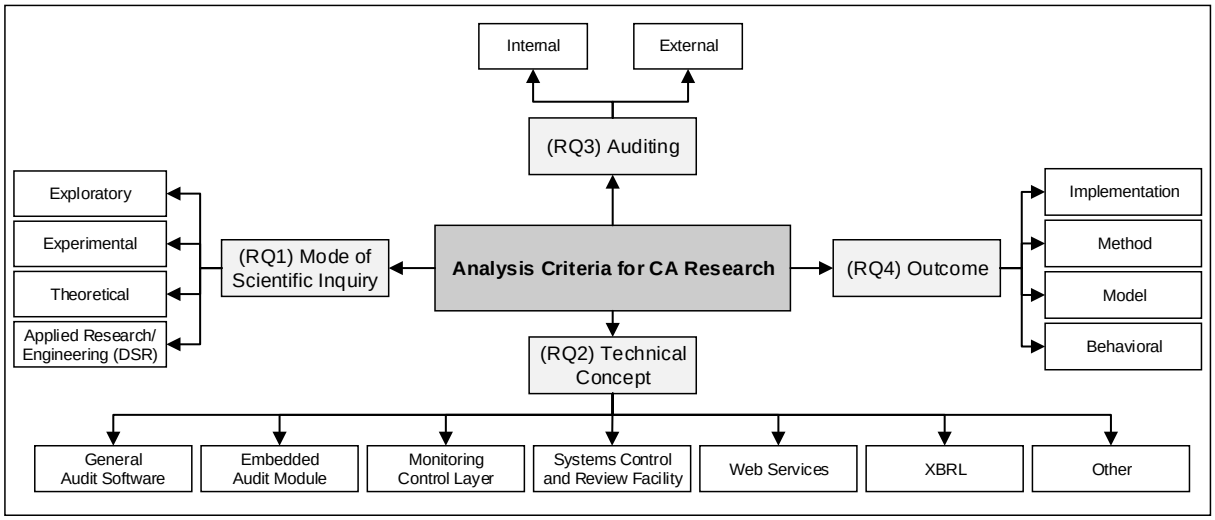


Figure 2. Analysis Criteria for CA research

3.2 Analysis of CA Literature

First, we analyzed the overall scientific context in terms of looking at the mode of scientific inquiry, which is an established way of determining the structure in a research field. As it can be seen in Figure 3, CA research was constantly driven by applied research and *design science research* (DSR). Concomitantly with SOX in 2002, the need for scientific guidance for implementing CA raised and, therefore, the number of theoretical publications increased in the following years. After this "first wave" of CA, evidence can be found that the predicted wide-spread adoption of CA did not take place in practice (Byrnes et al., 2012). Subsequent exploratory publications are mostly dealing with literature analysis, comparisons of CA approaches, and surveys of CA adoption in practice. Considering RQ1, it can be stated that the number of publications presenting exploratory research (31 publications), theoretical research (30), and DSR (27) are almost balanced. Our analysis indicates that experimental studies (6) play a minor role in CA research. Therefore, our results do not support the statement of Alles et al. that "*Design science research paradigm was the dominating methodology in continuous auditing research since its early days*" (2013 p. 107). We like to point out that the higher numbers of publications between 2013 and 2015 are caused by the restriction in the forward search. Without forward search, the ratio is likely the same: exploratory (19 publications), theoretical (20), DSR (19), and experimental (5).

