



Continuous Auditing

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Article information:

To cite this document: David Y. Chan,² Miklos A. Vasarhelyi,^{*} "Innovation and Practice of Continuous Auditing¹" *In Continuous Auditing*. Published online: 12 Mar 2018; 271-283.

Permanent link to this document:

<https://doi.org/10.1108/978-1-78743-413-420181013>

Downloaded on: 13 March 2018, At: 03:08 (PT)

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Innovation and Practice of Continuous Auditing¹

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Abstract

The traditional audit paradigm is outdated in the real time economy. Innovation of the traditional audit process is necessary to support real time assurance. Practitioners and academics are exploring continuous auditing as a potential successor to the traditional audit paradigm. Using technology and automation, continuous auditing methodology enhances the efficiency and effectiveness of the audit process to support real time assurance. This paper defines how continuous auditing methodology introduces innovation to practice in seven dimensions and proposes a four-stage paradigm to advance future research. In addition, we formulate a set of methodological propositions concerning the future of assurance for practitioners and academic researchers.

Keywords: Continuous auditing; Traditional auditing; Innovation; Audit methodology; Audit process; Audit stages; Audit practice; Analytical procedures; Data modeling; Data analytics

¹From *International Journal of Accounting Information Systems* 12(2), 152–160. Reprinted by permission of Elsevier.

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1. Introduction

The objective of financial reporting is to provide information that is useful to management and stakeholders for resource allocation decisions (FASB, 2006). For financial information to be useful, it should be timely and free from material errors, omissions, and fraud. In the real time economy (Economist, 2002; Vasarhelyi et al., 2010), timely and reliable financial information is critical for day to day business decisions regarding strategic planning, raising capital, credit decisions, and supplier or vendor partnerships. Advances in accounting information systems such as the advent of enterprise resource planning (ERP) systems have enabled the generation of real time financial information. However, the practice of traditional auditing has not kept pace with the real time economy, and the state of the art of assurance has lagged. The lack of support for real time assurance may be primarily attributed to the manual nature of traditional audit procedures. Manual audit procedures are labor and time intensive. These constraints limit audit frequency to an annual occurrence. As a result, management and stakeholder reliance on real time financial information can lead to adverse resource allocation decisions.

These time and effort constraints can be alleviated through the use of technology and automation. Reliance on technology throughout the audit process can reduce labor intensiveness (Elliott, 1998) and increase production efficiencies (Menon and Williams, 2001). Innovation of the traditional audit process using an automation technology such as continuous auditing (CA) will be an essential step toward the development of real time assurance. OECD (1997) defines a technological process innovation as the implementation of new or significantly improved production or delivery methods of goods or services. In the case of continuous auditing, the methodologies enhance the delivery of auditing services by making the audit process more efficient and effective through the use of technology and automation. The increased efficiency and effectiveness of the audit process enables more frequent or real time audits and hence enhances the reliability of real time financial information.

The continuous auditing paradigm introduces innovation to the traditional practice of auditing along seven major dimensions (Table 1):

1. Continuous or more frequent audits
2. Proactive audit model
3. Automation of audit procedures
4. Evolution of the work and role of the auditors
5. Change in the nature, timing, and extent of auditing
6. Use of data modeling and data analytics for monitoring and testing
7. Change in nature and timing of audit reporting

Collectively, these seven innovation dimensions aid in enabling real time assurance and enhancing the reliability of real time financial information. Furthermore, the paper proposes four stages for the continuous audit paradigm to advance future research and development. As the demand for real time reporting and assurance

Table 1: Traditional Auditing vs. Continuous Auditing Methodology.

