Managing Internal Control: Designing a Wiki-based Information System for Continuous Process Assurance

Research-in-Progress

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Abstract

The assessment of a client’s internal control environment is a recognized and crucial part of financial statements auditing. Appropriate tools and techniques are required in order to enable the auditor to understand the organizational environment and to evaluate the compliance of controls along accounting-relevant processes. This research-in-progress paper provides initial research findings in the area of continuous assurance in terms of collecting requirements for the support of process auditing, and the extension of core functionalities of an existing prototype. This prototype is realized as a web application combining complete wiki functionality with a modeling component, and enables the automated synchronization between workflow procedures and business process models. This empowers the auditor to monitor and assess changes of client’s business environment and internal control constantly. In conclusion, the paper introduces future work encompassing the strengthening of analysis and design as well as evaluation by implementing the prototype in multiple organizations.

Keywords: Computer Assisted Audit Tools and Techniques, Continuous Assurance, Process Auditing, Wiki, Design Science

Introduction

The assessment of a client’s internal control environment is a recognized and crucial part of financial statements auditing and, therefore, addressed by essential legal standards. A major legal standard is the Sarbanes-Oxley Act of 2002 (SOX) which was signed into law by the U.S. in July, 2002 (Congress of the United States of America 2002). A key issue of SOX Section 404 is the management reporting on internal controls, and auditors’ assurance over management’s assertions regarding the client’s internal control environment (Arnold et al. 2007). In 2014, the European parliament enacted Directive 2014/56/EU which inter alia demands that the “audit committee shall monitor the effectiveness of the undertaking’s internal quality control” (European Parliament 2014). Moreover, the International Auditing Standard...
The financial statements auditing needs the evaluation of accounting-relevant processes (process auditing), which is basically an evaluation of internal controls linked by the process (Schultz et al. 2012). Furthermore, experts stated that the successful completion of process auditing depends on three steps (Kiesow et al. 2014): First, the identification of (internal) controls. Second, the adequacy of (internal) controls must be evaluated regarding their technical ability to cover the addressed risks. Third, the efficacy of (internal) controls in terms of to what extent these controls are actually able to prevent the occurrence of the addressed risk. To follow these steps, practitioners apply methods to elicit and use information about how accounting-relevant data are generated and processed, and how completeness and accuracy according to accounting standards is ensured (e.g. Plan-Do-Check-Act-Cycle, Russell 2013). Whereas the adequacy of controls is a matter of professional judgement of the auditor and the effectiveness of controls is the result of a test of controls (which is extensively supported by existing tools and techniques), the identification of the internal control is considered as a concomitantly protracted and crucial activity which is insufficiently supported by existing approaches. In general, these approaches require an adequate documentation of organizational workflows and procedures (which we refer to in the following as process compliance specification, PCS) as well as a correct and up to date documentation of the enterprise business process model (which we refer to in the following as business process specification, BPS). However, in practice, this is rarely found. Hence, significant problems arise due to a lack of valid PCS and moreover due to the inconsistence between the enterprise PCS and BPS (Kiesow et al. 2014). In order to enable the auditor to gain an impression in terms of complete and accurate PCS and the correct implementation within the client’s business processes, appropriate tools and techniques are required.

Computer Assisted Audit Tools and Techniques (CAATTs) are mostly defined as computer tools and techniques enabling the auditing of proceeded data contained in a client’s information systems (Braun and Davis 2003; Mahzan and Lymer 2014; Singleton and Flesher 2003). However, in a broader definition, CAATTs can be understood as any information system (IS) assisting the completion of an audit (Braun and Davis 2003). The development of innovative CAATTs gains in importance because accounting-relevant data are almost completely generated and processed by digital Accounting Information Systems (AIS). This leads into an increasing volume of financial data which cannot be evaluated by manual auditing activities (Janvrin et al. 2009; Moffitt and Vasehrleyi 2013). Therefore, it is consensus among researchers and practitioners that CAATTs contribute to cost-efficient and timely audit. Nevertheless, most classification schemes of CAATTs are limited on tools and techniques supporting risk assessment and test of controls in order to evaluate the processed accounting-data, such as data analysis and extraction tools, audit sampling, security and privacy tools (e.g. Braun and Davis 2003; Hall 2011; Pedrosa and Costa 2014). Literature has given only little attention to CAATTs supporting the auditor’s understanding of client’s environment and internal control. Up to now, to the best of our knowledge there is no CAATT supporting (internal or external) auditors in terms of identification of internal controls and the assessment of business process models according to organizational workflows and procedures.

