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The Rutgers CarLab is pleased to provide comments on the PCAOB's Strategic Plan for 2018-2022

Participating Members:
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SUMMARY:
On August 2018 the PCAOB issued a draft strategic plan requesting input on its five-year vision. The comment period will end September 10, 2018. This commentary summarizes the suggestions of Professor Miklos A. Vasarhelyi and Ph.D. candidate Andrea M. Rozario on behalf of the Rutgers Continuous Audit and Reporting Laboratory (hereafter, Carlab). Our suggestions primarily address goal two and objective one and relate to the impact of technology and external sources of information on enhancing the quality of audit services. In addition, we propose the use of emerging technologies to further evolve the quality of auditing, an experimentation program to promote the seamless integration of technology to auditing, a plan to enhance the PCAOB's involvement in anticipating the rapidly changing environment, and other items that should be considered.

Our response document is divided as follows:

- **Section 1** – The impact of technology and external sources of information on enhancing the quality of audit services
- **Section 2** – The use of emerging technologies to further evolve the quality of auditing
- **Section 3** – An experimentation program to promote the seamless integration of technology to auditing
- **Section 4** – A plan to enhance the PCAOB's involvement in anticipating the rapidly changing environment
- **Section 5** – Other items

Among the many actionable items presented in this commentary, we concur that the items presented in sections 1, 3, and 4 require attention in the very near future, while items presented in sections 2 and 5 are items to keep in mind as the PCAOB develops a longer term strategy.

RESPONSE:
September 8, 2018

Dear PCAOB representatives,

The CarLab is pleased to provide comments on the draft strategic plan for 2018-2022. Although most of the comments are general, in some parts a linking of the document notation is used (e.g. G2.O1; goal 2, Objective 1).

The views presented in this commentary are those of the participating members and do not reflect an official position of Rutgers, The State University of New Jersey. Moreover, the comments reflect the consensus of the CarLab participating members, not necessarily the views of every individual member.

We hope that our comments and suggestions are helpful. If you have any questions or concerns concerning our input, please feel free to contact us for any clarification.

Sincerely,

CarLab
Accounting and Information Systems Department
Rutgers, The State University of New Jersey

COMMENTS:

The PCAOB's draft strategic plan describes the goals and objectives that are important to consider as audit regulators and practitioners seek to understand how to enhance audit and inspection quality in a rapidly changing environment. Our response primarily relates to goal two "anticipate and respond to the changing environment, including emerging technologies and related risks and opportunities," and objective one, "assess and address the impact of emerging technologies on the quality of audit services." While technology has the potential to substantially evolve auditing, it is also important to emphasize that the PCAOB is in the unique position to promote this progressive change in the profession.

Auditing standards were created in a different time, where paper-based audit trails were prevalent; and they remain largely unchanged since the 1970s (Appelbaum et al. 2017a). Hence, there is a dire need for standards to be revised to complement the digital business environment. It would be beneficial to both, the profession, and the public interest, for the PCAOB to be proactive about motivating the implementation of more sophisticated audit analytic techniques by external auditors. Our commentary discusses a few of these techniques and where possible, links them to the auditing standards that could be revised to identify actionable items in this area. We concur that a shift in audit methodologies is needed to enhance the quality of audit services and better serve the public interest.

Finally, as one of the leaders in both audit and accounting information systems research[1], we welcome discussions with PCAOB regulators to facilitate the suggested revisions to auditing standards.

[1] http://www.byuaccounting.net/rankings/univrank/rankings_per_univ.php?univid=434&univname=Rutgers,%20The%20State%20University%20of%20New%20Jersey

Section 1 – The impact of technology and external sources of information on enhancing the quality of audit services

Continuous Auditing to Enhance the Quality of Audit Services

Despite tremendous technological innovations in the last decade, auditing, by and large, remains unchanged. The current audit framework emphasizes an audit approach that is sample-based. In order for the audit profession to remain relevant by significantly improving audit quality and continue to add value to the public, it needs to more closely parallel and complement the digital and real-time economy that we live in. ERP systems often process substantial volumes of transactions and sampling may fail to precisely address audit risk in such populations. In addition, financial statement users' demands are evolving in terms of the quality, timeliness, relevancy, and reliability of the information that is provided to them by auditors. Research studies and anecdotal evidence indicate that some of these technological advancements (e.g., data analytics) can enable auditors to test complete populations of records, which can help the auditor in better identifying material misstatements and weaknesses in internal controls. The use of such technologies can be performed on a real-time, or close to real-time basis (Vasarhelyi and Halper 1991), therefore we will refer to them as Continuous Auditing (CA). Accordingly, the implementation of CA methodologies by external auditors has great potential to assist with the evolving demands of financial statement users for higher quality audits, more timely, relevant, and reliable information. As auditing evolves to more closely parallel a real-time digital business environment, it is essential to consider the adoption of CA. Importantly, the PCAOB is in the unique position to advocate for a progressive shift in auditing methodologies.