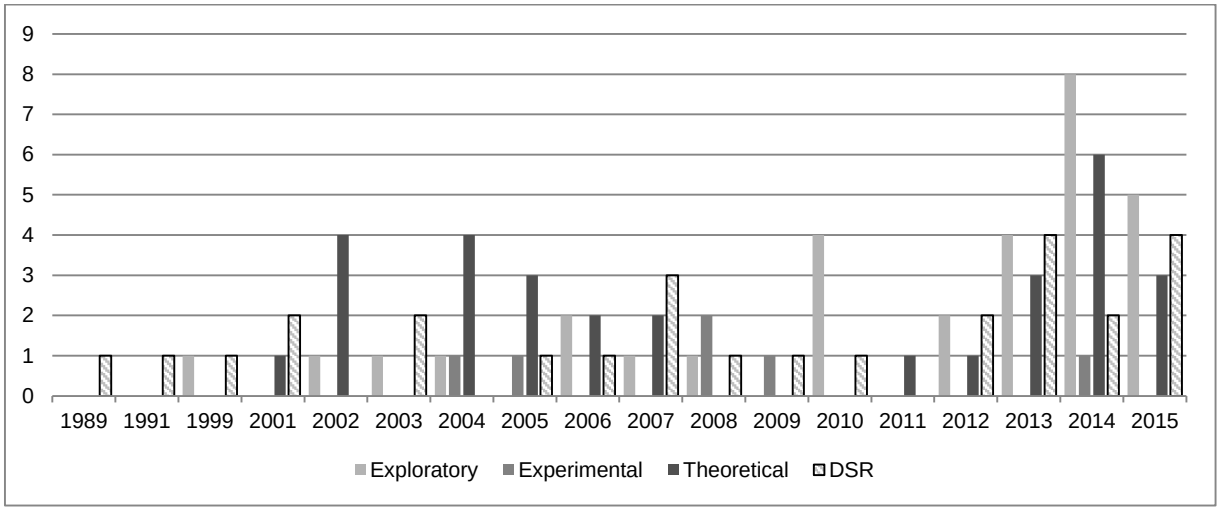


Figure 3. Scientific structure of CA research

Second, CA literature introduced and discussed various technical concepts, as presented in Table 2. Considering RQ2, our analysis supports the expectation that EAM and MCL are the prevalent concepts of design-oriented CA research. However, we found a number of publications introducing other concepts. Noteworthy techniques are digital agents (Kuhn et al., 2015; Woodroof and Searcy, 2001), data mining and process mining (van Aalst et al., 2010; Bukhsh and Weigand, 2013; Hunton and Rose, 2010) as well as system specific audit trail functions (Best et al., 2009; Shin et al., 2013; Singh et al., 2014).

Outcome	**Technical Concepts**								
	GAS	**EAM**	**MCL**	**SCARF**	**Web Services**	**XBRL**	**Other**	**No specific**	**Sum**
Model	3	9	7	1	4	3	19	5	**51**
Method	2	3	1	0	0	1	3	2	**12**
Implementation	2	5	6	0	3	0	8	1	**25**
Sum	**7**	**17**	**14**	**1**	**7**	**4**	**30**	**8**	**88**

Table 2. Technical Concepts by Outcome

Third, internal auditing and external auditing differ in several aspects considering time and audit procedures, access on accounting-relevant data, or independence. Therefore, we believe that CA literature has to outline clearly if it addresses internal, external auditing, or both. Surprisingly, various publications do not specify if the results are relevant for external or internal auditing. However, most publications in our review focus on both internal and external auditing (see Table 3). These publications are mostly exploratory and theoretical. With respect to RQ3, literature provides only limited evidence for applied CA research which focuses on external auditing (Best et al., 2009; Debreceny et al., 2005; Groomer and Murthy, 1989, 2003; Shin et al., 2013; Yeh and Shen, 2010). Considering the practical relevance of CA in terms of the intensified regulatory framework (e.g., SOX, audit reform in the EU) and the propositions of the "iron triangle" (i.e., cost, time, quality, Atkinson, 1999), we see an increasing need for design-oriented CA research for external auditors.

Outcome	**Auditing**				
	Internal	**External**	**Both**	**Not specified**	**Sum**
Exploratory	10	6	14	1	**31**
Experimental	3	0	2	1	**6**
Theoretical	4	8	13	5	**30**
Applied Research/DSR	10	3	7	7	**27**
Sum	**27**	**17**	**36**	**14**	**94**

Table 3. Addressed Auditing by Outcome

Finally, and in the regard of RQ4, we analyzed the outcome of the relevant publications in order to receive an expression of possible solutions considering the need for CA approaches (see Figure 4). The outcome of 41 publications can be classified as behavioral. These papers develop and investigate theories of human behavior, particularly, acceptance and adoption of CA or related CAATTs (e.g., Sun, 2012; Sun et al., 2015; Tumi, 2013; Vasarhelyi et al., 2012). From a design-oriented perspective, models are proposed in 40 publications, whereas methods are developed in 10 publications. In 15 cases, a model or a method was introduced first and, then, evaluated by an implementation in a business environment (e.g., de Aquino et al., 2015; Debreceny et al., 2003; Vasarhelyi and Halper, 1991). Overall, the number of 20 publications describing implementations seems to be comparatively low considering the practical relevance of CA research. This is, however, strongly connected with several challenges and barriers, which are rudimentary analyzed in the following section. Again, we like to point out that the higher numbers of publications between 2013 and 2015 are caused by the restriction in the forward search.

