# Big Questions in AIS Research: Measurement, Information Processing, Data Analysis and Reporting[[1]](#footnote-1)

## QI Liu and Miklos A. Vasarhelyi

### Introduction and Big Questions

Basu (2008) chaired a panel on “Big Unanswered Questions in Accounting,” which was subsequently published as a series of six commentaries in Accounting Horizons. In that spirit, and motivated by the unprecedented pace of change in technology, the current editorial raises questions regarding analytic and information technology issues.

In previous editorials, a set of emerging issues was discussed: 1) the context of the AIS field in an age of rapid change and evolution (Vasarhelyi, 2012a), 2) the role of financial accounting standards in a database-oriented world (Vasarhelyi, 2012b), 3) the potential for formalization of standards whereby soft and hard intelligent agents can perform much of the work (Vasarhelyi, 2013a), and 4) the emerging opportunities being presented by big data and the associated potential implications for accounting and auditing (Moffitt and Vasarhelyi, 2013). This editorial addresses major questions that could dramatically and fundamentally alter the accounting discipline.

Accounting is a field of data, information processing, measurement, analysis, and reporting. Unfortunately, technology has often been used to simply automate existing manual processes and methodologies, instead of first restating problems and reengineering processes in light of new technologies and capabilities. This editorial poses and explores the following big questions that emerge from the five aforementioned attributes of accounting:

1) Accounting is based on **data:** Has increasing data accessibility altered the accounting profession? How do accountants deal with data-related concerns such as security and privacy?

2) Accounting entails a substantive amount of **information processing**: Has the nature of data processing changed? If so, has it had feed forward effects on the profession?

3) Accounting is the field of business **measurement**: What has changed relative to this objective? Has the locus of measurement, have the variables to be measured, and/or has the frequency of measurement changed?

4) Accounting entails substantive **data analysis**: Have new data analysis techniques affected accounting practice? Will the emerging analytical approaches modify the nature of accountants’ work?

5) Accounting ultimately is delivered through **reporting**: How will information be delivered? Who will be the recipients? How will disseminated information be used?

#### Background: Big technologies

Technology’s influence on accounting methods has been substantially understated and misunderstood in the literature (Sutton, 2010). Information technology has made significant progress in the recent past, and this has had a profound global impact on contemporary human culture. Business operations have also dramatically evolved via information technologies, and this has facilitated numerous automation and redesign opportunities for the accounting profession. However, to better leverage this new frontier, the accounting discipline should initially seek to reengineer its service offerings. In light of this, Geoffrey Moore (2012) points out three fundamental trends that will shape the future of accounting services during the second decade of the 21st century: *digitization* (from paper to digital), *virtualization* (from physical to digital presence), and *transformation* (from generalization to specialization).

##### Digitization

With the advent of computing and networking, paper-based information is increasingly becoming **digitized**. For example, Cukier and Mayer-Schoenberger (2013) indicate that, in 2000, only about 25 percent of all stored information was in a digital format. By contrast, today more than 98 percent of all such accumulated information is electronic. In fact, for most contemporary organizations, the current default format for the majority of documents is digital, enabling accountants to apply advanced computer data analysis technologies to better fulfill their responsibilities. These technologies can not only increase the efficiency and quality of accounting services, but also allow accountants to expand the scope of traditional accounting functions. For example, with the application of decision aid tools, accountants are able to provide decision support services as well as strategic advice. Also, by using predictive models, auditors’ work can transition from simply identifying and assessing existing risks to preventing their materialization(Kuenkaikaew, 2013). Digitization has also facilitated the transition to automation in accounting. Using electronic data, many historically labor-intensive accounting services may be mechanized, and this automated platform represents a foundation for real time services such as continuous auditing and continuous monitoring (Vasarhelyi, 2013; Teeter, 2014).