RADAR Initiative to Promote Audit Quality with Technology

The RADAR[2] (Rutgers AICPA Data Analytics Research Initiative) initiative and other CarLab projects[3] are examining a variety of methodologies that can assist auditors with the problem of processing numerous notable items with the objective to improve the quality of substantive audit procedures and internal control testing. These methodologies range from developing composite "suspicion" scores that highlight risky transaction characteristics (e.g. payments made during holidays to vendors not approved on the vendor list) to clustering techniques.

[2] Supported by the AICPA, top 8 CPA firms and CPA Canada.
[3] http://raw.rutgers.edu/docs/dashboard

Multidimensional Audit Data Selection (MADS)

One of the challenges that arises as audits evolve from audit sampling to full population testing is the problem of large numbers of notable (unexpected) items, particularly early in the implementation of CA. While testing full populations of transactions can help auditors more accurately estimate the magnitude of misstatement or better evaluate control deficiencies, it is probable that audit analytics that test full populations will produce large numbers of notable items, many of which might not necessarily be related to accounting anomalies but rather routine abnormal events. In general, the treatment of large populations by MADS entails first the usage of appropriate "risk filters" that are used to separate more risky transactions and less-risky transactions which are named "notable items." This is followed by algorithmic prioritization of these, leading the auditor to examine as many as his/her threshold of risk requires.

Process Mining

The RADAR project has examined process mining technology (Jans, Alles, Vasarhelyi 2013, 2014; Chiu 2018; Alrefai 2018) that extracts logs from ERPs and examines transaction trajectories. This technology, originally developed for process engineering, has great promise in providing direct audit evidence of what were the steps of a transaction (as in the examination of routing sheets in manual audits) as opposed to indirect evidence of just tripping filters. Moreover, process mining could be used as an effective method to test the operating effectiveness of internal controls. Process mining has shown great promise as a self-contained audit methodology as well as together with MADS in generating exception suspicion scores.

The PCAOB should consider revising AS 2315 (PCAOB 2010b) on audit sampling to promote the use of CA methodologies that examine the full population of transactions, such as MADS and process mining, and provide guidance relating to how auditors could address the problem of notable items.

Visualization

It is important for the PCAOB to consider the various techniques that can be applied to process notable items as guidance in this area is developed. Auditors are currently expected to scan data at the substantive test phase of the audit. Human Information Processing capabilities are limited and in particular, large amount of data in tables is practically impossible to understand without some technological help. This help can be obtained by using techniques of dynamic multi-dimensional visualization as well as grouping tools that allow for significant trend discrimination. Dynamic

analysis of data and multidimensional visualization are methods that are progressively used more and more in business. The profession in general uses visualization tools mainly for showing results to the client (Rozario, Thomas, Vasarhelyi and Zhang 2018). The utilization of these tools would add tremendous man-machine synergy to the audit. Standards should be created to move the assurance process in this direction.

Improving Audit Quality Through the Use of External Data

An important byproduct of technological advancements is the emergence of external (exogenous) information from digital platforms, such as internet searches, social media postings, and devices that are connected to the internet (e.g. video cameras, waze, etc.). Organizations are using external data sources for many areas of their business processes such as perceiving the sentiment of their clients (*environmental monitoring*), use of locational and surfing data for direct client intervention (*operational enhancement*), as well as for *strategic analytic purposes* in activities such as capturing market trends and competitive monitoring. The usage of exogenous data in audit can be also be use in environmental monitoring processes as continuous risk monitoring and assessment (Vasarhelyi, Alles, and Williams 2010; Moon 2016), continuous audit operational monitoring and alerting (Vasarhelyi, Alles, and Kogan 2004), and in many audit strategic issues, including risk assessments of significant accounts.

The PCAOB should consider revising AS 1105 (PCAOB 2010a) on audit evidence. Audit evidence must be sufficient, relevant, and reliable. Sufficiency relates to the quantity of audit evidence. When applying CA methodologies, sufficiency may not be relevant as all transaction records are examined (Brown-Liburd and Vasarhelyi 2015). However, more emphasis would be placed on the relevance and reliability of audit evidence. Relevance is defined as the relationship between the evidence collected and the audit assertion or account being tested and the timeliness of this evidence, while reliability relates to the integrity of the evidence. Most data currently used in the audit is internal, however, auditors have access to vast amounts of external financial and nonfinancial sources of information, including information from social media, to improve their risk assessments (Louwers et al. 2013). Brown-Liburd and Vasarhelyi (2015) argue for an expanded role of exogenous data in audit standards and practice. Consequently, it is very important for PCAOB regulators to provide guidance on how auditors can assess the relevance and reliability of less traditional sources of information.