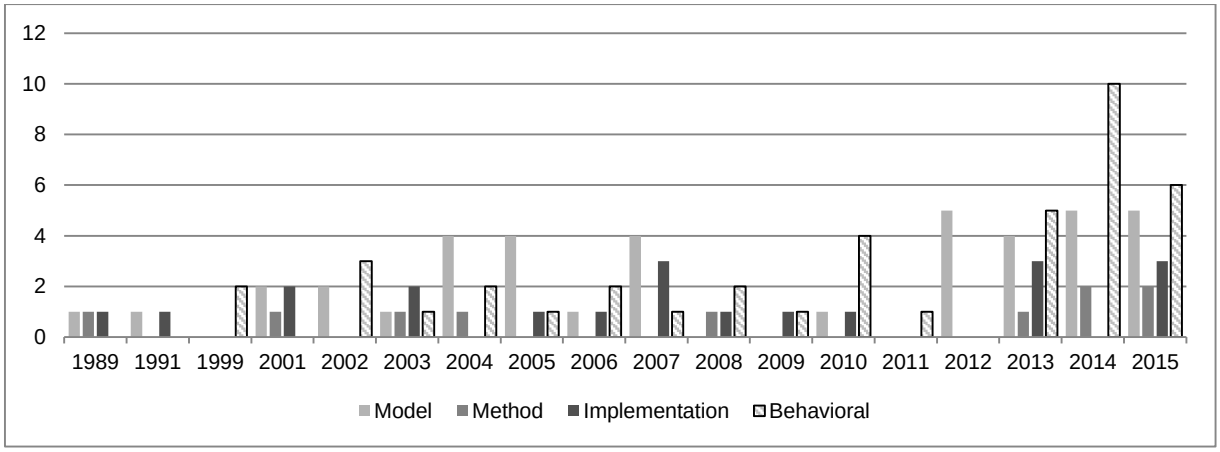


Figure 4. Outcome by year

3.3 Challenges of CA Adoption

Naturally, the adoption of CA is faced with several challenges and barriers, which impede the spread of CA approaches in practice. In order to answer RQ5, we analyzed implementation projects which were found in literature and elaborated major challenges. The results of these considerations are mainly influenced by critical success factors of CA implementation (see Table 4, Kiesow et al., 2015).

First and foremost, CA adoption is related to complex (1) *technical implementation*. Major concepts of CA (EAM, MCL) demand the installation of additional software components in client's business environment and AIS. Whereas some AIS offer automated interfaces, extraction logic has to be implemented in other AIS. Additionally, transformations layer and data links have to be implemented to realize data harmonization and data transfer in an audit data warehouse. Many audit firms do not provide capacities and technical expertise to realize these technical components. Moreover, implementation has impact on client's normal business operation, which results in additional cost and time restrictions of technical implementation. The implementation of CA requires a close cooperation of client and audit firm and, hence, is comparable with a consulting service. In this context, (2) *external auditors' independence* could be affected. Additionally, once implemented CA components are normally linked to a single audit firm. In case of (mandatory) audit firm rotation, the CA components could no longer be used. This situation could influence the appointment of independent auditors. Furthermore, CA has a tremendous impact on existing traditional (3) *audit procedures*. In the EU, this challenge is mainly affected by the upcoming reform of the audit market: *"(h) a statutory auditor or an audit firm shall use appropriate systems, resources and procedures to ensure continuity and regularity in the carrying out of his, her or its statutory audit activities"* (European Parliament, 2014b, Article 24 (h)). With regards to CA, Audit firms have to provide capacities to react on identified issues during the report year. The implementation and controlled operation of CA require an appropriate (4) *education of auditors*. This education has to build up a valid knowledge of business processes, internal control, and business risks. Additionally, auditors have to provide a valid knowledge of system procedures as well as AIS specific and programming skills. Additional soft skills mentioned in literature are willingness to change, flexibility, and capacity for teamwork. Concomitantly with continuous education of auditors, CA adoption requires a reasonable (5) *documentation* of methods, problems, and solutions of CA implementation scenarios. Documentation sets the baseline for improvement of techniques and skills and, hence, to build up expertise in this field. Techniques for preserving and sharing of information of CA implementation could face this challenge. Finally, the extraction and analysis of accounting-relevant data by third parties is strongly connected with (6) *data security and privacy*. CA projects have to consider that completeness and accuracy of data are constantly ensured through all phases of implementation and controlled operation. In this context, the EU parliament released the Directive 2013/0027 (COD), which aims to establish a high common level of network and information security in the EU.

