# *Continuous Auditing as a Strategic Tool in Public Sector Internal Audit: The Turkish Case*[1]

## *Kamu Sektörü İç Denetiminde Stratejik Bir Araç Olarak Sürekli Denetim: Türkiye Örneği*

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***ÖZ***

*Hem kamu hem de özel sektörde iç denetim mesleği, stratejik hedeflere ulaşmak için iş süreçlerini iyileştirmeye yönelik temel bir gereklilik haline gelmiştir. Bunun ana nedeni, iç denetimin katma değerli, riske dayalı yaklaşımı ve stratejik hedeflere ulaşmada güvenilir danışman olmasıyla önemli bir role sahip olmasıdır. Türkiye'de kamu sektöründe iç denetim, kamu idarelerinin öncelikleri ve performans göstergelerine uygun olarak kamu kaynaklarının ekonomik, verimli ve etkin kullanımını sağlamak amacıyla 2003 yılında 5018 sayılı Kamu Mali Yönetimi ve Kontrol Kanunu ile yürürlüğe giren nispeten yeni bir uygulamadır. Kısa bir geçiş döneminden sonra kamu idareleri, İç Denetim Koordinasyon Kurulu'nun tam desteğiyle iç denetim fonksiyonlarını bu kadar kısa bir sürede IIA standartlarına göre kurmaya başlamıştır. Bu çalışmanın temel amacı, Türkiye'deki kamu sektörü iç denetiminin mevcut durumunu analiz etmek ve en iyi uygulamalara örnek vermektir. Bu kapsamda, TC Tarım ve Orman Bakanlığı iç denetim fonksiyonu seçilmiştir. Bunun nedeni, Bakanlık iç denetim ekibinin, denetim planlarını, saha çalışmalarını ve raporlarını dijital olarak yürütmek için kurum içinde geliştirilen sürekli bir denetim yazılımı kullanmasıdır. İlk olarak, sürekli denetim ve veri analitiğinin önemi ilgili literatüre göre açıklanmaktadır. İkinci olarak, Türk kamu sektöründe iç denetim hakkında kısa bir arka plan bilgisi verilmekte ve Tarım ve Orman Bakanlığı iç denetim fonksiyonu kısaca tanıtılmaktadır. Üçüncüsü, Bakanlığın sürekli denetim vakasının verileri, metodolojisi ve ampirik sonuçları sunulmaktadır. Sonuç olarak, literatüre katkıda bulunmak için ampirik bulgulara dayalı politika önerileri yapılmıştır.*

***ANAHTAR KELİMELER***

*İç Denetim, Sürekli Denetim, Veri Analitiği, Kamu Sektörü*

***ABSTRACT***

*In both public and private sectors, internal audit profession has become a fundamental requirement to improve business processes to achieve strategic goals. This is due to the fact that internal audit has a significant role with its value added risk-based approach and being trusted advisor in achieving strategic goals. Internal audit in public sector is a comparatively new practice in Turkey which became operative with the Public Financial Management and Control Law (No 5018) back in 2003 in order to ensure economic, efficient, effective utilization of public resources in line with the priorities and performance indicators of public administrations. After a short transition period, the public administrations have started to establish their internal audit functions with the full support of Internal Audit Coordination Board of Turkey based on IIA standards in such a tiny period of time. The major aim of this paper is to analyze the current state of public sector internal audit in Turkey and provide an example for the best practice. In this respect, internal audit function of the Turkish Ministry of Agriculture and Forest is chosen. This is because internal audit team of the Ministry uses a continuous auditing software which was developed in-house to conduct their audit plans, fieldworks and reports in digital. Firstly, the importance of continuous auditing and data analytics is explained based on relevant literature. Secondly, brief background information about the internal audit in Turkish public sector is given and internal audit function of the Ministry of Agriculture and Forestry is introduced shortly. Thirdly, the data, methodology and empirical results of the continuous auditing case of the Ministry is presented. In conclusion, policy recommendations are made based on empirical findings in order to contribute literature.*

***KEYWORDS***

*Internal Audit, Continuous Auditing, Data Analytics, Public Sector*

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## INTRODUCTION

In today's world where technologies and business processes transform, it is inevitable to change the concept of classical audit. The use of information technologies in audits offers opportunities for continuous auditing and digital reporting, instead of the retrospective (past-sight) approach that the concept of auditing contains. Artificial intelligence, deep learning, virtual reality concepts are becoming widespread today. From now on, continuous audit (CA) approach with data analysis techniques is a necessity rather than a luxury or imagination. In public institutions that have started to realize all or part of the public services on the basis of information technologies, the data produced by these technologies is analyzed and started to be subject to audit. In this paper, it is aimed to present the transformation of internal audit in public sector in Turkey based on a case study to explain the achievements by using Continuous Audit technologies. For this purpose, the Internal Audit Department of the Ministry of Agriculture and Forestry is chosen as best practice.

The paper is organized as follows: Firstly, CA infrastructure is explained and the CA system is introduced based on the relevant literature of the evolution in the technology based audit. Secondly, brief information about the audit environment in public sector in Turkey is given and the Internal Audit Department of the Ministry of Agriculture and Forestry is introduced as best practice for CA implementation in Turkey. Thirdly, CA case of the Ministry is explained in detail and recommendations are made for next steps and future technological implementations to achieve value added internal audit in Turkey.

## 1. THE LITERATURE REVIEW OF EVOLUTION IN THE TECHNOLOGY BASED AUDIT

It is a fact that accounting and auditing profession has changed enormously in recent years. There is a need for increased assurance on financial information. Vasarhelyi et al. (2012) emphasize the effects of strict compliance policies due to recent fraud scandals which have deteriorated public confidence in international financial reporting standards (IFRS) as well as auditing standards. In addition Murcia et al. (2008) point out that it is hard to give assurance to the present with traditional audit since it is usually conducted not more than a year and retrospective. Hence, the organizations need to utilize new techniques and skills to achieve sustainability in the real-time economy such as being effective, efficient, economic, ethic and competitive (Marques et al., 2013). In this respect, the audit focus has been shifting from hand-held to the more data-driven and technology-based audit. Subhani (2013) proposes to change this situation by using more continuous analysis and automation in the audit fieldworks.

### 1.1.Continuous Auditing (CA)

For the Continuous Auditing CA, different definitions are made in the literature and the prominent definitions among these are given below. The very first academic works on CA were presented by Groomer and Murthy (1989), Vasarhelyi and Halper (1991). However, it is a fact that until lately internal auditors did not have the possibility to access relevant big data to process them via CA system (Chiu et al., 2014; Brown et al., 2007). The major reason for this situation is that there is a digital transformation which makes it possible to analyze big data through various software tools (Bierstaker et al., 2001; Warren et al., 2015). Based on this possibility, there is an increasing demand for the internal auditors both in private and public sector. Such an increasing demand leads to an increasing pressure on the internal auditors as well to fulfill the high expectations of stakeholders. Hence, the internal auditors should replace periodic reviews with the continuous assessments by using CA tools and approaches (Hardy and Laslett, 2015).

Continuous Auditing (CA) is defined as the environment whereby audit can rely on high frequency data continuously and automated processes as an alternative of performing an audit once a year. Groomer and Murthy (1989) and Vasarhelyi and Halper (1991) have defined CA as a strategic tool in the assurance processes which is “closer to the event”. Continuous auditing has been identified as an approach that permits auditors (both internal and external) to give assurance on a subject matter based on a series of reports prepared simultaneously with, or a short period of time after, the existence of events (ISACA, 2002).

CA is a procedure of collecting and evaluating evidence to detect the output and effectiveness of real-time accounting systems in protecting assets, sustaining data integrity, and generating sound financial information (Rezaee et. al, 2001). Coderre (2006) defines CA as a uniform framework that combines risk and control assessment together during audit planning, data analysis, and other audit approaches and techniques.

According to the American Institute of Certified Public Accountants (AICPA), CA provides a written assurance to the financial statements almost at the time of events and/or near to the time of events. The AICPA introduced a "Model of Enhanced Business Reporting" to enhance the financial reporting standards. The model is based on real-time, online financial reporting to ensure timely information to the stakeholders in the markets.

Basically, CA is needed for the real-time financial reporting and to ensure integrity of the reported information. The IIA's description of CA is that "any method used by auditors to perform audit-related activities on a more continuous or continual basis" (IIA, 2015). CA can be basically used within the entire auditing process, i.e. audit planning, audit fieldwork, reporting and the follow up process. In this way, CA is expected to provide improved consequences and timeliness for the financial statements of organizations (Vasarhelyi and Halper, 1991).

Considering the relevant literature, the data mining and machine learning methods are applied broadly for bankruptcy prediction (Min and Lee, 2005; Sung et al., 1999; Tam, 1991; Wu et al., 2007), going concern estimate (Martens et al., 2008), financial statement fraud (Kirkos et al., 2007; Kotsiantis et al., 2007), sampling (Kirkos et al., 2010), and audit quality (Dopuch et al., 1987; Doumpos et al., 2005).