With respect to relevance, it would be useful to provide guidance about how auditors may establish relationships between the external nonfinancial source of information and the existence (assertion) of sales. For example, is a correlation between sentiment and sales sufficient to meet the relevance requirement, if not, what would be the other requirements? Timeliness is not likely to be a challenge because most external information generated by digital platforms is publicly available and accessible close to real-time.

In general, external evidence is different in reliability than internal evidence. However, it is likely for external information that is generated by digital platforms to have integrity issues because much of it is not vetted. For example, how would auditors, evaluate the completeness and bias of social media information? Less traditional sources of information do have the potential to provide valuable insights about the entity's performance (Bollen et al. 2011; Tang 2017) and as a result, there is value in exploring the use of this information to improve the effectiveness of audit procedures. For example, information such as weather, has the potential to generate accurate sales expectations and detect accounting errors (Yoon 2016), hence, it is plausible that less traditional external sources of information could be used by auditors as audit evidence. It would be helpful to provide guidance on how auditors can use these less traditional sources of information as audit evidence.

Section 2 – The use of emerging technologies to further evolve auditing

Emerging technologies to look out for

As described in the PCAOB's strategic plan, technological innovations will evolve the way that audits are performed and improve audit judgment, which would naturally lead to higher quality audits. Technological changes occur at accelerating speeds and auditors should be cognizant of emerging technologies that can impact auditing. Some of the emerging technologies to be aware of are blockchain (Dai and Vasarhelyi 2017), smart contracts (Rozario and Thomas 2018), RPA (robotic process automation) (Moffitt, Rozario, and Vasarhelyi 2018), IPA (intelligent process automation) (AICPA 2018), artificial intelligence / deep learning (Sun 2018), and cognitive decision aids (Li 2018).

Blockchain and smart contracts

Blockchain and smart contracts are demonstrating to be disruptive to business practices and audit firms have started to create audit services for providing assurance over these technologies. PwC, for example, announced that it is providing blockchain audit services[4] as of March 2018. As these technologies present new opportunities and risks to public accounting clients, it is imperative to assure them. However, as auditing evolves to apply a variety of audit analytic tools, it is also important to guide auditors in understanding how they can leverage these technologies as audit analytic tools. Essentially, it is possible to execute preprogrammed audit tests as smart contracts on the blockchain. The blockchain supported by smart contracts can facilitate the autonomous execution of audit tests and close to real-time audit reporting (Dai and Vasarhelyi 2017; Rozario and Thomas 2018), which can also support the PCAOB's initiative to automate elements of its inspection process and prevent audit deficiencies from occurring.

RPA and IPA

RPA is also at the forefront of innovative technologies by enabling the seamless automation of separate audit actions to form one smooth and integrated audit process. Auditors can benefit by applying RPA to auditing by automating tasks that do not require audit judgment, are time consuming, repetitive, and manual. For example, auditors could benefit from automating evidence collection activities and tests of details (Moffitt, Rozario, and Vasarhelyi 2018). The natural progression of RPA is IPA. IPA combines the capabilities of RPA with the benefits of AI (artificial intelligence). IPA goes beyond RPA by making automation more scalable, intelligent, and flexible[5]. IPA can benefit auditors by automating the analysis of sales or purchasing contracts, or by assisting with complex audit tasks such as risk assessments.

Auditors should be ready to embrace blockchain, smart contracts, RPA, and IPA as they would certainly alter the work that they perform. Automating audits with technologies like RPA and blockchain for example, can offer auditors the opportunity to perform more value-added tasks that can increase audit quality. Consequently, the work of auditors would be repurposed to focus on more complex tasks that require audit judgment. The PCAOB, as the regulators of audits, should

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[4] https://www.wsj.com/articles/pwc-has-an-answer-for-the-blockchain-audit-it-1521194401

[5] http://blog.aicpa.org/2018/08/beyond-robotics-how-ai-can-help-improve-the-audit-process.html#sthash.9Exi09Ho.dpbs

be aware of the potential of these disruptive technologies in evolving auditing and consider the qualifications and competencies of their inspectors to be able to conduct successful audit inspections in a digital audit environment.