No.	CA Adoption Challenge	Source
(1)	Technical implementation	Kuhn and Sutton, 2010; Vasarhelyi and Alles, 2008; Zhao et al., 2004
(2)	External auditors' independence	Alles et al., 2002; Du and Roohani, 2007
(3)	Adjustment of audit procedures	Alles et al., 2008; Rezaee et al., 2001; Vasarhelyi and Halper, 1991
(4)	Auditors' education	Byrnes et al., 2012; Rezaee et al., 2002; Vasarhelyi et al., 2010
(5)	Documentation of CA projects	Shin et al., 2013; Sun, 2012
(6)	Data Security and Privacy	Debreceny et al., 2005; Woodroof and Searcy, 2001

Table 4. Major CA implementation challenges (cf. Kiesow et al., 2015)

4 Research Trends in CA Literature

Naturally, the IS research is significantly influenced by overall technical progress and paradigm's shift. The consideration of new trends may contribute to overcome the so far identified challenges of CA implementation in practice. Therefore, we analyze the development in CA research in this section. Essentially, the results of this analysis base on the publications we identified by conducting the forward step. Additionally, we considered also papers, which were not part of the review of Section 3, however, are relevant for the *accounting information systems* (AIS) discipline in common. According to Liu et al. (2014), converging trends in CA/AIS research are *digitization*, *virtualization*, and *specialization*.

Digitization is characterized by the automation of business processes and, hence, has tremendous impact on traditional business models and supply chains. Digitization results in the generation and processing of large data sets. Hence, the big data paradigm is frequently discussed in CA/AIS literature. In this context, CA approaches are considered as particularly relevant in order to overcome the limitations of sample testing and, therefore, to enable the audit of large amounts of accounting-relevant data (Alles, 2015; Cao et al., 2015; Moffitt and Vasarhelyi, 2013). Moreover, big data may offer the potential for deeper analysis and more informed decisions of auditors and accounting stakeholders and could contribute to enhanced assurance of financial statements (Krahel and Vasarhelyi, 2014). Finally, big data could be used to predict audit results and, therefore, to transform the detective audit function to a preventive audit function by estimating transaction's future status (Kuenkaikaew and Vasarhelyi, 2013; Liu and Vasarhelyi, 2014).

Virtualization of data enables the accessibility and availability of electronic data at any time. This paradigm is essentially driven by cloud technology, which offers novel opportunities for CA. On the one hand, CA-concepts can be used to audit cloud-based AIS and *enterprise resource planning* (ERP) systems (Doelitzscher et al., 2012; Lins et al., 2015). One the other hand, cloud-based auditing approaches are introduced in literature (Abo-alian et al., 2015; Liu et al., 2014; Subhani and Kent, 2015). However, both audit of cloud storage and cloud-based audit services are still in the very beginning and, hence, further research is necessary in this field.

Whereas the *specification* of accounting is frequently debated in literature, the outsourcing of CA services is rarely discussed in literature so far. Evidence can be found by Debreceny et al. (2005): A third party provider with expertise in both programming and auditing could specialize in the development and provision of EAM and, therefore, spread of CA in practice. Surprisingly, this aspect has not been further discussed in literature so far. The opportunities of digitization/big data analytics and virtualization through cloud technology could be used to develop the cloud-based service support, which integrates both cloud technology and innovative business models. Analogous to Gilder (2006), who considers cloud-based data centers as "information factories" (see also Moffitt and Vasarhelyi, 2013), cloud-based audit service support providers could be considered as "audit factories". The audit-as-a-service could be the next evolution step of financial auditing. A conceptual model of this approach is provided in the upcoming section.