Through digitization and advancements in networking technologies, the process by which individuals obtain information has dramatically evolved. For example, the Internet has progressively become the most convenient medium for accessing and consuming information. In benefitting from this phenomenon, businesses employ Internet capabilities to disseminate information to and interact with stakeholders in a more timely fashion. This raises issues relative to potential future guidelines concerning reporting activities of companies, including methodologies for both online and continuous reporting. Internet communication methods have been further enhanced through social media websites, such as Facebook and Twitter. These sites create virtual communities that allow individuals to interact with one another essentially anytime and anywhere. Furthermore, organizations can derive utility from using social media websites in conducting various business activities, thus creating additional data streams that can be collected and analyzed by accountants for assorted business purposes. Arising from this development, the optimal application of these new forms of evidence becomes an issue warranting rigorous investigation.

##### Virtualization

Digitization of data and other recent technological advances, such as cloud computing, enable the **virtualization** of business entities (including accounting firms). This phenomenon is enhanced and expanded through the widespread use of mobile computing devices (e.g. smartphones, tablets, etc.), which are progressively being used as primary mechanisms for accountants to manage their workflows. Consequently, accountants can work at essentially any time and place to provide and obtain real-time information. However, this implies that accountants are able to access confidential financial data at ostensibly any instance. Given this fact, ensuring the security of sensitive data when dispensing virtual accounting services is yet another question that deserves future research and investigation. Collectively speaking, the virtualization of business requires accountants to rethink the way they measure business activity. Similarly, auditors will need to fundamentally alter many existing procedures, such as documenting controls, selecting samples, and conducting confirmation, vouching, and tracing tests (Pepe, 2011).

##### Specialization

Expanding business complexity, knowledge requirements, regulatory and legal changes, and client expectations will favor accounting **specialists** over generalists (Intuit, 2013). For example, with the increasing number of fraud cases, the need and demand for forensic accountants and fraud examiners is growing rapidly. Specialization will presumably lead to greater collaboration and partnering among accounting firms and other financial professionals[[2]](#footnote-2), and will likely facilitate increased outsourcing of accounting services as well. For example, Information technology (IT), accounting, finance, and administrative processes are projected to dominate the future outsourcing plans of major companies (KPMG, 2013). Data security and privacy issues also exist in the collaboration and outsourcing context. Table 1 summarizes the opportunities and challenges related to the three converging trends and their relationships with big questions.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Converging trends*** | ***Related Opportunities*** | ***Related Challenges*** | ***Big Questions*** |
| *Digitization* | Application of Data Analysis  Automation  Online and real-time communication | Online and real-time reporting  Drawbacks of traditional data analysis methods | Receipts and Usage of Reporting  New data analysis approaches in accounting/auditing |
| *Virtualization* | Increased Data Accessibility  Cloud accounting services | New forms of accounting information | Information processing issues  The change of accounting measurement |
| *Specialization* | Collaboration  Outsourcing | Data security and privacy issues | Information processing issues. |

Table 1: Summary of big technologies and questions

By and large, extant accounting practice and technology still follow Pacioli’s (1514) use of Venetian merchant business measurement practices, although the methods have been adapted to accommodate for increased data capture, recording, and processing capabilities. In addition, accounting processes and rules are a direct consequence of economic tradeoffs regarding technology usage. The ensuing sections examine the big questions in AIS relative to accounting data, information processing, measurement, analysis, and reporting.

### Accounting data

Accounting is based on **data**: Has increasing data accessibility altered the accounting profession? How do accountants deal with related concerns such as security and privacy?

##### Accessibility

Data accessibility is greatly enhanced with the advent of cloud computing platforms (Weinman, 2012) and various mobile devices, which can access available data from virtually any location. In the accounting domain, the use of mobile devices can increase the effectiveness and efficiency of accounting services and data availability for auditors. As such, how accountants accept and adopt this technology needs to be studied. Arbore et al. (2014) explore the multifaceted motives for embracing personal technologies, such as smart phones. The authors decompose attitudinal beliefs into three components: functional value, hedonic value, and symbolic value. Based upon these components, three user types are identified: pragmatic, IT worried, and symbolic. Different user types and individual characteristics among potential users are found to be the key elements impacting adoption and diffusion of smart phones. These findings provide a baseline for future research regarding personal technology adoption by accounting practitioners.