Traditional auditing	Continuous auditing
1. Frequency: • Periodic	1. Frequency: • Continuous or more frequent
2. Approach: • Reactive	2. Approach: • Proactive
3. Procedures: • Manual	3. Procedures: • Automated
4. Work and role of auditors • Bulk of the work performed is centered around labor and time intensive audit procedures • Independent roles of the internal and external auditor	4. Work and role of auditors • Bulk of the work performed is centered around handling exceptions and audit procedures requiring human judgement • External auditor role becomes the certifier of the continuous auditing system
5. Nature, timing, and extent: • Testing consists of analytical review procedures and substantive details testing (nature) • Controls testing and detailed testing occur independently (timing) • Sampling in testing (extent)	5. Nature, timing, and extent: • Testing consist of continuous controls monitoring and continuous data assurance (nature) • Controls monitoring and detailed testing occur simultaneously (timing) • Whole population is considered in testing (extent)
6. Testing: • Humans perform testing	6. Testing: • Data modeling and data analytics are used for monitoring and testing
7. Reporting • Periodic	7. Reporting: • Continuous or more frequent

increases, the continuous auditing paradigm will progressively integrate with, and then supersede, the traditional audit and its set of processes.

The remainder of the paper is organized as follows: Section III details CA innovations to the traditional audit methodology. In section IV, the stages and process of the continuous audit paradigm are examined. Finally, section V concludes.

2. Continuous Auditing Innovations in Audit Methodology

The concept of continuous auditing was first introduced by Groomer and Murthy (1989) and Vasarhelyi and Halper (1991). Since then, CA has been progressively prototyped and/or adopted at such institutions as AT&T Corp., Siemens, HCA Inc, Itau Unibanco, IBM, HP, MetLife, and Proctor & Gamble. Furthermore, interest in exploiting CA methodology has advanced to the point where practitioners are collaborating and partnering with the academic research community.³ This interest in continuous auditing implies that management and their auditors recognize that the traditional audit paradigm is outdated and innovation to the practice of auditing is necessary in the real time economy.⁴

³19th World Continuous Auditing and Reporting Symposium (2009) and Continuous Auditing Research Projects at Rutgers Continuous Auditing Lab.

⁴<http://raw.rutgers.edu/Galileo>.



Fig. 1: Continuous audit cycle.

2.1. Continuous or Frequent Audit

Auditing continuously or in real time may seem ideal. However, the real time audit can impact the operation of the accounting information system and may not always be cost-effective. As a result, real time continuous auditing will tend to occur in high risk business processes. For example, in industrial firms it may be prudent to continuously audit the higher risk treasury disbursement process in real time. On the other hand, it may be sufficient to audit the lower risk prepayment expense process in periodic or frequent cycles. (Du and Roohani, 2007) propose a continuous auditing cycle model that mirrors the traditional audit engagement period. A cycle starts when the auditor connects into the accounting information system and ends when the auditor disconnects. The auditor can connect into the system after a period of time or a number of transactions (Du and Roohani, 2007). However, Pathak et al. (2004) finds a continuous audit cycle dependent on transaction volume may be more cost-effective. For example, an audit will be triggered after a number of accounts payable transactions have entered into the accounting information system (Fig. 1).

2.2. Proactive Audit

In the traditional audit paradigm, accounting information is audited on an annual basis. As a result, material errors, omissions, or fraud can go undetected for months before detection by an audit. In contrast, a continuous audit occurs on a more frequent or continuous basis. Continuous monitoring of internal controls and testing of transactions allows the auditor to actively detect and investigate exceptions as they occur rather than to react after the exception has long occurred. Transactions involving internal control violation and transaction anomalies can be aborted or suspended in real time until investigated by an auditor. Hence, a continuous audit can be considered a proactive than a reactive audit. As accounting information systems become increasingly complex and sequential business processes intertwine (ex. manufacturing, inventory, sales, etc.), proactive auditing may help preclude the transmission of errors, omissions, and fraud from process to process. Therefore, future information systems will feature reduced frequency of errors, omissions, and fraud occurring over a more limited set of sequential processes.