5 Theoretical Development of a Future Audit Approach

As described in Section 3.3, significant challenges of CA projects are (1) *technical implementation*, (2) *auditors' independence*, (3) *adjustment of audit procedures, (4) auditor's education, (5) documentation of CA projects, and (6) data security and privacy*. Additionally, technical progress and digitization of the economy (e.g., big data paradigm, cloud computing) have significant impact on existing CA concepts, as described in Section 4. Hence, besides technical issues, the bigger picture of CA implementation encompasses tremendous changes of auditing procedures, existing business models and the supply chain in the field of financial auditing. In order to close the identified gaps and to address the so far identified trends, we propose a conceptual model that aims to synthesize and extend existing research (Webster and Watson, 2002).

Conceptual modeling is defined as a design heuristic, which encompasses "*creating and experimenting with different types of representation of the problem solution to graphically, conceptually, or technically capture artifact solution components*" (Gregory and Muntermann, 2014). By designing a conceptual model grounded in theory on continuous auditing and the corresponding literature, we propose a theoretical schema of future auditing which addresses the so far identified research gaps. This model represents participants of the audit supply chain as static phenomena as well as data and service flows as dynamic phenomena (Wand and Weber, 2002).

5.1 Conceptual Model for External Auditing: Audit Service Support

Traditionally, the client provides documents, information, and access to accounting-relevant data in order to enable the conduction of the financial audit according to regulatory requirements. On this basis, an external auditor or an audit firm is able to evaluate the accuracy and completeness of financial data, and to produce a report, which can be understood as the outcome of the auditing process. Additionally, CAATTs are frequently used to support the auditor by the analysis of mass data. In short, traditional auditing is characterized by annual intermittency and evaluation of historical data.

From our perspective, imposing CA concepts on the described traditional auditing approach is neither purposeful nor efficient. This indicates to be a main reason why CA systems remain in a prototypical state and hesitantly spread in practice. Considering the analyzed research gaps at the paper at hand, we see a possible solution in the extension of the audit sector by a new player (i.e., independet provider with expertise in both programming and audit, Debreceny et al., 2005). This independent *service provider* is settled between client and audit firm. The expertise of this service provider is the development of mechanisms, which allow the implementation of CA systems. This includes the implementation of extracting routines independently from clients' accounting information systems. These routines set the baseline for the automated and continuous request, extraction, and preparation of financial data during the period. This approach could be considered as an extension of the well-known MCL approach.

In our model, the financial data are stored in a data warehouse. The audit firm in charge has restricted access on this data warehouse and is able to establish its own audit rules for the periods of assignment via cloud technology. Here too, the evaluation of the data according to the once implemented audit rules take place continuously during the period. The service provider monitors the results of the automated examination processing and reacts to alerts by informing the audit firm. Hence, the audit is supported by continuously delivered results generated by the service provider. Nevertheless, the audit of accounting-relevant documents and information as well as the creation of the report are still annual tasks of the audit firm according to regulatory requirements (see Figure 5).