Artificial Intelligence with Deep Learning

The large CPA firms have engaged in a series of efforts using Big Data and Deep Learning (multilayer ANN) technologies (Kokina and Davenport 2017). These efforts use large data histories and supervised learning / ANN to come up with formulae that predict outcome of a particular data rich environment. Deep learning consists of hierarchical artificial neural networks that contain several layers of neurons. Deep learning technology is capable of identifying abstract data features from raw data. For example, deep learning can assist with speech recognition, and text understanding. In auditing, deep learning can be applied to extract and examine useful patterns from big data, such as social media postings by consumers, to offer insights about consumer satisfaction of products and brands that belong to an audit client. In addition, this technology can assist auditors with performing assurance tasks related to the verification of contract terms and the completion of audit reports (Sun 2018).

Loan default prediction, which uses the history of loans and defaults to create a predictive equation can also be used in evaluating bad loan reserves. Although this type of technology has been used in many fields and problems, its results depend today in large investments and deep data containers. These are areas where accountants have little experience and little desire to get involved. Furthermore, restrictions on the use of client data (AICPA rule 301) make it somewhat questionable if the direct data of one client can be used for modeling and used in many clients (Kogan and Yin 2017). The understanding of what artificial intelligence models propose is of great importance for creating man-machine systems that use the judgmental capabilities of human auditors (Gunning, 2018). The PCAOB (G2.O1) should examine these issues in the context of audit.

Cognitive decision Aids

We find that although the usage of Deep Learning Artificial intelligence is important and will be part of the audit ecosystem, decision aids a la SIRI, Alexa, OK Google, and Cortana are where research should be emphasized and would provide the highest return for audit quality [G2, O4]. This is the area that most audits can be favored and allows for significant gathering of information and organizational knowledge (Li 2018). A cognitive decision aid that is used in audit, maybe at

the beginning of the planning process, can gather millions of knowledge bits and validated responses would allow for extensive knowledge organization and the accumulation of knowledge of thousands of auditors, thus creating a consistent knowledge base. Li (2018) used the verbal protocol analysis (Brown-Liburd, Rozario, Mock, and Vasarhelyi 2018) to examine the auditor brainstorming decision and created a set of ideas on how "LUCA", a cognitive decision aid, could be used building on publicly available code as an illustration. Overall, this approach is more coherent and reliable than large expensive adventures into artificial intelligence deep learning modeling [G2,O1;G4, O1, O2, O3].

Brainstorming meetings are an important step in the audit planning and risk assessment process. In this stage, audit team members discuss areas where the risk of material misstatement may arise. In general, auditors use a checklist to guide them during the risk assessment process. While checklists are useful, they may limit auditors to just focus on the items that are presented in the audit firm's checklist template, which may not cover an emergent panorama of risks in many audit clients. Auditors can benefit from using a cognitive assistant, such as proposed in LUCA, in this stage of audit planning as the cognitive assistant would be capable of retrieving information from a myriad of audit clients in similar industries and making risk assessment recommendations. For example, auditors could ask questions, such as "what is the revenue balance of client ABC?" and "what are the recent trends for clients in similar industries?" to the cognitive assistant. In addition, the cognitive assistant could offer suggestions for risk areas that auditors need to address. Finally, since cognitive assistants are capable of accumulating increasing knowledge, the risk assessment recommendations would improve as more client information is fed to them.

Section 3 – An experimentation program to promote the seamless integration of technology to auditing

Experimentation Program

To explore the use of technology on auditing and additions or revisions to auditing standards, the PCAOB should consider an experimentation program. Some public accounting firms have expressed their interest in technology and sophisticated data analytics, however, they are conservative in their application of new audit methodologies because auditing standards do not

encourage it. This conservatism arises from the fear of being penalized by the PCAOB for deviating from current auditing standards. Accordingly, it is important for the PCAOB to be proactive in initiatives relating to the use of technology and sophisticated data analytics on auditing.

The experimentation program would consist of a team of regulators, auditors, and researchers from an academic institution. The team would conduct a variety of experiments to measure the benefits provided from the use of technology and data analytics in audits. Rutgers University, Macquerie University and University of Sydney have partnered starting potentially three projects of audit experimentation (Martinov-Bennie et al. 2018). CPA Canada in conjunction with CPA firms is also conducting experimentation[6]. This concept of experimentation program should mirror the XBRL's voluntary filing program and provide a safe harbor provision to relax the requirements of existing auditing standards. (G1, O4:G2, O1; G3, O1; G4, O1, O2, O3]

Much of audit analytics research is in pre-paradigmatic stage and although hundreds of academic papers (Appelbaum et al. 2018, 2017a, 2017b) have proposed and demonstrated analytic methods their application and discussion in practice is very limited due to confidentiality, data privacy, and most of all fear by the firms of what the PCAOB's reaction would be. For example, a judgmental sample of 50 in a revenue audit could be permissible in a population of 600k P2P transactions but a full population screening leading to 34,000 notable items would create serious problems for the audit firm even if it would denote much better understanding of the population.[7]

The PCAOB should urgently engage in experimentation programs not only on already explored analytics and their inclusion in practice (Appelbaum et al. 2017a) but on leading edge disruptive technologies ahead of our times.