##### Privacy and Security

With increasing data availability and accessibility in the cloud platform, concerns such as data security and privacy attract progressively more attention. Companies must secure their private information, while simultaneously allowing employees access to necessary data via mobile devices. Four articles, included in the special privacy section of this editorial, discuss data privacy and security issues under various business scenarios. These studies offer guidance for organizations seeking to protect their sensitive data and accounting firms striving to optimize their service offering portfolios.

One method for protecting confidential organizational information entails constructing a set of protocols for controlling mobile device access to company data. This approach is generically referred to as the Bring Your Own Device (BYOD) policy. Loraas et al., (2014) apply the lens of Protection Motivation Theory in examining factors that determine whether employees follow BYOD policies. Through surveys of accounting students, non-accounting students, and full-time employees, results demonstrate that intentions to comply with a BYOD policy are primarily motivated by self efficacy and response efficacy. Compared with other professionals, accountants are more sensitive to the severity of potential threats, perhaps due to heightened sensitivity to confidential data. Employee respondents are also concerned about compliance costs, which can operate as strong deterrents to full compliance.

Besides data sharing within the organization, growing business complexity and specialization increase collaboration efforts between organizations. This kind of cooperation generally can be classified into two categories: vertical collaboration (along the supply chain) and horizontal collaboration (between competitors). Data security and privacy issues exist in both types of collaboration. Yuan et al., (2014) discuss how to protect private information of multiple participants in supply chain collaboration settings by reviewing related studies from theory to applications.

Data security and privacy protection in horizontal collaborations is studied by Dull et al., (2014). This research describes an electronic market for secure information sharing in which data are contributed to the market by members and made available from the market to members or pre-approved information buyers. In this Secure Information Market, shared data are protected and available in a highly granular or aggregated format, contingent upon specific policies and requirements of the information providers and consumers.

Consumer privacy is an additional concern, one so pervasive that a stream of research suggests accounting firms should extend their branding to include privacy-related services (Greenstein and Hunton 2003; Vandervelde 2003). Raschke et al, (2014) discuss how firms providing location-based services can protect consumer privacy. They find that privacy protection beliefs negatively impact concern for collection, unauthorized use, and improper access to information, and privacy risk beliefs positively impact concern for collection and existence of errors. Furthermore, concerns about collection and unauthorized use negatively impact behavioral intentions to disclose information. With this in mind, firms can begin to address both cognitive and affective consumer concerns, and enhance transparency while handling privacy controls as an extension of those services. Without question, as accounting data proliferates at an exponentially expanding rate, security and privacy issues and concerns will progressively become more salient. Consequently, practitioners must remain vigilant in contemplating and addressing these developments.

### Information processing

Accounting entails a substantive amount **of information processing**: Has the nature of data processing changed? If so, has it had feed forward effects on the profession?

#### Nature

Modern systems will benefit from potential information utilities (Carr, 2012) where incremental computing and storage resources are plentiful, moderately and incrementally priced, and easily scalable. The nature and cost of these information services, based on modular processes of Enterprise Resource Planning (ERP) systems, will tend to vary with usage as opposed to the fixed cost structure of the past. However, present organizations continue to endure a slow and cumbersome process of automation. The contingencies in this process are described in Table 2.