2.3. Automation of Audit Procedures

A traditional audit is labor and time intensive due to the preponderance of manual audit procedures. Automation of audit procedures utilizing continuous auditing methodology can alleviate these constraints. Pre-existing audit procedures can be used as a starting point to determine which audit procedures can be formalized for automation (Alles et al., 2006; Vasarhelyi et al., 2004). However, the automation of all traditional audit procedures may not be immediately feasible. Audit procedures requiring complex judgment and professional skepticism will still require manual performance by the auditor in the continuous auditing environment.⁵ For example, the evaluation of management estimates (e.g. allowance for doubtful accounts) may not be automatable. However, advancements in artificial intelligence⁶ may someday lead to automation of audit procedures requiring human judgment and professional skepticism. Regardless of extent, the automation of some manual audit procedures reduces labor and time intensiveness and contributes to the efficiency of the overall audit.

For automated audit procedures to be effective, standardization of data collection and formalization of internal control policies is necessary. For example, free form input text-fields should be avoided in the accounting system to avoid discretionary input. If the data entered into the accounting system is not standardized, the auditor would have to manually clean the data before automated audit procedures can be performed. The tedious process of manual data cleaning will partially offset the benefits and efficiencies of automated audit procedures. Furthermore, internal control policies within a company should be well defined or formalized in order to support automated monitoring of internal control violations.

Standardized data and formalized internal control policies will allow automated audit procedures to run seamlessly with limited or no auditor intervention.

2.4. Work and Role of Internal and External Auditor

Vasarhelyi et al. (2004) proposed four levels of audit objectives for continuous assurance and analytical monitoring;

- Level 1: Transactional Verification
 - Detection of business transaction irregularities
- Level 2: Compliance Verification
 - Substantiation that measurement rules (ex. GAAP) have been properly applied
- Level 3: Estimate Verification
 - Evaluation of accounting estimate reasonableness

⁵Although audit judgment can also be substantially formalized/automated this is a higher level process which typically takes substantive time to develop (Vasarhelyi and Halper, 1991).

⁶The 6 volume series Vasarhelyi, Miklos et al, *Artificial Intelligence in Accounting and Auditing*, published by Markus Wiener Publishers from 1989 to 2005 presents a wide range of relevant potential AI applications.

- Level 4: Judgment Verification
 - Application of complex high level judgment for overall audit risk reduction

Audit procedures used for transaction and compliance verification are automated in the continuous auditing environment. The automation of transaction and compliance audit procedures shifts the auditor's work to more complex audit objectives, such as dealing with estimate and judgment verifications that require auditor judgment and professional skepticism. Hence, the auditor's main role in the present continuous auditing environment involves investigating irregularities/exceptions from the CA system and dealing with audit procedures requiring judgment and professional skepticism.

The implementation of continuous auditing technology and methodology has evolved to become the province of internal audit (Vasarhelyi and Kuenkaikaew, 2010). The implementation of CA by both internal and external auditors will inefficiently duplicate the performance of audit procedures due to the nature, timing, and extent of testing and monitoring. Consequently, the implementation of CA by internal auditors may be ideal because of the large amount of data and the frequency of monitoring and testing required. However, external auditors can perform high level analytics and monitor an audit trail of the CA system to detect inconsistencies or fraud by management. Consequently, the external auditor's role may eventually evolve to become an independent certification provider of the internal audit CA system. Furthermore, in the future, the external auditor may act as an insurer (Elliott, 2002) against materially faulty financial information generated by a certified internal audit CA system.

As a certification provider, the external auditor would evaluate and attest to the proper function of the internal audit CA system. A third party "black box" log file can be used as an audit trail of the continuous audit system (Alles et al., 2004). This log file would be used to continuously monitor for abnormalities or interventions made by management during the operation of the CA system. The log file could also serve as evidence that audit procedures were performed consistently with audit standards. As a value-added audit procedure, the external auditor could periodically perform peer level analytics and provide advisory comments to management on the internal audit CA system. Using homogenized client analytics, external auditors can perform peer level analytics by comparing clients in the same industry (Hoitash et al., 2006). Furthermore, the knowledge and experience gained from evaluating and attesting CA systems of peer clients allows the external auditor to provide advisory comments on improving the CA system of clients.