This research in progress study follows a Design Science Research (DSR) approach (Hevner et al. 2004; March and Smith 1995) that deals with the construction of information technology (IT) artifacts for solving a research problem which has not been deeply investigated in literature and practice yet. A major research goal of this ongoing study is to develop an IT artifact for bridging the gap between organizational workflows and procedures and enterprise’s business process model by designing a new approach for documenting both in conjunction with a bridging tool. This bridging tool is considered as a specific software component which enables the synchronization between the processes and their documentation (BPS) and the organizational regulations and their documentation (PCS). It therefore has the potential to provide the auditor with up-to-date information and hence enables continuous assurance. Such information may encompass information about the organizational environment, the nature and characteristics of internal control as well as compliance of process documentation. The bridging tool moreover aims to enable an efficient audit according to legal standards (e.g. International Standard on Auditing (ISA) 315) and, therefore, fits into the aforementioned definition of CAATTs. According to the chosen design science approach, the artifact will be evaluated using different methods following a triangulation research strategy. This strategy encompasses a pilot application of the proposed approach, a case study and an experiment with external auditors, which in sum provide a holistic evaluation from
different perspectives and hence make our results more valid. Significant prerequisites of this approach are the existence of a wiki system, and maintenance by the enterprise’s operational staff. This is no serious limitation of our approach since major companies are using wikis. In this regard, a major study among nearly 1,700 executives from around the world working in wide spectrum of industries and functional areas revealed that 62% of the enterprises are using wikis, 40% among them even with measurable benefits (Bugrin et al. 2009). These numbers are also confirmed by newer studies, e.g. among German enterprises where 79% of the enterprises (n=161) with more than 500 employees use social software for internal purposes (BITKOM 2015). In regard to the financial industry, social software is also quite commonly applied. 51% of the enterprises report measurable benefits from using social software such as wikis for internal purposes (Bugrin et al. 2009). Among the most important benefits reported in regard to an internal use of these tools are increased speed of access to knowledge, reducing communication costs, and increasing speed of access to external experts. Our aim of using wikis to improve knowledge sharing and organization in continuous auditing processes is thus in line with the empirically reported merits and use cases of wikis in such studies (Fellmann et al. 2010).

The overall research goals of the ongoing study include a sound exploration of requirements to efficient and effective process auditing regarding the identification and evaluation of internal controls; the provision of a tool enabling the synchronization of organizational regulations and enterprise business process model to support the identification and evaluation of internal controls; and the successful evaluation of this tool in terms of the fulfillment of the requirements, technical feasibility (prototype), and value in practice via a case study and an experiment. These results could be used by all involved parties, which are (internal and external) auditors, IT managers, software providers, and researchers.

The overall research will cover the complete DSR cycle including analysis, design, evaluation, and diffusion of a prototypical assurance tool. Moreover, we expect that our studies add fundamental input to the knowledge base in this research field and, therefore, provide the basis for further academic work. Practical contributions concern both IT management and auditors. The proposed approach allows the synchronization between workflows and procedures and a client’s business process model, and, therefore, ensures the consistence of these so far technical separated constructs. Consequently, the proposed approach allows the identification of internal controls and supports the monitoring of the compliance regarding legal requirements (e.g. SOX Section 404). The academic contribution of this research-in-progress paper is that it provides initial research findings in the area of continuous assurance of accounting-relevant processes in terms of analyzing the needs for process auditing, collecting requirements for the support of process auditing, and devising core functionalities of a prototype. The prototype is actively developed as part of our ongoing research activity and will be evaluated in a case study which is already planned in conjunction with leading consulting firms in the financial sector.