The major motive of interest to CA is the aim of a decrease in labor intensiveness (Elliott, 1998) and a boost in production efficiencies (Menon & Williams, 2001). CA is expected to revolutionize the traditional audit method by its key features in terms of "Timeliness, Automation and Precision". The comparison of the traditional auditing versus CA is given (Vasarhelyi, et.al, 2015) at Table 1.

**Table 1: The Comparison of Traditional Audit vs. Continuous Audit**

| | Traditional Audit | Continuous Adit |
|---|---|---|
| Frequency | Periodic | Continuous and more frequently |
| Approach | Reactive | Proactive |
| Procedures | Manual | Automated |
| Role of Auditors | Labor and Time Intensive Work | Handling exceptions and audit procedures requiring judgment |
| Scope | Sampling | Entire Population |
| Testing | Auditors make manual testing | Data modelling and data analytics for testing |
| Reporting | Periodic | Continuous and more frequently |

**Source:** Chan and Vasarhelyi, 2011.

The traditional audit approach is behind the dates in the real time economic system. There is a need for innovating the traditional audit approach to support the real time assurance process. Auditors are discussing about CA as a possible successor to replace the traditional audit approach. CA methodology has the potential to enhance the efficiency and effectiveness of the modern audit approach and also to support real time assurance process. It is a fact that due to the manual nature of traditional audit approach it is difficult to support for real time assurance. In traditional audit approach, most of the audit procedures are done manually and hence they are usually labor and time intensive. Because of this limitation, the traditional audit frequency is usually planned and conducted on an annual basis. This situation may lead to an adverse resource allocation decision of stakeholders who need real time assurance in a competitive global business environment. Such an adverse selection context can be changed through the use of technology and automation. It is possible to reduce the labor intensive nature of audit process and also to increase efficiencies by relying on technology (Menon and Williams, 2001). CA can be treated as an important step towards the enhancement of real time assurance process.

According to Eulerich et al. (2013), the role of the internal auditors has changed from applying particular control activities to integrating the risk profile with the risk based audit plan to give assurance for improved the risk management processes. Indeed, Davidson et al. (2013) claim that CA methods provides internal auditors the chance to go beyond their boundaries put by the traditional audit methods.

It is a fact that CA approach has been existing for more than four decades. There is an ongoing debate related to the benefits and models on implementation of CA which make it as a concerning issue. Regarding the early stages of CA back in the 1970s, the priority was on the electronic data processing and mostly the computer-assisted testing approaches were applied for internal controls (Vasarhelyi, 2002). After the

development in the network infrastructures and Enterprise Resource Planning (ERP) systems, CA is widely accepted in business operations (Murcia et al. 2008). Recent surveys verify that a majority of organizations accepted the value added approaches offered by CA. These organizations are planning to implement or already have implemented CA approaches in their business operations. In addition, they state the benefits of transforming audit methodology by using CA approaches (KPMG, 2012; PwC, 2014; Hardy, 2014).

Hardy (2014) presents empirical findings indicating that most of the organizations are not aware of the existence of any standard approach on how to adopt CA. Furthermore, Kiesow et al. (2016) argue that although CA is proposed as a revolutionary solution but need to be properly supported by empirical evidence for best practice. Considering the global supervision provided by the Institute of Internal Auditors IIA (2015), there are still remaining unanswered questions in the CA implementation framework for internal auditors such as how to design CA and essential tools to improve the efficiency of the audit; how to collaborate among assurance providing parties, especially considering the critical role of internal and external audit.

Continuous Auditing (CA) has emerged as a reaction to regain the reputation of the auditing profession as well as satisfying Sarbanes-Oxley (SOX) requirements. In fact considering the complexity of financial statement fraud prevention process, auditors should pay attention to this issue. Hence, it is essential to discover new mechanisms to fight fraudulent acts (Pathak et.al, 2005). Meanwhile, information technology is considerably changing the manner financial statements are constructed, controlled, utilized and audited (Zhao et.al, 2004). Flowerday et.al (2006) propose that auditors should learn creative ways to validate financial reports.

The AICPA state that CA could assist Certified Public Accountants (CPA) companies to determine material misstatements and fraudulent transactions in financial reporting. Compared to the tradition financial statement audit, CA is more convenient, complete, precise and more economic (Alles et.al, 2005). CA can be described as the audit of an entity's living picture instead of the historical data. (Hunton et.al, 2003). Porter et.al (2003) state the importance of financial statement audit. In this respect, the major issue about the auditing services regards the consistency of the information been investigated. In this sense, the major role of an auditor is to confirm the quality of the data. One of the key measures of data quality is the amount of mistakes within a database. Thus, it is possible to minimize the mistakes when database is monitored against potential errors (Pathak et.al, 2005).

CA is perceived as a vision rather than a certain technological tool and in that sense, CA is yet in its beginnings (Rikhardsson and Dull, 2016; Vasarhelyi et al., 2012). However, considering the recent research, it demonstrates that the awareness of the CA vision has gained importance among internal auditors (Deloitte, 2016; Gonzalez et al., 2012a, 2012b; KPMG, 2012; Protiviti, 2016; PwC, 2006; Vasarhelyi et al., 2012).

CA is also accepted as an essential stage in organizations' ability to have accurate monitoring and assurance on strategic business objectives. The traditional audit methods are behind the expectations of stakeholders due to the fact that organizations transform into more complex and competitive business environment.

This approach is also supported by major worldwide institutions such as IIA, SEC and AICPA, which consider CA as a essential factor in improving the audit profession (AICPA, 2015; Coderre, 2005). Vasarhelyi et al. (2012) state that although there is a positive tone at the top towards adapting CA process fully and application of CA technologies in organizations, such large-scale transformation projects are infrequent in practice.

### 1.2. The Establishment of CA Process

The establishment of CA process is briefly explained below. Firstly, the key requirements and advantages of CA system is described. Secondly, major phases of CA establishment process are indicated by defining most important issues. Thirdly, CA infrastructure is defined by explaining typical CA interface modules which is called "CA cockpit". Fourthly, the audit objectives for CA are given depending on the capabilities, data and internal audit sophistication. Fifthly, CA environment is defined considering each audit process. Finally the difference between CA and CM is given to prevent any misunderstanding respectively.

#### 1.2.1. The Requirements and Advantages of CA

Even with its usefulness, CA has a few prerequisites. Searcy and Woodroof (2003) argue that there are six necessary building blocks in order operate a continuous auditing system:

1) There is a need for dedicated *web servers* and they should be given the permission to communicate.
2) There is a need for *data flow* from the entity's system to the auditor's CA tools within the system.
3) There is a need for *continuous audit agreement* which is a contract defining the roles between the parties participating in a continuous auditing process.

4) There is a need for *reliable interconnected systems*.
5) There is a need for *circulation of information* between parties based on secure infrastructure with authorized, confidential, and integrated system.
6) There is a need for *access to audit reports continuously* in the CA environment. CA makes it possible to consistently and continuously tests transactions by utilizing smart software instruments. (Flowerday et. al, 2006). Thus, the audit procedures are accomplished on a daily basis or in a real time. In this way, CA enables entities to generate audited financial statements instantly when requested by stakeholders (Searcy and Woodroof, 2003).

O'Reilly (2006) proposes the advantages of CA as follows:

- CA makes the auditing process quick, low-cost, more efficient and effective
- CA reduces the auditing cycle period to ensure timely risk and control assurance
- CA provides more audit coverage without the need to enlarge your resource basis.
- CA enables to perform audit fieldworks more frequently such as on a daily, monthly, or quarterly basis
- CA provides automated and recurrent audit testing and hence, enhance audit cycle times
- CA relies on the whole population, i.e. %100 of data instead of just data samples
- CA enables to evaluate and recalculate population and hence it improves the assurance quality as well as speed of auditing process

Aquino et al. (2008) have defined the six major stages during the implementation process of a typical continuous auditing: (1) Set up the priorities for concerning areas to continuously audit; (2) Specify the major rules for follow up process of the continuous audit; (3) Define the periodicity of processes; (4) Identify the key parameters for continuous audit; (5) Trace the alarms and errors generated from the continuous audit; and (6) Inform auditees about key findings. For instance, Alles et al. (2006) presented a pioneering execution of a continuous auditing system at Siemens. They established an entirely self-sufficient continuous monitoring of business process controls system performing onto Siemens' own business information system. After Siemens, CA has been more and more adopted globally starting from well known institutions such as IBM, HCA Inc, Itau Unibanco, AT&T Corp., HP, MetLife, and Proctor & Gamble.

It is a fact that some entities are hesitant to accept the implementation of CA, due to concerns about such embedded audit modules. They claim that CA could have adverse effects on processing systems such as declining response times. These adverse effects to CA usage are being reduced by the development of eXtensible Markup Language (XML) and eXtensible Business Reporting Language that decrease the network system and interface issues. CA generates audit evidences simultaneously with accounting events and is facilitated by eXtensible Business Reporting Language (XBRL). XBRL is used for seamless transmission of information to the auditor data warehouses. XML is known as a mark-up language that provides tagging of data to determine the data meaning. XBRL is a well known version of XML which is intended to be used for financial reporting and supports the potential of real-time online performance reporting. Both XML and XBRL allow the data to seamlessly download information to the linked data warehouse. In addition, the arrival of XBRL and XML give chances for auditors to apply CA by transferring user information to auditor databases. David and Steinbart (2000) propose that data warehouses enhance the audit quality and efficiency by declining the time which is needed to reach data and conduct data analysis. In this way it is possible to establish early warning mechanisms to prevent fraudulent acts related to financial reporting.