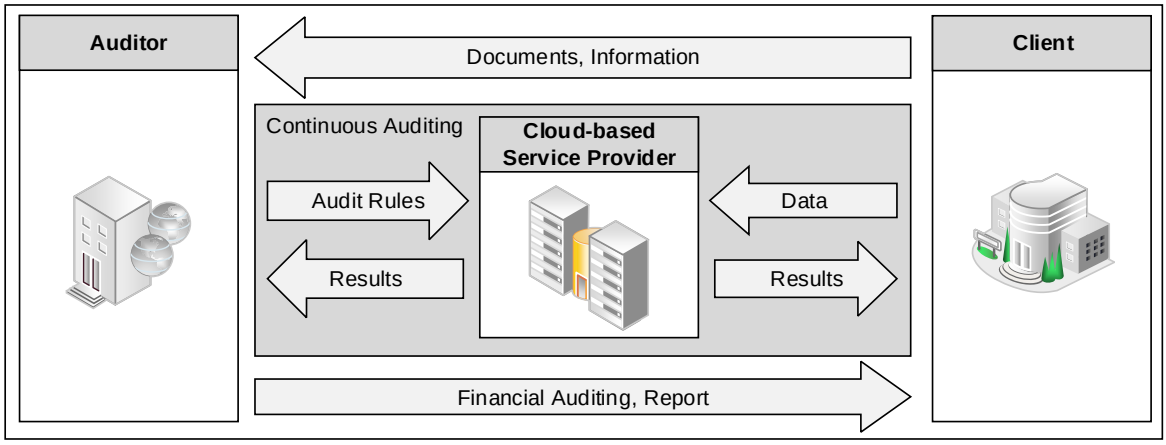


Figure 5. Conceptual Model of an Audit Service Support

5.2 Explanation of related Propositions

The introduced conceptual model is related with supporting propositions, which stand in order to accomplish the developed theory. Reasoning or justification for the model and its propositions is a crucial part of the development process (Webster and Watson, 2002). Therefore, the effectiveness of the proposed conceptual model is theoretically explained by the following propositions, which were derived and by the challenges of CA adoption as mentioned in Section 3.3. We believe that focusing on these challenges increases the use of CA and contributes to a wide-spread of CA in practice.

The first proposition of our theory (P1) is that *the technical realization of CA systems by a specialized service provider is time-saving, efficient, and leads to high quality implementation results*. A major barrier of implementing CA is the perceived complex technical realization. Naturally, the expertise of audit firms is evaluating accuracy and completeness of financial statements and internal control. The implementation of routines for extracting and examination of financial data is neither a core competence of audit firms nor a cost-efficient undertaking. In the described scenario, the service provider is able to build up expertise by developing mechanisms for extracting and examination of accounting-relevant data from various clients. This effect is described by the learning curve and already subject of research in the area of internal auditing (Pendegraft et al., 2014; Vasarhelyi et al., 2012).

The second proposition (P2) states that the described *audit service support by the provider ensures the independence of the external auditor*. On the one hand, existing CA concepts assume high involvement of the audit firm in the CA implementation process. This is reasoned by the necessity to design and maintain CA concepts in the client's system, which violates potentially auditors' independence (Kuhn and Sutton, 2010). On the other hand, a major concern of the reform of the audit sector in the EU is the deficient independence of statutory auditors and audit firms, which is addressed by the corresponding EU Directive (European Parliament, 2014, Article 13). Theoretically, the conflict of these opposing effects can be solved by the audit service support because the service provider is independent from client and audit firm and, hence, not responsible for the final evaluation of the results.

The third proposition (P3) is that *outsourcing of significant CA implementation tasks relieves audit firms* because the service provider observes the automated monitoring procedures during the report year and informs auditor and client in the case of control violation. However, the establishment of a third party audit service provider is related to massive changes of traditional supply chains and business models. Therefore, the realization of the proposed conceptual model refers not only to a technical implementation but also on business and pricing models, which would be necessary in this context.

As a result of the outsourcing of CA implementation activities, *audit firms have not to implement the technical components of CA by itself* (P4). According to the idea of specification, the audit service provider has to build up expertise in CA projects, and, hence, the audit firms could focus on core competences, which is mainly the financial audit of the disclosure. Nevertheless, continuous education in terms of digitization is required for all participants (i.e., audit firms, clients, and audit service provider) in the auditing domain.

The fifth proposition (P5) is that *a specialized audit service provider facilitates a comprehensive documentation of CA implementation methodology, issues, and individualized routines*. As mentioned above, we assume that the service provider develops knowledge and techniques in efficient documentation of results by conducting a large amount of CA projects. This knowledge and techniques could be used to apply CA implementation on comparable clients of the same industry or size and, therefore, supports the wide-spread of CA in practice.

Naturally, data security and privacy are major issues of cloud computing. However, our last proposition considering the proposed conceptual model (P6) is that *data security and privacy can be addressed by outsourcing CA functionality*. This could be achieved by storing data in a protected data warehouse. The access on this data is only possible for the auditor in charge. This could be realized by an audit dashboard, which is by a sophisticated user access control. Additionally, the audit service provider could be subject of compliance audits and, hence, be certified according to regulatory requirements.