The remainder of this paper is structured as follows. Section 2 describes the applied research approach which is placed in the area of DSR. Section 3 provides an overview of literature considering tools and techniques supporting the auditor’s work. Section 4 introduces preliminary steps that have been taken in the design of an assurance tool as an IT artifact, which addresses auditor’s requirements. Section 5 summarizes our initial results and explains future work.

**Research Model**

Towards designing an appropriate IT artifact, it is necessary to use a research approach that addresses the specific characteristics of IS research in auditing. DSR is a prevalent theory enabling the rigorous development of effective IT artifacts for relevant research problems (Kuechler and Vaishnavi 2011). Thus, a recent number of studies is dealing with DSR driven auditing research (e.g. Debreceny et al. 2003; Majdalawieh et al. 2012; Perols and Murthy 2012; Yeh and Shen 2010) and DSR can be considered as the dominating methodology in IS related (continuous) auditing research because it enforces the constant interaction between researchers and industry partners (Alles et al. 2013).

We strive for the design of IS-based solutions for the needs of (internal and external) auditors, and IT management. Our aim is therefore the development of artifacts serving human purposes according to the definition of DSR (March and Smith, 1995). The authors compared various DSR approaches (e.g. Nunamaker Jr and Chen 1990; Peffers et al. 2007; Sein et al. 2011), and, finally, chose the DSR approach according to Österle et al. (2011) because it significantly emphasizes the iterative process of design-
oriented IS research. Hence, the authors intend to demonstrate a complete DSR-cycle by presenting the related four basic phases, namely: analysis, design, evaluation, and diffusion. First, the requirements for successful process auditing have to be analyzed through literature review, expert interviews, and the related relevant legal standards (analysis). Second, the design process of the aforementioned approach has to be soundly explored and presented. Third, the approach has to be evaluated in order to prove the concept, ensure the technical feasibility, and address the practical value (evaluation). Finally, to achieve the best possible diffusion among researchers in the area of IT audit and controls, the results of this study have to be condensed in a scientific paper. As mentioned above, DSR is an iterative process. Hence, the presentation of the four basic phases can be extended into a circle (Kiesow et al. 2015). These considerations are shown in the upcoming Figure 1. Analysis and design are partially addressed in this paper since we analyze the needs for (continuous) process auditing, collecting requirements for the support of (continuous) process auditing, and devising core functionalities of a prototype.

DSR is characterized by the usage of “principles of form and function, methods, and justificatory theoretical knowledge” for the development of IS (Gregor, 2006). In order to ensure the precise application of DSR, the research is verified against the guidelines of DSR (Hevner et al. 2004): The proposed artifact bases on an existing prototype system and, therefore, an instantiation according to guideline 1 (design as an artifact). This artifact indicates to solve a relevant problem (problem relevance, guideline 2), which is the support of (internal and external) auditors in order to complete a successful process auditing. Evaluation as well as research contribution is subject matter of future work and not addressed in this paper (design evaluation, guideline 3, research contribution, guideline 4). Through all phases of the research process (analysis, design, evaluation, and diffusion) methodologies from the knowledge base will be assessed and effectively used considering research rigor (guideline 5). In order to reach the research goals mentioned in Section 1, this paper presents the initial considerations within the first design cycle (design as a search process, guideline 6). The results of this study will be condensed in a scientific paper considering technology as well as management-oriented audience (communication of the research, guideline 7).

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<td>(e.g. WorldCom, Enron)</td>
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**Figure 1. Design Science Research Framework for IS auditing, in the style of Hevner 2007**