It is a fact that CA could be performed in diversified types of tasks and processes (Brown et al., 2007). On the other hand, considering the difference of CA from the traditional audit approach, there may be certain impacts during the implementation stage. One of the major impact is related to the initial setup costs of CA (Brown et al., 2007). The set up costs are declining with the incline to affordable technologies regarding the improvements in storage and computer capacity. There is a mind shift among auditors with the emergence of CA whereby they start using a client's sensitive big data. In addition, there is a particular increase in confidence on non-financial data (NFD). Based on the increased technical skills of the audit team, and increased business intelligence for analyzing data transformed the audit tools and techniques. The major theme of this transformation can be summarized as follows:

- improved audit quality
- smarter audit approaches through data analytics
- improved audit reporting
- increase in the level of integrity
- enhanced internal control infrastructure

### 1.2.2. The Major Phases of CA Establishment Process

The establishment of a typical CA process consists of four major phases which is explained as follows:

*Phase 1: Automating audit procedures*: Firstly, the auditors should identify the priorities to start a CA establishment process. For instance it is recommended to begin with a pilot business process area where continuous auditing can be easily applied. It should be noted that data access should be a major concern when determining key business process areas in which to establish CA. After identifying a primary business process, the auditors should review the current audit procedures to decide types of monitoring and testing which will be automated in CA process (Alles et al., 2006; Vasarhelyi et al., 2004).

*Phase 2: Data modeling and benchmarking*: Data modeling is needed to form related benchmarks for assessing future transaction data and account balances. Benchmarking activities are quite important and they are formed by making prediction, classification, correlation, or clustering methods based on related audited historical data. The major aim of data modeling is to interrelate analytical models and algorithms to differentiate or forecast future transaction data or account balances which may be regarded as anomalies. During the data modeling process, the audited historical data is divided into two datasets, namely training and recognizing. The training dataset is the one for training an analytical model or algorithm to compose related benchmark computations for transactions and account balances. Afterwards, the recognizing dataset is taken to test and evaluate the previously trained analytical model's quality and efficiency.

*Phase 3: Data analytics*: Data analytics are applied to compare the figures of internal controls, transactions, and account balances against related benchmarks. In case of any need for further investigation, the auditors should prepare reports for the anomalies based on relevant information which is taken from CA process.

*Phase 4: Reporting*: According to CICA/AICPA (1999), CA is a kind of audit based on exception. When the CA process does not generate exception reports based on alerts then, the main accounting and financial information is considered to be exempt from material mistakes, and fraud. It should be noted that it is possible to issue a clean audit report when there is no significant exceptions.

### 1.2.3. The Infrastructure of CA

There are three major user interface modules available for all auditing parties within the CA infrastructure which is called "CA cockpit".

*1. Alerts:* In CA environment, the auditors will be able to see the control weaknesses captured by the routine control testing process via scenario based "red flag" alerts. In addition, there may be "instant alerts" for the case of any audit item which is exceeding a pre-defined threshold for risk values as part of the risk assessment trigger. These alerts will only be shown to the relevant audit parties for related auditing activity. Regarding each alert, there is a special field for entering the "status of finding" as well as a traffic light to show the potential risk level assigned to the primary control weakness to proceed on the next stage.

*2. Dashboard:* There is a real-time dashboard to show the current results of ongoing risk assessments in comparison to the key risk indicators (KRI). CA Dashboard is useful to continuously monitor the control risk level of the whole audit universe based on various aggregated levels. In this way, auditors will be able to make risk based audit planning and hence, to achieve an optimum resource allocation. It should be noted that audit planning in s CA environment is totally different from the traditional audit planning approach. There is no need for changing the audit cycles in CA, rather it is just done by adjusting the factor level of audit schedule or by adjusting the thresholds of each KRI. Individual dashboards can be prepared for different risk appetite levels based on its own thresholds for each risk values depending on the existing risk tolerance level.

*3. Risk Landscape:* The risk landscape makes it possible to view the current risk exposure of whole operations, processes and sub-processes of an organization. This can be used by the auditors as a strategic tool to evaluate the risk strategy of the management as an important counterpart. In some organizations risk management departments are responsible for providing risk assessment reports and current risk exposures. The major risk categories can span from operational, legal, financial and strategic in nature and they may change depending on the industry specific issues and business model. The value at risk approach is the most familiar concept among auditors depending on the availability of data from risk management department. The risk landscape is valuable for the auditors not only for the usage of risk based audit planning, but also it is a strategic tool to perceive the risk appetite of the management based on the current risk exposure levels. There is a need for a holistic approach to both for coordinating risk landscape among stakeholders and for enabling the auditors assess the actual residual risk level of the organization. In this way, risk management process will operate based on the real-time data to assess the inherent and residual risk levels by risk category automatically and any kind of anomaly will be reported by generating alert logs. In addition, it will be possible to predict the

major trends in risk exposure and the key findings can be integrated with the related historical data to make relevant comparisons.

### 1.2.4. Audit Objectives for CA

Vasarhelyi et al. (2004) recommended four major stage of audit objectives for CA as follows:

*Level 1: Verification of transactions:* This level consists of the identification of transactions leading to inconsistencies in business processes. The level 1 one is also called Continuous Data Audit (CDA).

*Level 2: Verification of conformity:* This level consists of the collection of evidence on the measurement rules and standards to ensure that they have been applied accordingly. The level 2 is related to controls and usually called Continuous Control Monitoring (CCM).

*Level 3: Verification of forecast*: This level consists of the assessment of the reasonableness of accounting estimates. This level is called Continuous Risk Monitoring and Assessment (CRMA).

*Level 4: Verification of Judgment*: This level consists of the implementation of complex high level judgment in order to minimize the audit risk level. This level is known as Continuous Compliance Monitoring (CCMO). CCMO is used for establishment of taxonomies regarding the complex compliance matters and CCMO makes it possible to monitor the compliance with rules and regulations.

Vasarhelyi and Kuenkaikaew (2010) state that considering the recent technological developments the implementation of CA technology has positioned to be a valuable business domain for auditors.

### 1.2.5. CA Environment

The contribution of CA environment can be analyzed considering the audit process as a whole and it should be noted that CA contributes to the improvement and efficiency of each and every sub-process of audit respectively.

*Audit Planning and Scoping Process in CA environment*

Audit planning in a CA environment is not necessary to be based on a periodic plan any more, instead it is possible to make fully dynamic audit planning over time. In the traditional audit approach external auditors usually request the audit plan of internal auditors in order to harmony audit activity. This can be useful to prevent redundant audit scopes and to identify potential audit gaps. In this respect, the typical audit scope is often derived from previous audit reports in the same and similar audit field. Considering the traditional audit environment, it is a fact that there is a transaction cost of exchanging information which determine the intensity of collaboration. Hence, it is difficult to leverage all potential synergies in such an audit environment due to the non-standardized style of exchanging suitable information. In addition, the procedures implemented by internal auditors to define the risky areas in the traditional audit approach may make it difficult to collaborate with external auditors. Internal audit risk assessment frequently contains professional judgments to identify risks in given risk categories. COSO (2012) states that these professional judgments may be majorly subjective due to biases and potential misperceptions in the decision making process. On the other hand such judgments are not fully transparent to third parties and, external auditors cannot be expected to rely on these audit scopes for their own audit fieldwork.

The Institute of Chartered Accountants in Australia (ICAA) authorizes all auditors to apply the identical risk indicators for audit planning. In this way, both internal and external auditors have direct access to the risk assessment outcomes through the risk dashboard and the risk universe, hence a unnecessary and manual risk assessment process by auditors is totally eliminated. Since the algorithm supporting the key risk indicators is objective and consistent, auditors can be confident about the outcomes of the risk assessment.

*Audit fieldwork Process in CA environment*

CA environment supports the ongoing control testing approach for auditors and also, audit routines will be running automatically. The scheming and performing the CA routines will substitute the traditional audit fieldworks. The extensive usage of transparent CA routines through the red flag logs allow auditors to avoid from duplicate audit fieldworks. Since all auditors will have access to all relevant CA routines through the red flag logs, a whole outlook of the audit activities can be provided to all auditors and stakeholders. This CA approach additionally prevents audit gaps and strengthens transparency i.e. CA will become a strategic tool for decision making process.

*Audit Reporting and Follow Up Process in CA environment*

It is a fact that the traditional audit is represented by separate audit report drafting by internal and external auditors. Both internal and external auditors manually and independently prepare the audit reports on the findings of its auditing activity to its stakeholders. These audit reporting processes are separately based on their own reporting formats, wordings and standards to evaluate the rigidity of audit findings. This means that

there is no coherent terminology in audit reporting. At the same time, this situation leads to inconsistencies within the audit reporting processes.