2.5. Nature, Timing, and Extent of Testing

Continuous auditing methodology changes the nature, timing, and extent of traditional audit testing (Vasarhelyi and Halper, 1991).

- In a traditional audit, manual internal control and substantive detailed testing are periodically performed to evaluate management's assertions. In contrast,

automated continuous controls monitoring (CCM) and continuous data assurance (CDA) are used in a continuous audit (Alles et al., 2006, 2008a,b) (Nature). For continuous controls monitoring, the CA system will continuously monitor internal controls for violations. In continuous data assurance, transactional data are continuously tested for anomalies. Internal control violations and transaction anomalies are manifested into an audit exception report by the CA system for auditor investigation.

- Generally, in traditional auditing, internal control testing occurs in the planning and substantive detail testing occurs in the fieldwork stage of the audit. Conversely, internal controls monitoring and transaction data testing occur simultaneously in a continuous audit environment (Timing). The simultaneous monitoring of internal controls and testing of transaction data is necessary to support real time assurance (Rezaee et al., 2001).
- A traditional audit relies on the use of sampling due to the labor and time intensiveness of manual testing. In contrast, a continuous audit considers the whole population of transactions in monitoring and testing (Extent). The consideration of the whole population of transactions in monitoring and testing can enhance the effectiveness of an audit and increases the probability that material errors, omissions, fraud, and internal control violations may be detected. However, this does not preclude that all material errors, omissions, fraud, and internal control violations can be detected by the CA system because management can collude and override the continuous auditing system.

2.6. Data Modeling and Data Analytics for Monitoring and Testing

Basic statistical techniques such as ratio, trend, and regression analysis are used for analytical procedures in a traditional audit (Stringer and Stewart, 1986). In a continuous audit, data modeling and data analytics techniques are used for analytical procedures. Data modeling and data analytics techniques emerged from statistics, data mining, and machine learning research. Although the use of statistics is more common in research, accounting and auditing literature have also been using data mining and machine learning techniques extensively for bankruptcy prediction (Min and Lee, 2005; Sung et al., 1999; Tam, 1991; Wu et al., 2007), going concern prediction (Martens et al., 2008), detection of fraudulent financial statements (Kirkos et al., 2007; Kotsiantis et al., 2007), auditor selection (Kirkos et al., 2010), and audit qualification prediction (Dopuch et al., 1987; Doumpos et al., 2005).

Data modeling and data analytic techniques are applied to transaction details and account balances in a continuous audit for monitoring and testing (Kogan et al., 2010). Data modeling involves the use of historical audited transaction data and account balances to create benchmarks. Data analytics are used to compare present unaudited transactions and account balances against the benchmarks created by data modeling. In the continuous auditing environment, the processes of monitoring and testing consist of comparing current observations with benchmarks (Vasarhelyi et al., 2004). The assumption behind data modeling and data analytics

is that future unaudited transaction data and its behavior characteristics should be similar to history. For internal controls monitoring, internal control policies serve as the benchmark against which employee actions are compared. Generally, internal controls monitoring uses rule based data analytics to perform binary tests of compliance.

When data modeling and data analytics techniques are applied at the transaction level, the attributes and behavior characteristics of each transaction is considered. For example, the bill date, vendor, items order, item cost, order pattern, and the total amount are considered in testing an invoice transaction. These considerations make the testing of management's assertions more comprehensive and hence enhancing assurance. For account level analytics, the behavior of each individual balance is considered in relation to other account balances. Vandervelde (2006) suggest the consideration of the overall financial statements and the relationship between accounts when determining risk. The correlated relationship and behavior between accounts can be used to monitor and assess areas of potential risk. The dual-level analysis of transaction data and account balances is used in the CA environment to help detect fraud or collusion by management.