**Prevalence of CAATTs in Auditing Standards and Literature**

The American Institute of Certified Public Accountants (AICPA) provides a broad categorization of CAATTs related to the testing of financial data (SAS No. 94, AICPA 2001). This categorization was enhanced by the Information Systems Audit and Control Association (ISACA, Cerullo and Cerullo 2003). In 2008, ISACA published the IS Auditing Guideline G3 considering the usage of CAATTs (ISACA 2008), and ISA 330 suggests the use of CAATTs because it contributes to an efficient audit. Moreover, CAATTs have been deeply investigated in the recent years and the related research literature on IT audit is fairly
extensive (Mahzan and Lymer 2014). Mahzan and Lymer (2008) define CAATTs as “computer tools and techniques that an auditor (external or internal) uses as part of their audit procedures to process data of audit significance contained in a client’s information systems”. Sayana (2003) defines CAATTs as software used by auditors to perform audits and to reach the objectives of the audit activities. From a broad perspective, “CAATTs include any use of technology to assist in the completion of an audit” (Braun and Davis 2003). According to this broad definition, the possibilities of computer-assistance in audit are numerous, in terms of electronic guidelines, checklists, or templates to individual data-processing. For example, the generation of audit reports can be supported by the eXtensible Business Reporting Language (XBRL, Taylor and Dzuranin 2010). Coderre (2005) provides an overview of automated control testing tools and its use for implementing continuous auditing.

To the best of our knowledge, no academic work to date elaborates the development of CAATTs enabling the synchronization of organizational regulations and the business process model. Our contribution at this stage of the ongoing research is to begin to close this gap in analyzing requirements to advanced CAATTs and identifying core functionalities required for transferring them into an IT artifact which will be evaluated as part of our future research.

Design of an IT-supported continuous auditing approach

Requirements to Process Auditing Derived from Interviews

Requirements have to be soundly explored in order to gather information about the needs of users (Tiwari et al. 2012). The analysis of requirements encompass all aspects of system development before the actual system design (Ross and Schoman 1977) and is supported by various methods and techniques to explore the user’s needs (Hickey and Davis 2003). Experts’ interviews are considered as efficient describing the interactions between system and stakeholders (Sabahat et al. 2010). Therefore, we carried out a first step of a structured requirements analysis by interviewing three experts in the field of process auditing in prior work. The experts were selected by a heterogeneous purposive sample approach in order to meet predefined key criterions (Ritchie and Lewis 2003), which are at least two years of work experience in the internal or external audit, and successful certified information systems auditor exam. Additionally, all experts were highly aware with using CAATTs in practice. Consequently, the interviews were conducted as semi-structured interviews and followed an interview guideline. This approach seemed to be appropriate because we expected an open conversation with the interviewees (Skinner 2012). We are aware that the requirements analyses so far can only be considered as an initial point for the first research activities and that structured and comprehensive requirements analyses must be addressed by an extensive approach involving IT management, IT staff, and (internal and external) auditors from different industries.

The experts mentioned that cooperation with the audited client is essential for the understanding of the client’s environment. The client has to hold the workflows and procedures (i.e. PCS) as well as the graphical representations of the processes and systems (i.e. BPS) ready and up-to-date. All experts stated that the identification of internal key controls indispensable for successful process auditing. In order to complete the process auditing, the conduction of interviews to collect the necessary information is important. Hence, the client’s domain experts must share their knowledge in a truthful and in appropriate manner. Finally, the derived requirements are: The client has up-to-date organizational regulations (R1). The client’s domain experts are identified (R2), and they share their knowledge in a truthful and in appropriate manner (R3). Furthermore, all experts stated that the gained understanding has to be documented in graphical and textual representation (R4).

Representation of Process Documentation

Accounting-relevant processes predominantly are documented within the business process documentation. This documentation consists of a textual representation as well as a graphical representation. The textual representation encompasses descriptions of workflows and procedures (workflow description). The graphical representation in turn serves as an abstraction of the workflow (business process model). The auditor requires both textual representation and graphical representation to gain a valid understanding of the organizational requirements and the internal control (cf. R4). However, as mentioned above, the auditor is faced with inconsistent textual and graphical representations or the lack of description.
In the proposed approach, the workflow description is represented as a *wiki page* in a Semantic Media Wiki. Likewise, the business process model is represented in *decision patterns*, which are characterized by ‘AND’, ‘OR’, and ‘XOR’ decisions. The major goal of the prototype that will be developed is to ensure consistence between process knowledge enshrined in a textual workflow description and generated graphical models condensed in decision patterns by an automated *synchronization* in order to fulfill R1 and R4. The link between the business process model and the organizational regulations enables the auditor to retrieve meta-data of the process and, therefore, to identify the experts of the audited (sub-)process. By the aforementioned automatic tracking of activities, the auditor can see which user changed wiki content. Based on this information, the auditor can make contact with domain experts and announce further audit procedures (R2). The formalization of process documentation in an organized and structured form reduces the need for verbal and non-structured information by the domain experts. Although the proposed approach does not prevent (intended or unintended) false input by the domain experts, the changes of contents can be seen and controlled by a four-eye principle. This enables the traceability of changes and reduces the likelihood of false inputs (R3). The amelioration of the process documentation and the requirements of process auditing are shown in the upcoming Figure 2.