It is possible to achieve a common real-time audit reporting model which is totally automated by CA environment. In CA environment, there is an automated control testing applied to predefined processes and for each breach of testing rules, the responsible management will automatically and immediately get a notice. As an alternative, read-only access for the red flag logs can be given to the auditees. It is planned to inform responsible management and the audit committee immediately in case of occurrence of any serious control weaknesses and breaches of risk thresholds. In this way, CA provides an automated and central audit reporting to relevant stakeholders which brings additional advantages such as increasing the efficiency of resources by excluding redundancies and inconsistencies. It further simplifies the audit reporting process by relying on a common risk and reporting terminology through a integrated reporting tool for both internal and external auditors.

Considering the audit follow-up process, coordination can be achieved by intending to monitor the responsible management whether they are taking the agreed upon actions. The joint usage of the CA Platform makes it possible to have a centralized audit follow-up process for all audit findings. Such a Platform combines the whole audit follow-up process and also, the database by each auditing party as well as the accounting reconciliation processes.

Data mining tools and techniques are convenient to analyze CA generated data warehouses. Data mining tools and data analysis software are frequently used by auditors (Bierstaker, et. al, 2003). Data mining and data analysis software mostly contain auditor specific models like Benford's Law[2] and such software rely on low level statistical modeling techniques. Pushkin (2003) defines CA as the tactical unit of the audit. Tactical actions are usually conducted for the purpose of getting transactional symptoms as an attribute on which to detect the accuracy and validity of assertions in relation to the relevant account balances.

It is a fact that having the chance to audit continuously or on a real time basis appear to be the best. However, the real time audit can influence the operation of the accounting information system and hence it may not always be the cost-effective solution. For this reason, auditors tend to start using CA in high risk business processes. For instance, considering an industrial company it may be economical to continuously audit the higher risk treasury disbursement process on a real time basis. Yet, it may be more than enough to audit the lower risk prepayment expense process in periodic cycles.

(Du and Roohani, 2007) recommend a CA cycle approach that reflects the traditional audit approach. A typical CA cycle starts when the auditor is connected into the accounting information system and ends when the auditor is disconnected. (Du and Roohani, 2007) claim that the CA cycles can be defined in two ways, i.e. firstly when the auditor can connect into the system after a period of time, secondly after a certain number of transactions. However, Pathak et al. (2005) argue that transaction volume can be a more cost-effective criteria for CA cycles. For instance, an audit will be initiated after a certain number of accounts payable transactions have recorded into the accounting information system. Considering the fact that accounting information systems become progressively complicated and consecutive business operations inter connected, CA may help prevent the transmission of failures, and fraud from one process to another.

When the transactions recorded into the accounting system are not standardized, then the auditors usually be in a position to spend significant time for cleaning the transactions manually. It should be noted that there is a need for a clean data before automated audit procedures can be conducted by the auditors. In such a manual data cleaning process, the advantages and efficiencies of automated audit procedures will be partly offset. Furthermore, clear roles and well-defined internal control policies is a must to maintain automated monitoring of internal control deficiencies. In other words, consistent data and formalized internal control policies will permit automated audit procedures to function without any intervention.

### 1.2.6. The Comparison of Continuous Auditing vs. Continuous Monitoring

Although CA system is based on controls, CA is a different from Continuous Monitoring (CM). CM is defined as a process that management apply to maintain policies, procedures, and also to ensure that business processes are effective. In order to achieve these objectives, there is a need for automated testing of all transactions against a set of controls rules. (Coderre, 2005, p. 8).

CA and CM have common features and they are related to each other. However, their users are different, i.e. CM is applied by management and CA is applied by only the internal auditors. (Davidson et al., 2013). In addition, there is an opposite relation between CA and CM. In other words, when there is a robust monitoring

[2] The logic behind Benford's Law (Nigrini, 2002) is that when there is a significant alteration from the expected number pattern may be due to incorrect or fraudulent transactions.

of internal controls by management (CM), the fewer effort will be employed by the internal auditors (CA). Essentially, Coderre (2005) discusses that the internal auditors should have a proactive role during the establishment of CM. It should be noted that the ownership should belong to management Hardy and Laslett (2015).

Rutger van Hillo (2016) claims that the major objective of CM is to grant a data surveillance mechanism on a real or near real-time basis against a set of predetermined data rule sets including in the field of CA. The auditors need to change their evidence gathering methods by employing CA to adapt the use of big data analysis. CA enables large amounts of transactions to be frequently assessed and hence increase the audit efficiency and effectiveness. CA also allows the internal auditors to assess whether the transaction and control patterns are in line with management expectations (Power, 1997). According to Rikhardsson and Dull (2016), the automation in audit will not be able to substitute fully the need for professional judgment.

## 2. AUDIT ENVIRONMENT IN PUBLIC SECTOR

The emergence of cloud computing, considerable drop in data storage costs, and progress in data integration tools jointly contribute to the governments to achieve their commitments with better policy decisions based on performance analysis while still being able to handle the spending. After gaining the power of big data in the government, there is a contemporary approach to information. This approach, on the one hand eliminates data silos and, on the other hand enhance sharing while supporting the highest standards in governance, structure, security and, quality of data. This approach allows government agencies to explore, expand, unite, correlate, and integrate growing volumes of data in new ways that lead to deeper understanding and greater performance.

The major objective of the internal audit function is to conduct independent, periodic and systematic examination of the internal control infrastructure in order to give reasonable assurance that such a control environment continues to run efficiently and effectively (Abdul Aziz et.al, 2010). It is a fact that a well established internal audit function has high potential for maintaining accountability and increasing corporate performance within the public sector organizations (Md Ali et al., 2009).

Governments are making huge investments on IT infrastructures due to the potential benefits and higher performance expectations that IT can bring to their operations and services. Most of the end users fully rely on IT systems to make decisions without exactly knowing how the computers function. For this reason internal auditors play critical role in this process in order to reduce all the operational risks associated with the use of computers. Specifically internal auditors have to give assurance the data generation process so that the data that have been produced to the decision makers are reliable. Investing in data integrity and management in the short run will contribute governments to achieve more understanding, strength and relevance from their data in the long run.

### 2.1. Background Information on the Public Sector Internal Audit in Turkey

Internal auditing is defined as an essential part of corporate governance in both private and public organizations since it provides services that are unbiased, independent and objective for the organization and its stakeholders (Davidson et al., 2013; Gramling et al., 2004). This approach is adapted with the approval of Public Financial Management and Control Law No. 5018 in public sector in Turkey in 2004. Afterwards, internal audit, internal control and risk management practices have been harmonized with international standards considering the EU directives.

The highest-level coordinating institution in Turkey is the Internal Auditing Coordination Board (The Board). The Board plays an forceful role in the establishment, administration and coordination of auditing, internal control and risk management policies of different public entities based on the Law no 5018. Article 63 of law of 5018 explains internal audit. However to some extent, considering the recent enactment of the Law no 5018 about the auditing system in Turkey, this situation reflects also the need for public sector research requirements and auditing strategies. The Board determines the policies designed and proposed by the Internal Audit Coordination Board Members, validates action plans for the implementation of national policies, monitors the appointment process of certified internal auditors for each public entities and follows and coordinates the implementation of audits and related action plans.

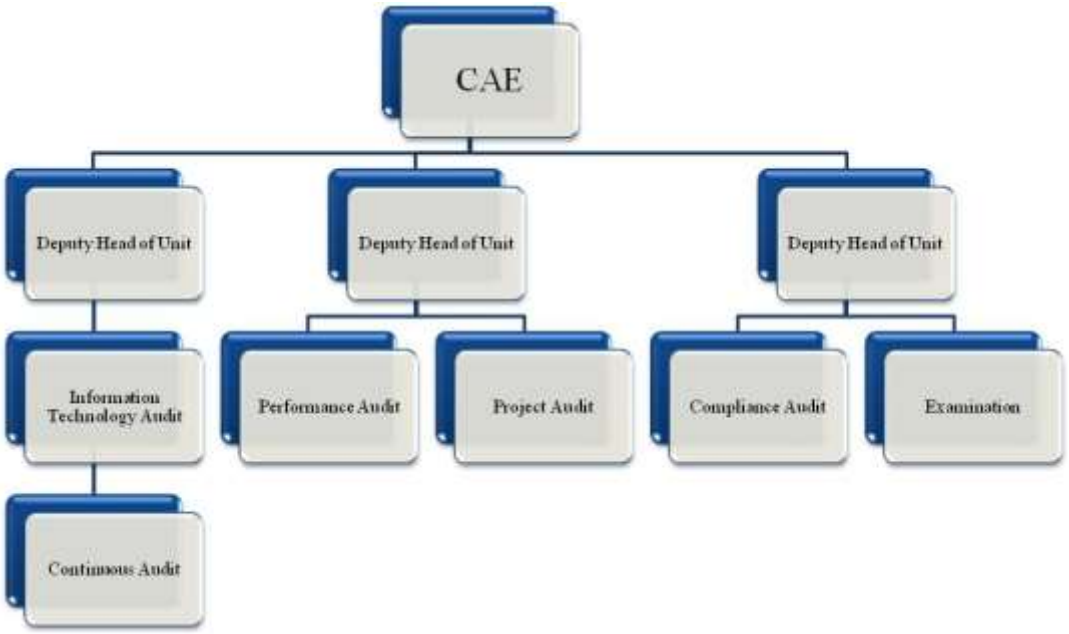
On the operational level, each internal audit department within the public entities is responsible for the design and execution of internal audit fieldwork, reporting and follow up process. In this study, the case of the Internal Audit Department in the Ministry of Agriculture and Forestry has been selected to present CA approach as a strategic tool for public sector internal audit in Turkey.