2.7. Audit Reporting

Information generated by the accounting information system is deemed to be free from material errors, omissions, and fraud if there are no audit exception reports indicating otherwise. If an exception report indicates a material internal control violation or transaction anomaly, that exception must be cleared before financial information can be assured. From the external audit perspective, a certified clean audit opinion or report can be issued on the CA system if no abnormalities or interventions were detected in the black box log file. A more drastic role for the external auditor would be of monitoring attestation where a "ever-green seal/ opinion" (CICA/AICPA, 1999) would be issued at the time of audit and maintained if no impairing conditions arose during continuous monitoring and testing. However, assuring both financial reporting and control and data integrity would require substantial departure from today's regulations. The external auditor would have to assume (and be permitted to) a role of monitorer and probably have to provide a different (although complementary) form of assurance product.

3. Continuous Audit Stages and Process

The continuous audit consists of four stages; Stage 1: Automation of audit procedures, Stage 2: Data modeling and benchmark development, Stage 3: Data analytics, and Stage 4: Reporting. The stages and process of the continuous audit paradigm are illustrated in (Fig. 2).

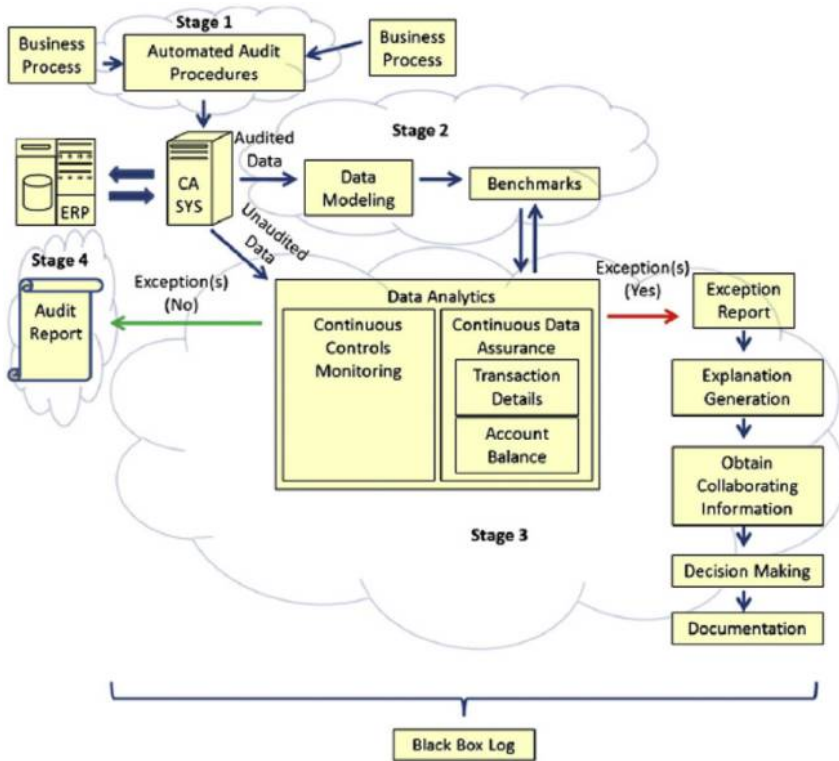


Fig. 2. Continuous audit paradigm and process.

- Stage 1: The auditor identifies a business process area where continuous auditing can be applied. Anecdotal evidence suggests that data access should be a primary consideration when determining initial business process areas in which to apply continuous auditing. Once a business process is identified, the auditor examines preexisting audit procedures to identify types of monitoring and testing that can be formalized and automated (Alles et al., 2006; Vasarhelyi et al., 2004).
- Stage 2: Data modeling is used to develop benchmarks for evaluating future transaction data and account balances. Benchmarks are created using estimation, classification, association, or clustering techniques on historical audited data. The purpose of data modeling is to train analytical models and algorithms to discriminate or estimate future transaction data or account balances that are considered abnormal. The data modeling process consists of dividing audited historical data into two datasets: training and validation. The training set is used to train an analytical model or algorithm to create benchmark measurements for transactions and account balances. The validation set is then used to test and measure the trained analytical model's accuracy and performance.
- Stage 3: Data analytics are used to evaluate internal controls, transaction details, and account balances against benchmarks. In continuous controls monitoring,