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Manual*** | ***Automated*** | ***New contingencies*** |
| ***Recording*** | Costly and laborious to record | May be manually and automatically captured | Automatic capture allows for repeated short time measures (e.g RFIDs of items in inventory |
| ***Data Storage*** | Voluminous, not easily accessible, potentially deteriorative, format flexible | Prices rapidly declining but storage needs exponentially growing. | The expanded data world does not have mature processes for data organization, extraction, and interpretation. If these are urgent, they are costly to develop |
| ***Data capture observation*** | Typically observable | Not observable allowing for long term systematic errors. The CCM (Vasarhelyi, Alles, Williams, 2010) methodology aims to curtail control aberrations | Takes accounting data to new levels of formalization and progressively eliminates much of the human element in the accounting data manipulation process |
| ***Error systemacity*** | Subject to human variation | Procedures that are wrong are systematically wrong | High level analytics and alerts must be constantly monitored in corporate dashboards |
| ***Retrieval*** | Laborious and expensive | Cheap, flexible, and on demand | Users must work hard to understand their data. The accountant will be more of a data identifier, provider, and analyst than a processor |

Table 2: Manual vs Automated Contingencies

In general, accounting information processing has already become largely automated and will further evolve in this direction, with many of its current functions disappearing and new functionality being created along the way.

#### Feed forward effects

A large majority of routine bookkeeping entries are formalized in ERPs, which requires accountants to focus on using more complex accounting knowledge to properly address the few unusual end-of-period adjusting entries. ERPs make thousands of pre-packaged reports available, many of which are unfamiliar and difficult to understand. The business climate is becoming progressively more complex, with sophisticated instruments, advanced management practices, and rapidly changing business conditions. Standard setters (Krahel, 2012) have substantively increased the number of accounting standards, clarifications, and guidance. Increasingly, the world of accounting disclosure (particularly internal) will be driven by automatic alerts generated as a function of comparing actual measurements with analytically generated models. These alerts will be examined with the help of ad hoc reports, visualization dashboards, and analytical modeling. As these reactions are better understood they will be progressively automated, particularly the more common and systematic variances.

Potential consequences of this automation include:

1. Issuance of standards that are formal and easily transformable into computer code (Krahel, 2012)
2. Development of taxonomies of alerts, and methods for treatment
3. Progress toward continuous reporting and analysis of internal reports
4. Development of methods for external validation of accounting numbers through peer modeling and data sharing
5. Higher-level and more integrative instruction and education of accountants
6. Focus of ERP reports and training in ad hoc report preparation.

Many unintended consequences of this paradigmatic change in internal reporting will occur. Progressive module automation will become the norm, with accountants focusing on exception treatment and model development.

### Business Measurement

Accounting is the field of business **measurement**: What has changed relative to this objective? Has the locus of measurement, have the variables to be measured, and/or has the frequency of measurement changed?

The advent of big technologies paradigmatically altered what can be done with data. The ensuing question focuses on what is needed, economically desirable, and informative for management and other entity stakeholders.

#### Has the objective of accounting changed?

Since Pacioli (1514), the nature of the business production process has substantially evolved. In general, the corporate format and the more recent consolidated and “chained corporate organizations” (Figure 1) structures have brought increasing opacity, but the basic measurement objective has not changed. The small business owner/manager strives progressively to be positioned to respond to the requirements of a complex society where taxation and compliance must be performed.

In order to manage, it is necessary to measure. With the progressive increase in complexity of organizations and their exponentially expanding data stores, improved algorithms and data access processes can be made available. Figure 1, for example, presents the Enron structure of special purpose entities (SPEs). Although there has been some curtailment in usage of SPEs, they remain commonplace in banking and financial institution structures. In this context, simple addition algorithms (such as consolidation rules) are not useful. Vasarhelyi, Kogan and Alles (2002) argue that continuous audit and monitoring could have attenuated the Enron measurement problems. In general it can be argued that if access to a separate entity data is granted, a better understanding of the individual components and the aggregate value can be derived. However, corporate data stores will have information about many of these entities and could be drilled down for additional information. It is difficult to conceive generic accounting rules that would make this and other complex structures comparable at the aggregate level.