### 2.2. The Internal Audit Department of the Ministry of Agriculture and Forestry

The proposed budget size of the Ministry of Agriculture and Forestry in 2019 is 33.743.778.000 TL (approx. 6.5 billion dollars). According to the 2019 Budget Law of Turkey, 16.1 billion TL of this budget consists of agricultural subsidies. The activities of the Ministry is one of the most common tasks based on operations in 81 provinces in Turkey. The number of internal auditors of the Ministry of Agriculture and Forestry is 28 with the organization chart as shown at Figure 1.

The Continuous Audit and Data Analysis Center was established on 31.10.2018 under the Internal Audit Department of the Ministry of Agriculture and Forestry. The required approval procedures have been completed for the establishment of the Continuous Audit Center, the development of the continuous audit software and the implementation of the audits based on data analysis via related software. Continuous audit software was developed by the Internal Audit Department with the contribution of the Ministry's Information Technology Team without making any purchasing agreement with third parties. The audit software was developed in a short period of time to monitor many critical processes within the Ministry.

**Figure 1: Organization Chart of The Internal Audit Department of the Ministry of Agriculture and Forestry**




**Source:** The Ministry of Agriculture and Forestry, 2019.

The priority has been given to the purchasing processes within the Ministry to start the project. In this context, data were obtained from the tender software used online during the purchasing process of both the central and provincial units of the Ministry. Red flag areas are defined and some scenarios have been prepared by the internal auditors with high probability values and which can be transformed into algorithms. Hence, the algorithms to which continuous audit software can query these scenarios have been defined. It has been observed that the continuous audit software is able to control big data in a very short time and reached to the audit findings.

As an assurance provider, the internal auditors have the ability to evaluate and to confirm the proper function of the operations held in the Ministry of Agriculture and Forestry in Turkey via CA system. They continuously monitor the abnormalities or interventions made by process owners during the routine operations via the CA system. These CA alerts could also be used as proof that audit procedures were applied systematically in relation to the relevant audit standards. In order to achieve a value-added audit procedure, the internal auditors could periodically apply high level data analytics and present consultative comments to the management through the internal audit CA system.

Using homogenized client-procurement analytics, internal auditors can perform data analytics for pricing strategy by comparing clients providing the same products for different regions (Hoitash et al., 2006). Besides, the knowledge and experience gained from evaluating and confirming the critical business processes and sub

processes allow the internal auditors to provide recommendations on improving the governance system as a whole.

The Internal Audit Department of the Ministry applied the CA methodology to shift the character, time schedule, and scope of traditional audit testing (Vasarhelyi and Halper (1991). Firstly, the character shift in audit can be explained as follows: The significant issues and management assertions are evaluated by all manually applying internal control and substantive testing in a traditional audit. In contrast, CA approach is used in a continuous form and this can be accepted as a proof for a *character shift* (Alles et al., 2006, 2008). There are two major scope in CA implementations, i.e. the first one is based on continuous controls monitoring (CCM), the second one is based on the continuous data assurance (CDA). In a typical CCM and CDA, CA system is supposed to continuously monitor internal controls for deficiency, and too continuously test the transactional data for anomalies respectively. Afterwards the internal auditors prepare an audit report to highlight internal control violations and transaction anomalies based on the CA alerts.

Secondly, the *time schedule shift* of audit can be described as follows: Normally, in traditional auditing, internal control testing is applied in the planning stage of audit and substantive detail testing is executed during the fieldwork stage of the audit. On the contrary, both internal controls monitoring and transaction data testing activities are performed simultaneously in a CA environment. Rezaee et al. (2001) claim that relying both on monitoring of internal controls and the testing of transaction data simultaneously is essential to provide real time assurance.

Thirdly, the *shift in audit scope* can be defined as follows: A traditional audit commonly relies on sampling and this is due to the fact that manual testing is applied at traditional audit fieldworks which is mostly labor and time intensive. In contrast, CA makes it possible to use the whole population of transactions which can be considered as a shift in audit scope. In this way, the audit effectiveness can be increased by considering the whole population of transactions in monitoring and testing and hence, CA approach could improve the chance that material mistakes, omissions, fraud, and internal control weaknesses may be timely detected. On the other hand, it should be noted that CA could not totally prevent all material mistakes, omissions, fraud and internal control weaknesses because management could consciously conceal some critical issues and disregard the CA system.

There are some elementary statistical methods such as ratio, trend, and regression analysis performed for analytical procedures in a traditional audit fieldwork (Stringer and Stewart, 1986). In CA approach, data modeling and data analytics methods are applied as analytical procedures. Data modeling and data analytics methods mostly rely on statistics, data mining, deep learning, and machine learning research.

In CA environment, the monitoring and testing processes is based on comparing recent observations with benchmarks (Vasarhelyi et al., 2004). Data modeling and data analytic methods are applied to transaction details and account balances in CA both for monitoring and testing (Kogan et al., 2010). Data modeling contains the usage of past audited transaction data and related account balances to establish benchmarks. Data analytics are used to compare existing unaudited transactions and related account balances against the benchmarks established via data modeling.

The key assumption and logic behind the data modeling and data analytics is that it is expected to have similar behavior and characteristics between future unaudited transaction data and historical data. For instance, considering the internal controls monitoring, internal control policies and procedures are assumed to be the benchmark against which process owners' activities are compared. For this reason, internal controls monitoring generally relies on a rule based data analytics by applying binary tests.

When data modeling and data analytics methods are used at the transaction level, the property and manner of each transaction should be taken into consideration. For instance, the date, vendor, the order type, and the total amount are noted in testing an accounting transaction. CA approach makes it possible to apply complete testing of management's assertions and hence, improve the assurance quality. Similarly, considering the account level analytics in CA approach, the behavior of each individual balance is taken into account in relation to other balances. Vandervelde (2006) claims that in order to detect the risk potential precisely, it is important to assess the consolidated financial statements and the correlations between accounts. This is because the correlated behavior between accounts provides valuable information to assess areas of potential risk and also this can be used as a key risk indicator. Hence, CA provides a strategic tool for auditors to detect fraud and mistakes via the binary analysis of transaction data and account balances.

## 3. THE CASE OF THE MINISTRY OF AGRICULTURE AND FORESTRY ON CA SYSTEM

There is a sample audit case from CA system approach as follows:
*Institution Name*[3]*:* A Institution
*Structure*: Central and Provincial (81 provinces)
*Year of Inspection*: Year 2018
*Data Record:* 298 Purchase Process, Total Amount Approximately 6.000.000TL
*Data Analysis Period*: 60 minutes (including 55 minutes to be evaluated by internal auditor)
*Recommendation for Improvement*: Central Procurement on Some Products
*Benefit*: Point Detection, Accountability, Decision Support

It should be noted that as a result of the control tests carried out through the CA software, the lists of red flag purchases are subject to judgments by the internal auditors. Auditing activities are carried out on the original data entered by the Ministry of Agriculture and Forestry to carry out public services, i.e. there is no need for double entry.

The CA process and infrastructure is shown at Appendix 1 & 2 simultaneously and explained as follows:

### 3.1. The Software Screen

*Detailed Search:* Any purchase data can be searched on the basis of the date, number, subject, institution. On the basis of type (e.g. information material amounts received in the last two months) can be questioned. This module has been developed in order to reach the details of the specific control tests required by the auditors in case of any complaints about the procurement process.

*Alert Management:* The software continues to interrogate the data that has been received for 7 days and 24 hours as it is taught. The software is designed to give the internal auditors information by SMS or e-mail in case of occurrence of scenarios. This module is designed to be able to intervene in the deficiencies detected before the tender takes place.

*Risk Management:* This module is designed analyze some of the auctions and also to be able to make more detailed tests, including the risk value for a variety of reasons (eg, High-volume auction, urgent work, etc.).

*Reporting:* This screen is designed as a chart containing dashboard to present relevant findings and recommendations to top management. There are four major types of reports, namely Simultaneous Report (Digital), Evaluation Report (Digital), Audit Report and Analysis Report generated via CA system including the following type of information:

- *Trend analysis* to show changes in the amount of the institution's acquisition over the years, changes by months.
- *Benchmarking* tables which presents comparison of purchasing volumes of sub-units, regions and departments with each other.
- *Heat map* is used to identify the auditing priorities based on the information that it indicates the provinces with most purchases as of red color on the map of Turkey and the provinces with the least purchases as of green color.
- *Red flag*: In this module, the defaults are listed based on the defined red flag scenarios. The red flags are supported by various heat maps and visuals which belong to identify the related city and district. In addition, it is aimed to prepare risk based audit plan based on the results obtained from these red flags.