6 Discussion and Implications

Initially, our review points out that CA research is both applied and behavioral (i.e., exploratory, explanatory, and theoretical, RQ1). Whereas applied work focuses on models and implementations in specific business environments, behavioral work elaborates factors of adoption and acceptance of CA in various regions. Overall, CA research is mainly driven by regulatory requirements, particularly SOX in 2002. With respect to the upcoming audit reform in the EU as well as the propositions of the digital age, we predict an increasing demand for high quality audit results in real-time and once more a thrust in CA research. Conversely, we note that little research has been done in the derivation of design principles of CA systems. Therein, we see high potential to enhance existing prototypical systems and to reach the wide-spread adoption of CA.

The results of our review indicate that the technical basis for CA adoption (RQ2) is generally given because CA literature provides a reasonable number of technical concepts. In recent publications, we found evidence that ERP providers increasingly deliver functionality to extract and evaluate accounting-relevant data. Nevertheless, the literature in our review does not provide any concepts, which could be understood as standard tools of CA. Even instantiations of GAS (e.g., ACL, CaseWare IDEA) or XBRL require customization to specific platforms and organizations. From our perspective, research should focus on novel technical concepts, which supports independence of clients' platforms.

Whereas literature provides evidence for the acceptance and adoption of CA by internal auditors, only little contribution can be found considering the acceptance and adoption by external auditors. Particularly, the investigation of challenges and adoption factors of external auditing is deficient. Consequently, we would like to encourage researchers to focus on the specific needs of external auditing (RQ3). Moreover, various models and methods, which may work out for internal auditing very well, cannot by applied on external auditing. Therefore, we suggest that researchers should clarify *whether* and *how* their work addresses internal auditing or external auditing.

The outcome of the analyzed publications (RQ4) are in most cases models i.e., conceptual models and broad architectures. It is important to note that we could identify neither process models of CA systems in controlled operation nor data models, which represent the structure of CA systems in use. None of the publications in our review provide a reference model of CA implementation or operation, which facilitates the application of CA concepts to different clients. The proposed models are mostly designed for specific business environments. Approximately 38% of these models are transferred to an instantiation, i.e., implemented in a business environment, which serves as evidence of technical feasibility of an artifact (proof of concept). According to Nunamaker and Briggs (2011), we state that CA research must broaden the contributions of designed CA systems beyond proof-of-concept to achieve an evidence of the efficacy of the designed solutions (i.e., proof-of-value), and, moreover, provide evidence of holistic understandings of the rich social, political, economic, cognitive, emotional, and physical context in which CA systems operate (i.e., proof of use). Therefore, we see demand for longitudinal case studies in business environments.

Various challenges of CA adoption were discussed in this paper (RQ5). Beyond these factors (see Section 3.3), our review does not provide any source which proves a positive cost-benefit tradeoff of CA in practice, which might cause the lack of competency in this field. Corresponding to the demand for longitudinal case studies, long-term economic impact of CA adoption has to be elaborated.