rule-based analytics compare the actions of employees against internal control policies for violations. For continuous data assurance, unaudited transaction details and account balances are compared with benchmarks developed in the data modeling stage for deviations or anomalies. Transactions involving internal control violations or other anomalies are flagged as exceptions and can be aborted or suspended in real time. For each flagged exception, a report indicating the details of the problem is generated. The auditor will evaluate the exception report details and decide whether to investigate further. The investigation process is similar to the process of performing analytical review procedures described in (Hirst and Koonce, 1996). If further investigation is warranted, the auditor can generate possible explanations for the exception and seek out collaborating information to support these explanations. Based on the collaborating information, the auditor decides whether to pursue further evidence. If the auditor is satisfied with the explanations and collaborating information then the auditor can document findings and resolutions.

- Stage 4: A continuous audit is an audit by exception (CICA/AICPA 1999). If the CA system does not produce any exception reports, the underlying accounting/financial information is deemed to be free from material errors, omissions, and fraud. A clean audit opinion/report can be issued or a level of assurance can be maintained by the system if there are no outstanding material exceptions.

4. Conclusion

Continuous auditing is a technological innovation of the traditional audit process. The concept of CA has been around for nearly two decades, however, CA in practice is quite novel. CA innovates and advances the practice of traditional auditing by using technology and automation. Practitioners and academics are now beginning to embrace continuous auditing as an audit methodology to support real time assurance, evidenced by the prototyping and test implementation of CA at large institutions. Furthermore, the development of CA technology and methodology has advanced to a point where practitioners, for innovation, are beginning to collaborate and partner with academic researchers. The above discussions lead to a set of propositions concerning the environment of future assurance:

- The continuous audit paradigm (Fig. 2) will progressively integrate and eventually replace the traditional audit paradigm.
- Real time continuous auditing will occur in high risk business processes and frequent audits will occur in other business processes.
- In the CA environment, information systems will have a lower frequency of errors occurring over a more limited set of sequential processes.
- Standardization of data collection and formalization of internal control policies is essential for audit automation.

- The auditor's role will evolve from performing tedious audit procedures to investigating irregularities/ exceptions and dealing with audit procedures requiring judgment and professional skepticism.
- In the CA paradigm, the external auditor's role may eventually evolve to become an independent certifier of internal audit's CA system.
- Consideration of the whole population of transactions in monitoring and testing can enhance the effectiveness of an audit and increases the probability that material errors, omissions, and fraud may be detected.
- Dual level analysis of transaction data and account balances will be used in the CA environment to help detect fraud or collusion by management.
- Initial application of CA will occur in business processes where there is no barrier to data access. The contribution of this paper to the CA literature is threefold. This paper 1) defines how CA has innovated the practice of the traditional audit, 2) describes the audit stages and processes of the continuous audit paradigm and 3) formulates propositions concerning the future of assurance.

These contributions will allow future researchers to advance the development of CA. Researchers can use the CA paradigm as a springboard for development of specific stages or process within a continuous audit. Although CA research by industry and academics may overlap, academics have the clear competitive advantage to innovate the stages of data modeling and data analytics. Academics are generally well educated in the area of statistics, data mining, and machine learning. However, academic research innovations are fruitless without the implementation and validation by practitioners. As a result, we emphasize that continuing partnerships between practitioners and academic researchers are necessary to create genuine advances in the practice of continuous auditing.

Acknowledgments

We express our gratitude to Andreas Nicolaou, anonymous reviewer(s), participants of the Rutgers Accounting Research Forum, participants of the 2nd Annual Pre-ICIS Workshop on Accounting Information Systems, and JP Krahel for their contribution to the refinement of this paper.

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