*User Management:* This is the module in which the software is accessible and given the authorization to relevant users.

### 3.2. Next Steps for Sustainability of CA System at the Ministry

First of all, a patent application was made for the CA Software. To our knowledge, this is the very first CA software supported by block chain infrastructure in the world. It is impossible to negotiate the value of IT anymore considering the current information age. Either it is agreed on or not, IT usage is a must for auditors to conduct audit fieldworks within the current computerized environment. In addition, Yermack (2017) states the importance of the need for correct and timely financial information with block-chain technologies in the future business environment based on real-time accounting data. This is because, block-chain infrastructure provide a secure platform for transactions extracted from system and the data is accepted as safe, complete,

[3] The company name is not explicitly written because of privacy issues.

objective, and confirmable since it is impractical for anybody to command, alter, or turn it off alone (AICPA, 2017; Nakamoto, 2008).

The required approval procedures were completed and the data security controls were determined for the future extended utilization of CA. Digital office furnishing operations where continuous auditing activities are carried out are currently in progress. In addition, the Internal Audit Department will store the data and ensure the security of the server. The Internal Audit Department of the Ministry is taken CA as a strategic tool and they are planning to develop new modules in the near future to improve their capabilities for fraud prevention.

## CONCLUSION

Technological developments have changed the structure of the audit. As a result contemporary internal audit methods, approaches and techniques have been emerged. The main characteristic of this method, approach and techniques is that the risks are based on the specification of criteria and key determinants. In general, risks can be defined as the highest probability of loss. The determination of the probability of occurrence of these risky events is based on two factors. The first factor is data and data analysis. Considering the scale of public sector in today's world, both data processing and analysis is based on big data analysis. Regarding the public internal audit activities and business processes, it has been a necessity for internal audit and internal control processes to be intertwined with the technological infrastructure. Turkish public sector is also showing a parallel development to the world tendencies and hence, internal audit has taken its place as a fundamental unit within the organizational structure of the public sector, together with technological development. When the Ministry's audit practices are evaluated within the scope of international standards, traditional audit processes of the Ministry have been transformed into audit analytics. Considering the public sector audit, this is the most important development in the Turkish public reform process.

Analytics is defined as tools to analyze and solve the concept. Nowadays, it can be defined as information generation process by analyzing the data with algorithms of related business processes. In the internal audit processes of Ministry of Agriculture and Forestry, it has become a structure where these developments are used. In this framework, artificial intelligence, block chain and audit information were collected and a substructure was prepared. As a result, an IT audit team has been formed within the internal audit department where the infrastructure is continuously developed and ready for analysis.

It is a fact that CA assists auditors to view the whole audit universe more clearly and define the risk universe more precisely. In addition, CA provides advanced visualization capabilities and also CA can enhance the risk assessment process and indicate unexpected instances, outliers, and penetrations. CA environment is based on the capabilities, technologies, and practices to get continuous iterative observations. CA enables the investigation and comparison of previous performance to obtain a deep understanding of the business strategy. CA platform makes it possible to practice on widespread scope, big data, quantitative analysis, explanatory and predictive modeling, and fact-based management to achieve integrated decision-making process.

The success of CA depends on the auditors' acceptance, and stakeholders' confirmation, of this transformation in Turkey. It should be noted that CA environment provides valuable circumstances for more powerful audit positioning within the organization with balancing between the implementation and education expenses. However, public institutions still need quality data and software that can mimic the auditors for continuous audit practices based on data analysis.

## REFERENCES


Abdul Aziz, A., Amirah, M.N. and Syed Ahmad, S.N. (2010). "Fraud in Federal Statutory Bodies", 2010 International Conference on Financial Theory and Engineering. IEEE, 221–224.

AICPA (2015). "Audit analytics and continuous audit: looking toward the future". AICPA, New York. Available at https://www.aicpa.org/InterestAreas/FRC/AssuranceAdvisoryServices/DownloadableDocuments/AuditAnalytics_LookingTowardFuture.pd

AICPA (2017). "Blockchain Technology and Its Potential Impact on the Audit and Assurance Profession", https://www.aicpa.org/content/dam/aicpa/interestareas/frc/assuranceadvisoryservices/downloadabledocuments/blockchain-technology-and-its-potential-impact-on-the-audit-and-assurance-profession.pdf

Alles, Michael G.; Kogan, Alexander; Vasarhelyi, Miklos A. (2005). "Implications of section 201 of the Sarbanes-Oxley Act: the role of the audit committee in managing the informational costs of the restriction on auditors engaging in consulting". International Journal of Disclosure and Governance, v.2, n. 1, p. 9-26, feb. 2005.

Alles, Michael G.; Brennan, Gerard; Kogan, Alexander; Vasarhelyi, Miklos A. (2006). "Continuous monitoring and business process controls: a pilot implementation of a continuous auditing system at Siemens". International Journal of Accounting Information Systems, v. 7, n. 2, p.137-161, jun. 2006.

Alles MG, Kogan A, Vasarhelyi MA. (2008). "Putting continuous auditing theory into practice: Lessons from two pilot implementations". Journal of Information System. 2008;22:195–214.

Aquino CE, Sigolo N, Vasarhelyi MA. (2008), "Six steps to an effective continuous audit process". Internal Auditor; February 2008. https://iaonline.theiia.org/six-steps-to-an-effective-continuous-audit-process

Bierstaker, J. L., Burnaby, P., and Thibodeau, J. (2001). "The impact of information technology on the audit process: an assessment of the state of the art and implications for the future". Managerial Auditing Journal, 16(3), pp. 159–64.

Bierstaker, J.L., Burnaby, P., and Hass, S. (2003). "Recent Changes in Internal Auditors' Use of Technology". Internal Auditing, 18.4, 39-45.

Brown, C. E., Wong, J. A., and Baldwin, A. A. (2007). "A review and analysis of the existing research streams in continuous auditing". Journal of Emerging Technologies in Accounting, 4(1), pp. 1–28.

Chan, D. Y., and Vasarhelyi, M. A. (2011). "Innovation and practice of Continuous Auditing". International Journal of Accounting Information Systems, 12(2), 152–160.

CICA/AICPA. (1999). "Continuous Auditing Research Report". Canadian Institute for Chartered Accountant and American Institute of Certified Public Accountants.

Chiu, V., Liu, Q., and Vasarhelyi, M. A. (2014). "The development and intellectual structure of continuous auditing research". Journal of Accounting Literature, 33(1-2), pp. 37–57.

Coderre, D. (2005). "Global Technology Audit Guide (GTAG) 3: Continuous Auditing: Implications for Assurance, Monitoring, and Risk Assessment". Altamonte Springs, FL: IIA. Available at https://na.theiia.org/standards-guidance/recommended-guidance/practiceguides/

Pages/GTAG3.aspx,

Coderre, D. (2006). "A continuous view of accounts". Internal Auditor, p. 25-31, apr. 2006.

Committee of Sponsoring Organizations of the Treadway Commission (COSO). (2012). "Enhancing Board Oversight, Avoiding Judgment Traps and Biases", Thought Paper, March 2012, available at: http://www.coso.org/documents/coso-enhancingboardoversight_r8_web-ready%20(2).pdf

David, J.S. and Steinbart, P.J. (2000). "Data Warehousing and Data Mining: Opportunities for Internal Auditors", Altamonte Springs, FL: The Institute of Internal Auditors Research Foundation.

Davis, F.D. (1989). "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology". MIS Quarterly, 13.3, 319-40.

Davidson, B.I., Desai, N.K., and Gerard, G.J. (2013). "The effect of continuous auditing on the relationship between internal audit sourcing and the external auditor's reliance on the internal audit function". Journal of Information Systems, 27(1), pp. 41–59.

Deloitte. (2016). "Evolution or irrelevance, internal audit at a crossroads", Global Chief Audit Executive Survey. Available at https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/risk/ca_en_risk_Deloitte_Canadian_perspectives_from_Deloitte_Global_CAE_survey.pdf,

Doumpos M, Gaganis C, Pasiouras F. (2005). "Explaining qualifications in audit reports using a support vector machine methodology". Intelligent Systems in Accounting Finance & Management. 2005;13(4):197215.

Dopuch N, Holthausen RW, Leftwich RW. (1987). "Predicting audit qualifications with financial and market variables". Accounting Review. 1987;62(3): 431454.

Du and Roohani (2007). "Meeting Challenges and Expectations of Continuous Auditing in the Context of Independent Audits of Financial Statements", International Journal of Auditing, 11 (2), pp. 133–146.

Elliott R.K. (1998). "Assurance services and the audit heritage". CPA Journal, 1998; 68(6):40.

Eulerich, M., Jochen, J., Patrick, V., and Stiglbauer, M. (2013). "Self-perception of the internal audit function within the corporate governance system - empirical evidence for the European union", Problems and Perspectives in Management, 11, pp. 57–72.

Flowerday, Stephen; Blundell, A. W.; Von Solms, Rossouw. (2006). "Continuous auditing technologies and models: a discussion". Computers & Security, v. 25, n. 5, p.325-31, jul. 2006

Gramling, A. A., Maletta, M. J., Schneider, A., and Church, B. K. (2004). "The role of the internal audit function in corporate governance: A synthesis of the extant internal auditing literature and directions for future research". Journal of Accounting Literature, 23, pp. 194–244.