![Figure 2. Representation of Process Documentation and Requirements to Process Auditing](image)

**Prototype of the Bridging Tool**

From 2011 to 2014, we developed a prototype in cooperation with a medium-sized software provider in the field of business process modeling. This pilot system can be understood as a proof-of-concept for the technical feasibility of the synchronization approach which will be leveraged as part of our (continuous) assurance approach. It is realized as a web application combining complete wiki functionality with a modeling component. This system relies on user-generated (i.e. domain experts) content in terms of textual descriptions of workflow activities. In the following, we identify the core functionality of the system that is going to be re-used and adapted for the (continuous) assurance approach. A graphical overview is provided in Figure 3.

**Description of the information flow from the modeling tool to the wiki:** If a user (i.e. domain expert) saves information about a business process model within the (1) *modeling component*, the modelling component sends a model in a specific standard format to a (2) *page generating component*. This component (2) divides the received model into different wiki pages. For that purpose, the algorithm “model2page” generates an abstract (i.e. independently from the actual wiki technology) hypertext representation of the model. Afterward, the algorithm sends this hypertext representation to the (3) *transformation component* “page2wiki”. This component (3) transforms the representation into the concrete syntax structure of the used wiki.

**Description of the information flow from the wiki to the modeling tool:** If a user (i.e. domain expert) updates information in the wiki (e.g. workflow description), the information flows vice versa from the wiki to the modeling component. Initially, wiki information (in its wiki specific representation) is automatically exported and sent to the (4) *transformation component* “wiki2page”. After the transformation of the wiki specific representation into an abstract hypertext representation, the component (4) sends this information to a (5) *comparing component*. Within this component (5), the
The algorithm “page-diff” compares a hypertext representation of the model in the modeling component (1) and the received hypertext representation of the wiki article. To do so, the component (5) requires meta-information of the current model defined in the wiki as well as the abstract hypertext representation transformed by component (4). The so calculated difference or modification of the description in the wiki is automatically added to the modeling component (1). There, the modification (e.g. considering internal control) can be controlled by a second pair of eyes ("four-eye-principle").

So far, the development of the prototype has shown the technical feasibility, although not in the domain of (continuous) assurance. It was tested with artificial data which consists of two exemplary workflows of a public institution. Despite changing these data (e.g. order of activities, additional activities, description of activities) within the prototype, the algorithms and functions were able to ensure the synchronization between textual and graphical representation. Thus, it was demonstrated that the tool provides the core functionality which is required to enable the synchronization between workflow descriptions (condensed in wiki articles) and graphical process representation (i.e. business process model).

![Figure 3. Core Functionality of the Bridging Tool](image)

**Conclusion**

**Contributions**

The study at hand seeks to explore which audit tools or techniques exist to support the auditor to gain a valid understanding of client’s environment and to identify internal control, and therefore contributes to a successful auditing of accounting-relevant processes. Nonetheless, the completion of process auditing (i.e. the audit of accounting-relevant processes) relies also significantly on the auditor’s understanding of the client’s environment and its internal control. Additionally, the development of appropriate solutions gains extensively in importance regarding legal requirements and the increasing occurrence of structured and unstructured information about the nature of organizational environments. Literature deals extensively with tools and techniques enabling the extraction and analysis of accounting-relevant data processed in the AIS. However, we explored that relevant literature does not provide any tools and techniques for synchronizing organizational regulations with business process models. In fact, auditors have to rely on the client’s process documentation, which is however often characterized by inconsistency of workflow descriptions and business process model.