[66] Comments made by CPA Canada representative at the ASEC meeting in the AICPA on July 2018.
[7] Dohrer, McCollough and Vasarhelyi presentation to the IAASB in Spetember 2015.

Section 4 – A plan to enhance the PCAOB's involvement in anticipating the rapidly changing environment

Organization and Staff of the PCAOB

Research Focus

The PCAOB has emphasized economic analysis of impacts of standards and it should now consider dividing its research into three areas: 1) analytics technologies, 2) disruptive technologies, and 3) economic impact. Visitors (interns) to the PCAOB were chosen typically among researchers doing "market research" but in the future, just as the large firms are doing, PCAOB research initiatives must encompass analytic methods and studies using the inspection database and machine learning techniques.

Training of the PCAOB staff

Inspectors should be trained in analytics and modern technologies (Tschakert, Kokina, Kozlowski, and Vasarhelyi 2016) not necessarily to apply these methodologies directly, but rather to create a climate of change and acceptance to change. Many of the PCAOB inspectors were in the past "Big Four" auditors and consequently their methodologies are of "auditing a firm" not of "auditing auditors"

Section 5 – Other Items

Other items to consider

- Feedforward Effect of PCAOB research initiatives.

  The PCAOB has a unique position to observe the quality not only of accounting assurance through its inspections, but also on a comparative basis the quality of business measurement and its deficiencies. It can provide the FASB and the SEC valuable inputs and directions for change. For example, the concern with non-financial variables (Lev and Gu 2016) and their need on inclusion in business measurement as well exogenous variables (Brown-Liburd and Vasarhelyi 2015).

- Funding research not only on economic impacts but mostly on analytic methods and artificial intelligence.

  The PCAOB database of inspections (guarded the natural restrictions) provides a valuable source for big data analytics and machine learning. Furthermore, the structure and data capture

of the PCAOB inspection database should be reengineered for the future in order to collect data necessary for these efforts. Group sourcing of information relevant data as direct inputs by users and auditees and other stakeholders should also be a big part of the PCAOB inspection database. A far-fetched suggestion was to make PII free, audit workpapers public, and part of the group-sourcing data surge.

- There is little doubt that the creation of the PCAOB has created better obedience to auditing standards, but
    - What happens if these standards are antiquated and their obedience (e.g. sampling) leads to deterioration in audit quality?
- What is the role of PCAOB inspections when the audit is done by robots?
  Although full robot audits are not yet in the making, RPA and cognitive technologies are going to create a fertile scenario for man-machine (Vasarhelyi 1973) interaction. There, parts of the audit will be performed by humans and part by automata (Zhang et al. 2018).
- How can auditors harmoniously implement technology to achieve higher quality audits while at the same time meeting the requirements of auditing standards?
  Experimentation and research must be the answer. Furthermore, audits of audits are not the same as audits of entities. Consequently, there is scarcity of research of how the PCAOB inspectors should audit and none proposing continuous audit/ continuous monitoring (Vasarhelyi, Alles, and Kogan 2004) of audit engagements by the PCAOB with cooperating firms.
- What would be the impact of technological tools on auditor judgment?
  If machines take over part of the auditor judgement how will we have experienced auditors to make the more complex decisions? This is analogous to the problem with pilots and automatic pilots.
- How can the PCAOB apply technology to enhance their inspection process?

  The PCAOB has issued a series of reviews with wordings like “the firm must prepare a checklist with objectives, goals, and applications of data analytics and describe how these data analytic techniques would change the firm’s audit methodology, tools, etc.” to the smaller firms. The same effort of research, milestones, and specific plans would be very useful for the audit process.

The PCAOB would also benefit from a process of risk monitoring a la CRMA (Vasarhelyi et al. 2010) that would pick up key risk indicators of firms, and separately of auditees, to help in the choice of engagements to be examined and to guide on the moments that continuous monitoring and audit must lead to intervention.

The Large firms have been investing substantively in analytic technologies and have grown to be 65% advisory and only 35% auditing. By and large they have NOT used much of this investment in the external audit. How can this be reverted?

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