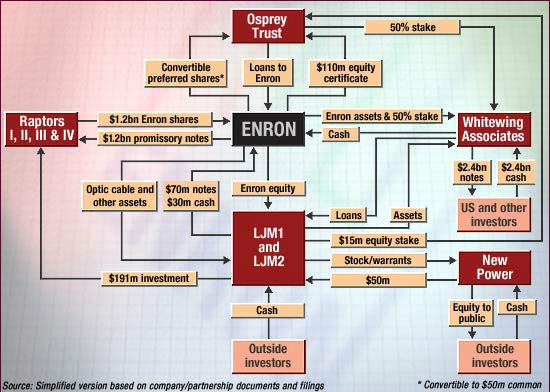


Figure 1: Intricate organizational structure[[3]](#footnote-3)

#### Has the locus of accounting measurement changed?

Traditionally, transactions and events are recorded when physically realized. However, the most interesting parts of economic activity have already occurred by the time a transaction is booked (McCarthy, 1982; Vasarhelyi et al., 2012). The ability to estimate economic activity and monitor its realization has progressively emerged. Figure 2 symbolically describes a set of business processes wherein the recognition of a transaction will be performed once it is completed. However, substantive additional information can be provided if these are linked to contractual obligations that drive the transaction, provisions that limit or facilitate the transaction, returns that negate the event, or supporting activities (such as technical support) that maintain the transaction. Furthermore, predictive analytics (Schmueli and Kopius, 2010; Guazzelli, Stathatos, & Zeller, 2009) could allow for activity measurement on a more proactive basis.

This set of contingent / interlinked measures can be performed with a combination of extensive data storage, real-time measurement, continuity analytics (Kogan et al, 2013), statistical estimation, predictive analytics, and other methods. These new measurements would add to the accuracy of the system, but would also increase its complexity. Overall, the cost of storage and processing is decreasing and the quality of models is progressively improving such that the deployment of highly sophisticated business systems and analytics is increasingly becoming more feasible.

Although not as complex or precise as financial measures, ERPs have progressively improved the scope of business measurement by expanding into the non-financial domain. These systems go to the transaction level, record incipient events, and cover a wide range of “intangible” processes such as human resources, intellectual property, supply chain, and so forth. Corporate measurement and reporting became bipolar with rich and plentiful internal reporting at one end of the spectrum, and a limited, anachronistic set of corporate reporting structures for external reporting at the other end.

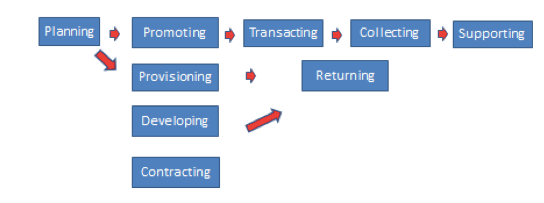


Figure 2: Locus of Measurement

The generic concept of probabilistic reporting (Daily, 1971) has been in the literature for many decades. The argument is that accounting numbers convey a sense of exactitude that is misleading, and suggests that better estimates would ensue with a probabilistic approach. The counter-argument is that the public and accountants cannot deal effectively with estimates. Although these discussions reflect reality, ERPs progressively incorporate an increasing number of analytics that rely upon estimations.

#### Have the variables to be measured changed?

Big data (Moffitt and Vasarhelyi, 2013) and its cloud hosting merge structured ERPs with a multitude of unstructured data. Furthermore, new sources of data such as social media, RFID[[4]](#footnote-4), GPS, e-mail, and others are of value to many business processes and can be aggregated or linked to accounting variables. While some data (social networks, e-mail, etc) are human activated, others (RFID, GPS, IoT[[5]](#footnote-5) etc) are automatically generated. The actual generation, time tagging, and other variable interaction, also provide informational metadata. For example (Figure 3), a car dealer places RFID in its inventory of cars. In doing so, it agrees with the manufacturer to have the tags attached at inception of the manufacturing process. In addition, the dealer uses locational devices in order to track each auto geographically. Consequently, at any time the dealer will know the location of the car and thus infer its status (sold, not sold)