This work attempts to fill the gap by proposing an approach to enable the continuous assurance of the internal control environment and to support the auditor to gain a valid understanding of the business environment. At this stage of the research in progress, we analyzed requirements to advanced CAATTs based on empirical research (interviews) and identified core functionalities required for implementing an advanced CAATT on top of a well-established wiki engine (Semantic Media Wiki, SMW). In order to
complete this study, requirements to successful auditing of accounting-relevant processes will be investigated in further detail during the design of an IT artifact which will then be implemented and evaluated using case study research. In doing so, we use and extend an existing prototype web application able to synchronize the organizational regulations (condensed in an SMW) and its graphical representation using annotations. This mechanic offers several opportunities which in turn can be used to realize a continuous assurance approach. This in turn empowers the auditor to keep the understanding of a client’s environment constantly up to date, identify internal controls, and prepare further audit procedures (e.g. test of controls). The value for client’s management and staff is that the proposed approach enforces the breakdown of organizational regulations in structured workflow descriptions and their transformation in wiki articles, which contributes to their manageability and checkability. Additionally, the compliance of process models is permanently ensured by the automated synchronization of workflow descriptions and the corresponding graphical process model.

All in all, our research aims to contribute both to research and practice in several aspects. It provides a design-oriented research approach considering analysis, design, and evaluation of an innovative solution for a relevant and so far unsolved problem in process auditing. Our approach does not only provide a solution to the practical problem, but also enriches the knowledge base of auditing (cf. Figure 1). The implementation of the proposed approach is complex and requires a lot of further research effort. The paper at hand represents a first move in our research endeavor towards improving the (continuous) assurance via an advanced IT-support on top of well-established and usable wiki systems. This research in progress and is not complete yet. At this stage, we presented requirements to advanced CAATTs and identified core functionalities required for transferring them into an IT artifact.

**Future Work**

The research described in this paper is characterized as an IS design science approach. In the context of the research process in design science, the evaluation of artifacts is a crucial component which enforces a rigorous methodology. Hevner et al. (2004) describe and classify the following evaluation methods: (i) observational, (ii) analytical, (iii) experimental, (iv) testing, and (v) descriptive. Innovative artifacts need appropriate time to reach acceptance in practice. Hence, we first have to implement the prototype according to the requirements presented in this paper and covering the core functionality we presented in the previous section (cf. Figure 3). Subsequently, a threefold evaluation shall ensure the utility of the approach: The technical feasibility of the approach has to be evaluated by a pilot application of the prototype with real business data (iv). Additionally, we seek to evaluate the implementation in business environments by a multi case study approach (e.g. according to Yin 2013) involving companies from different industries (i). Finally, the practical value has to be evaluated by a parallel simulation involving external auditors (iii). For all three evaluation steps, we have already contacted business partners (case study companies, external auditors), who agreed to participate in this research.

Beyond the evaluation, there are several areas which have to be addressed in order to cover the so far recognized limitations and complete the research. First, literature in the area of continuous auditing has to be soundly explored in order to complete the research (e.g. Alles et al. 2008; Rezaee et al. 2002; Vasarhelyi and Halper 1991). Second, the requirements to successful process auditing and to the artifact have to be sharpened by conducting more qualitative research (e.g. expert interviews, surveys). Third, prerequisites of the proposed approach (e.g. cooperation of client’s management and IT staff, adoption of wikis, and maintenance by client’s process owners) have to be delved in future research.

With our research, we pave the way for a design theory capturing the principles of effective developing of CAATTs. According to Baskerville and Pries-Heje (2010), an explanatory design theory “provides a functional explanation as to why a solution has certain components in terms of the requirements stated in the design. For explanatory design theory, only two elements are essentially necessary for a complete design theory: requirements and solution components”. Since this type of theory is criticized by Venable (2013) as being constituted by a (too) simple binary relation between requirements and components, we abstain from theorizing at this state of research and instead conduct more empirical evidence in order to finally provide a well-justified utility relation between, on the one hand, elements of the general design, and on the other hand general requirements. In this regard, our preliminary evaluation of the design of the prototype, which following a naturalistic ex-ante strategy (Venable et al. 2012), will be complemented by artificial ex-post-strategies such as lab experiments.
References