Groomer, S. M., and U. S. Murthy. (1989). "Continuous auditing of database applications: An embedded audit module approach". Journal of Information Systems 3 (2): 53–69.

Gonzalez, G. C., Sharma, P. N., and Galletta, D. (2012a). "Factors influencing the planned adoption of continuous monitoring technology". Journal of Information Systems, 26(2), pp. 53–69.

Gonzalez, G. C., Sharma, P. N., and Galletta, D.F. (2012b). "The antecedents of the use of continuous auditing in the internal auditing context". International Journal of Accounting Information Systems, 13(3), pp. 248–262.

Hardy, Anne C. (2014). "The Messy Matters of Continuous Assurance: Findings from Exploratory Research in Australia", Journal of Information Systems, American Accounting Association, 28 (2), pp. 357–377.

Hardy, C. A. and Laslett, G. (2015). "Continuous auditing and monitoring in practice: lessons from Metcash's business assurance group". Journal of Information Systems, 29(2), pp. 183–194.

The Institute of Internal Auditors (IIA). (2015). Global Technology Audit Guide, Continuous Auditing: Coordinating Continuous Auditing and Monitoring to Provide Continuous Assurance – 2nd Edition, The Institute of Internal Auditors, Altamonte Springs.

ISACA. (2002), "Continuous Auditing: Is it fantasy or reality". Information Systems Control Journal. 2002;5.

Hoitash, R., A. Kogan, and M. Vasarhelyi. (2006). "Peer-Based Approach for Analytical Procedures". Auditing A Journal of Practice & Theory. 25 (2) 53-84.

Hunton, J., Wright, A. & Wright, S. (2003)."The Supply and Demand for Continuous Reporting". Trust and Data Assurances in Capital Markets: The Role of Technology Solutions. Roohani, S.J. (Ed.) New York: Research Monograph funded by PriceWaterhouseCoopers LLP.

Kiesow, A., Schomaker, T., and Thomas, O. (2016). "Transferring Continuous Auditing to the Digital Age – The Knowledge Base after Three Decades of Research". Twenty-Fourth European Conference on Information Systems (ECIS), 1–18.

Kirkos E, Spathis C, Manolopoulos Y. (2007). "Data mining techniques for the detection of fraudulent financial statements". Expert System with Applications 2007;32(4):995-1003.

Kirkos E, Spathis C, Manolopoulos Y. (2010). "Audit-firm group appointment: an artificial intelligence approach". Intelligent Systems in Accounting, Finance and Management 2010;17(1):117.

Kotsiantis S, Koumanakos E, Tzelepis D, Tampakas V. (2007). Forecasting Fraudulent Financial Statements using Data Mining. International Journal of Computational Intelligence 2007;3(2).

Kogan A, Vasarhelyi MA, Wu J. (2010). "Continuous Data Level Auditing Using Continuity Equations". Working paper, Rutgers Business School; 2010. http://raw.rutgers.edu/docs/Innovations/Continuity%20Equations.pdf

KPMG (2012). "Leveraging data analytics and Continuous Auditing processes for improved audit planning, effectiveness and efficiency", available at http://www.kpmg.com/us/en/issuesandinsights/articlespublications/documents/data-analytics-continuous-auditing.pdf

KPMG (2015). "Internal Audit: Top 10 key risks in 2015", available at: https://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/Documents/top-10-considerations-internal-audit-2015.pdf

Marques, R. P., et al. (2013). "A Conceptual Model for Evaluating Systems with Continuous Assurance Services." Procedia Technology 9: 304-309.

Martens D, Bruynseels L, Baesens B, Willekens M, Vanthienen J. (2008). "Predicting going concern opinion with data mining". Decision Support Systems. 2008;45(4):765-777.

Md Ali, A., Ahmi, A., Ali, A., Ghazali, M., Gloeck, J. and Lee, T. (2009). "Internal audit in the federal organizations of Malaysia: Is there light at the end of the long dark tunnel?", Southern African Journal of Accountability and Auditing Research, 9 (2), 23–38.

Min JH, Lee Y-C. (2005). "Bankruptcy prediction using support vector machine with optimal choice of kernel function parameters". Expert Syst Appl 2005;28(4):603-614.

Menon, K., & Williams, D. D. (2001). "Long-term trends in audit fees". Auditing: A Journal of Practice & Theory, 20(1), 115–136.

Murcia Dal-Ri, Fernando; Cruz De Souza, Flávia and Alonso Borba, José. (2008). "Continuous Auditing: A Literature Review", Organizações em contexto, 4 (7), pp. 1–17.

Nakamoto, S. (2008). "Bitcoin: A Peer-to-Peer Electronic Cash System". http://ecee.colorado.edu/~ekeller/classes/fall2014_advsec/papers/bitcoin.pdf

Nigrini, M.J. (2002). "Analysis of Digits and Number Patterns". Fraud Examination for Managers and Auditors, Robertson, J. C. (Ed.), Austin, Texas: Atex Austin, Inc., 495-518.

O'Reilly, Anthony. (2006). "Continuous auditing: wave of the future?". Corporate Board, p. 24-6, set./oct. 2006.

Pathak, Jagdish; Chaouch, Ben; Sriram, Ram. (2005), "Minimizing cost of continuous audit: counting and time dependent strategies". Journal of Accounting and Public Policy, v. 24, n. 1, p. 61-75, jan./feb. 2005.

Power, M. (1997). The audit society: rituals of verification. Oxford Press, Oxford.

Protiviti. (2016). "Arriving at internal audit's tipping point amid business transformation". Available at https://www.protiviti.com/sites/default/files/united_states/insights/2016-internal-audit-capabilities-and-needs-survey-protiviti.pdf.

PricewaterhouseCoopers (PwC). (2006). "State of the internal audit profession study: Continuous auditing gains momentum". Available at https://www.pwc.com/us/en/internalaudit/assets/state_internal_audit_profession_study_06.pdf

PricewaterhouseCoopers (PwC). (2014), "State of the Internal Audit Profession Study", available at: https://www.pwc.com/m1/en/publications/documents/pwc-state-of-the-internal-audit-profession-2014.pdf

Porter, Brenda; Simon, Jon; Hatherly, David. (2003). Principles of external auditing. Indianapolis: Editora Wiley, 2003.

Pushkin, A.B. (2003). "Comprehensive Continuous Auditing: The Strategic Component". Internal Auditing, 18.1, 26-33.

Public Financial Management and Control Law No. 5018 (2003), http://kontrol.bumko.gov.tr/Eklenti/5373,5018pdf.pdf?0

Rezaee, Zabihollah; Elam, Rick; Sharbatoghlie, Ahmad. (2001). "Continuous auditing: the audit of the future". Managerial Auditing Journal, v. 16, n. 3, p. 150-8. 2001.

Rogers, E.M. (2003). Diffusion of Innovations, 5th ed., New York: Free Press.

Rutger van Hillo, H. W. (2016). "Continuous Auditing & Continuous Monitoring: Continuous Value?" 2016 IEEE tenth international conference on research challenges in information science (RCIS).

Searcy, Dewayne L. and Woodroof, Jon B. (2003). "Continuous auditing: leveraging technology". The CPA Journal, v. 73, n. 5, p. 46-8, may 2003.

Sung TK, Chang N, Lee G. (1999). "Dynamics of modeling in data mining: interpretive approach to bankruptcy prediction". Journal of Management Information System. 1999;16(1): 6385.

Subhani, S. (2013). "Continuous Audit - An Evolving Paradigm for Real Time Assurance." Business Journal for Entrepreneurs, 2013(3): 130-137.

Stringer K.W., Stewart T.R. (1986). Statistical techniques for analytical review in auditing. New York: Wiley; 1986.

Rikhardsson, P. and R. Dull (2016). "An Exploratory Study of the Adoption, Application and Impacts of Continuous Auditing Technologies in Small Businesses". International Journal of Accounting Information Systems. Vol. 20. pp. 26-37.

Tam KY. (1991). "Neural network models and the prediction of bank bankruptcy". Omega .1991;19(5): 429445.

Vasarhelyi M.A., Halper F.B. (1991). "The continuous audit of online systems". A Journal of Practice & Theory, 1991;10(1):110–25. https://www.researchgate.net/profile/Miklos_Vasarhelyi/publication/255667612_The_Continuous_Audit_of_Online_Systems/links/5410341a0cf2f2b29a3f4fbf/The-Continuous-Audit-of-Online-Systems.pdf?origin=publication_detail

Vasarhelyi, M. A. (2002). Concepts in continuous assurance. In S. Sutton & V. Arnold (Eds.), Researching accounting as an information systems discipline. Sarasota, FL: American Accounting Association

Vasarhelyi Miklos A., Michael G. Alles, and Alexander Kogan (2004). "Principles of Analytic Monitoring for Continuous Assurance". Journal of Emerging Technologies in Accounting: December 2004, Vol. 1, No. 1, pp. 1-21.