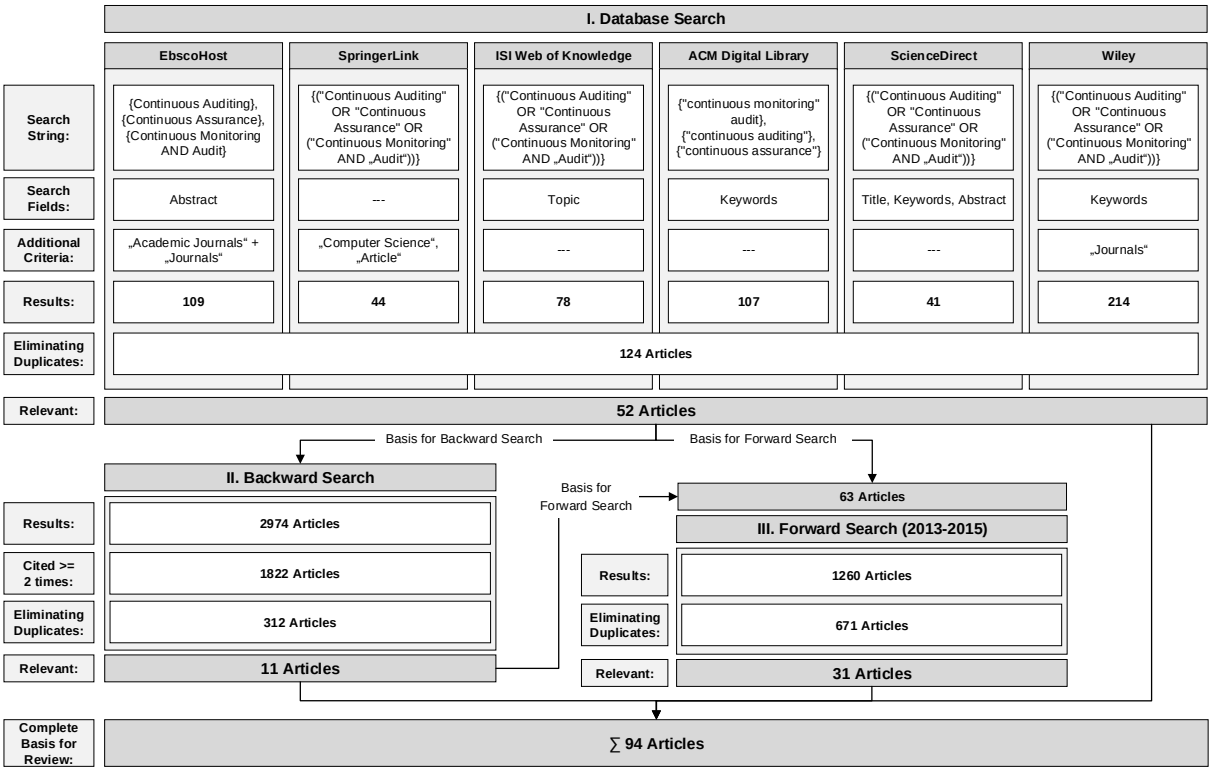
Considering novel approaches and techniques (RQ6), both CA and AIS literature provide promising propositions, particularly, in the context of big data analytics. Moreover, recent publications connect CA with cloud technology. However, we could not identify any work which regards the disruptive impact of cloud computing on traditional business models in auditing. From our perspective, this is extremely important because the fusion of CA and cloud technology will change traditional supply chains and, therefore, requires novel business models and prizing models. With a first conceptual model, which represents the outsourcing of CA mechanics to a cloud-based service provider, we aim to extent the knowledge base in this context.

7 Conclusion and Limitations

In this work, we have given a comprehensive overview of major concepts and outcome of CA literature. To do so, we followed a structured literature search process including backward search and forward search as proposed by Webster and Watson (2002) and vom Brocke et al. (2015). Considering that this research area is mainly driven by limited key concepts, we set the scope of our search process on a manageable number of papers (94) that encompasses a larger body of publications. Debatable aspects are the limitation of articles which were at least cited twice in the backward search as well as the timely restriction (2013-2015) in the forward search. However, from our perspective, the selected basis allows an objective evaluation of the state of the art in the research area of CA. Therefore, we elaborated wide implications and provide guidance for future CA research. Additionally, we proposed a conceptual model of an audit support service in this paper. It was shown *how* this model could overcome major challenges of CA adoption and, therefore, could lead to a wide spread of CA in practice.

It is, however, important to note that the proposed conceptual model is also characterized by various limitations. The concept represents a rather broad perspective on the process. Future work has to strengthen the conceptual modeling by developing detailed process models considering process quality and correctness (e.g., syntactic, semantic and pragmatic correctness, Lindland et al., 1994). Additionally, the establishment of a new market player is usually related to barriers to market entry (e.g., cost, resources, or social aspects). Moreover, the change of the existing financial auditing paradigm requires the development of new business models for all involved participants. For the time being, there is no practical experience of feasibility and usability of the scenario because it is subject matter of theoretical considerations. Therefore, future work has to provide empirical research and interaction with practice in order to evaluate the theory and its propositions developed in this paper.

Appendix A



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