Vasarhelyi MA, Kuenkaikaew S. (2010). "Continuous auditing and continuous control monitoring: case studies from leading organizations": Rutgers Business School, Rutgers Accounting Research Center; 2010.

Vasarhelyi, M. A., Alles, M. G., Kuenkaikaew, S., and Littley, J. (2012) "The acceptance and adoption of continuous auditing by internal auditors: A micro analysis". International Journal of Accounting Information Systems, 13(3), pp. 267–281.

Vasarhelyi, M. A., et al. (2015). "Big Data in Accounting: An Overview." Accounting Horizons 29(2): 381-396

Vandervelde SD. (2006). "The importance of account relations when responding to interim audit testing results". Contemporary Accounting Research. 2006; Vol.23:789821 Canadian Academic Accounting Association.

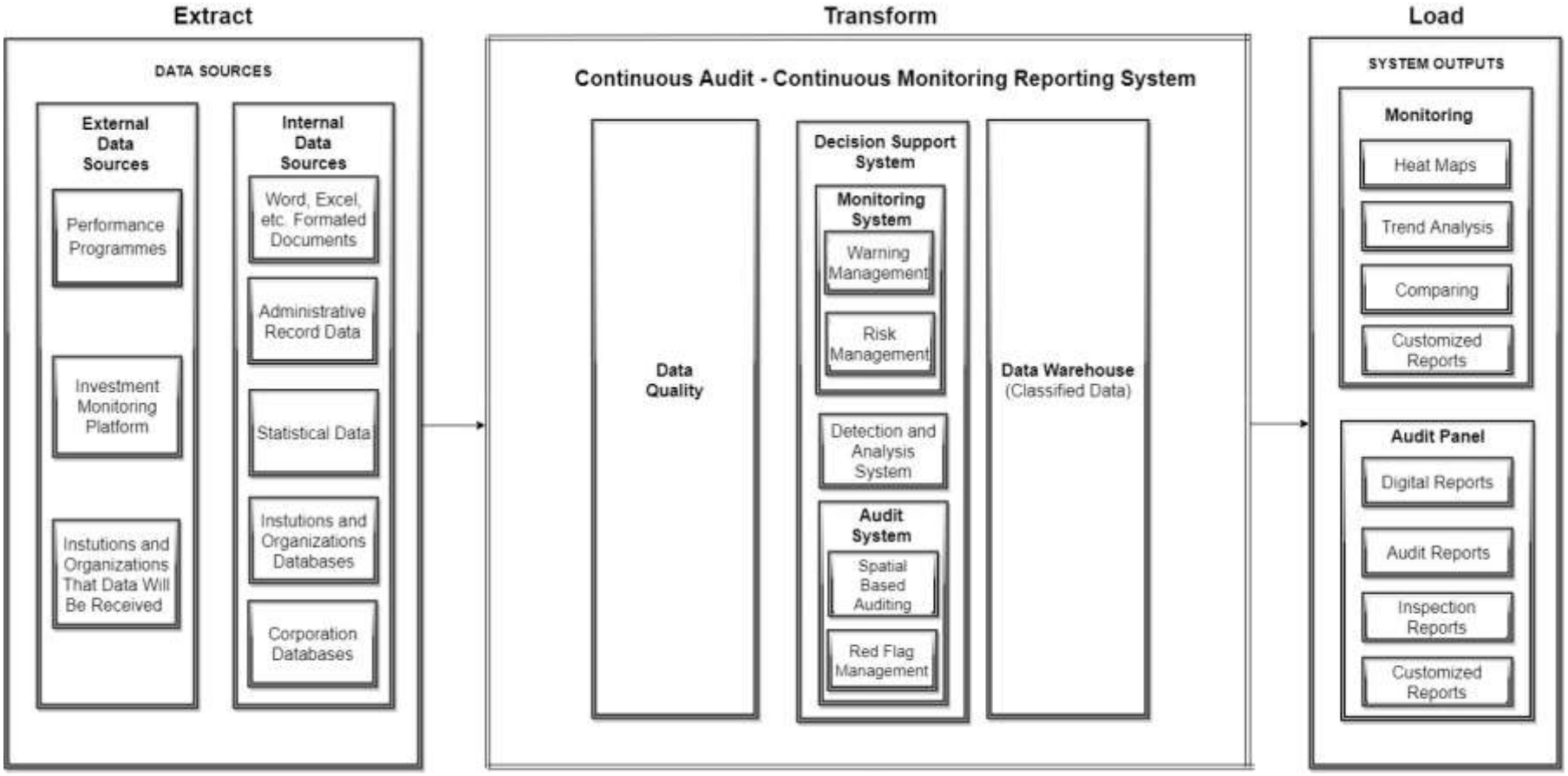
Yermack, D. (2017). "Corporate Governance and Blockchains", Review of Finance, Volume 21, Issue 1, 1 March 2017, Pages 7–31.

Warren Jr, J. D., Moffitt, K., and Byrnes, P. (2015). "How big data will change accounting". Accounting Horizons, 29(2), pp. 397–407.

Wu C-H, Tzeng G-H, Goo Y-J, Fang W-C. (2007). "A real-valued genetic algorithm to optimize the parameters of support vector machine for predicting bankruptcy". Expert Systems with Applications. 2007;32(2):397-408.

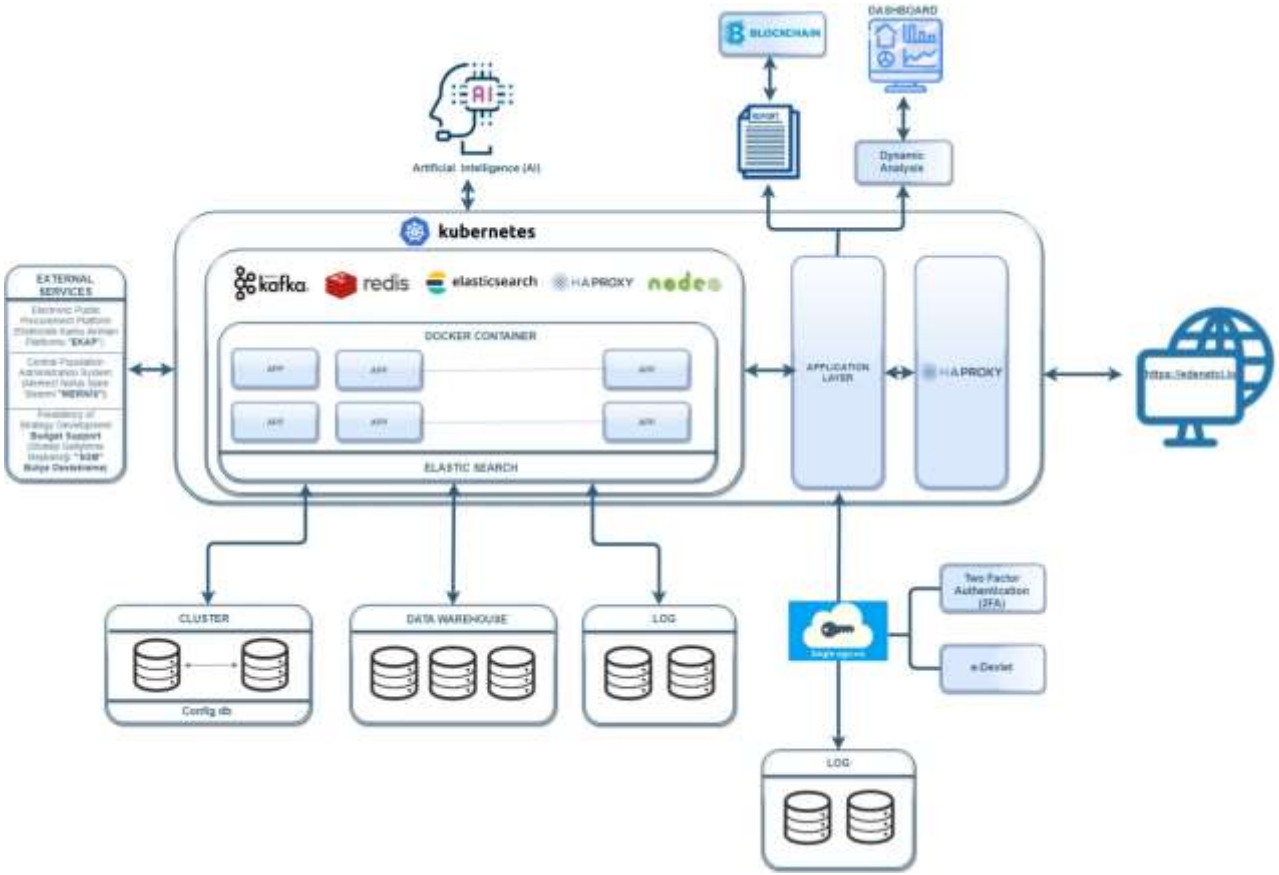
## APPENDICES

### Appendix 1: The CA Process in The Minsitry of Agriculture and Forestry




**Source:** The Ministry of Agriculture and Forestry, 2019.

## Appendix 2: The CA Infrastructure in The Minsitry of Agriculture and Forestry




**Source:** The Ministry of Agriculture and Forestry, 2019.