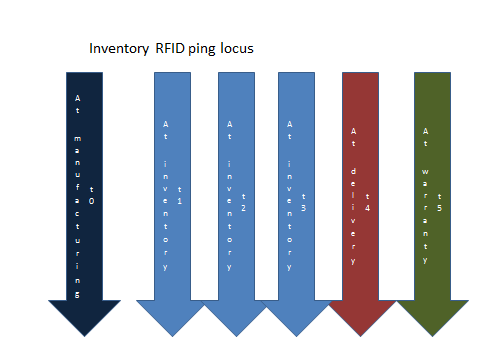


Figure 3: Inventory RFID identification, timing, and state of the world

This locational tracking system can be associated with e-mail and web access data collection that would indicate other vehicle status information, such as customer intention to buy an item, negotiation, and, potentially, a transaction. Prior probability distributions, text mining of e-mails, and click path analysis of Web visitors would add to analytic knowledge of the process stream to the point that reasonable estimates of sales could be made on a predictive basis. A feedback loop with the marketing department may facilitate modification of these predictions as a consequence of management’s remedial actions.

Deeper in the sales cycle (Figure 2), returns, support, and collections could be estimated and included as modifiers in a more complete analytical value estimation model. These operational events could be linked and cross analyzed with the traditional corporate accounting system.

#### Has the frequency of measurement changed?

Progressively, the world is turning to a real time economy (Economist, 2001; Vasarhelyi, Alles, & Williams, 2010), where every attempt is made to reduce latencies within and between processes. If processes experience diminished latencies, then costs of capital are likewise reduced, conferring competitive advantage.

Most ERP systems have some variables that approximate real time measurements. Cash, receivables, payables, and JIT related inventory must be maintained on a timely basis for the company to operate. Traditional financial reporting contains both “level” variables, measured at a point in time (assets, liabilities, equity) and “flow” variables (revenues, expenses, income, etc.) measured during a period of time. Modern systems may measure level attributes at any time on demand, and flow variables at any interval, although some common baseline period may be desirable to maintain comparability.

Until recently, reporting systems have been systematic with fixed timing for reporting purposes. Most current business software packages have a large component of “on demand” ready-made reports that are available to management on a per need basis. The main technical frequency limitation relates to time granularity of base data. On the other hand, statutory accounting rules create a dated, infrequent, and rigid report. This is very different from *online real time reporting*, *on demand reporting*, and *selective content reporting,* and will be further discussed later.

Over the next few years, the locus and method of data capture, variables being collected, analytic information being incorporated, and frequency of reporting will experience paradigmatic shift. However, the pace and adoption of these changes in external reporting is difficult to predict, due mainly to the rigidity of regulatory mechanisms and the strong aversion to usable disclosure accountability by organizations.

### Data Analysis

Accounting entails substantive **data analysis**: Have new data analysis techniques affected accounting practice? Will the emerging analytical approaches modify the nature of accountants’ work?

##### ***New Analytical Techniques***

Because accounting aims to provide useful information to economic decision makers (FASB, 1980), numerous accounting research efforts have been devoted to applying analytical methods to business data to assist both internal (managers and employees) and external (investors, customer, government, etc.) stakeholders in making various economic decisions, such as budgeting, costing, investment, and purchase. The application of data analysis techniques in accounting pervades every accounting subsection, including managerial accounting (Kaplan, 1984), financial accounting (Verrecchia, 1982), and auditing (Biggs et al., 1988). Traditional approaches of evaluating business data include financial ratio analysis (Beaver, 1966) in addition to conventional statistical methods, such as regression analysis, linear and nonlinear programming, probability theory, and decision theory (Salazar and Sen, 1968; Deakin, 1972, Stringer, 1975; Kinney, 1978). These technologies intend to provide indicators to fairly reflect an organization’s current financial situation and/or predict its future based on historical information.

In the emerging big data environment, traditional data analysis technologies prove inadequate. Therefore modern data evaluation technologies, such as data mining (Chang et al., 1999; Chen and Du, 2009) and text mining (Kloptchenko et al, 2004), have been utilized. These contemporary data analysis technologies can not only improve the accuracy of prediction results, but also expand analysis scope to include both structured data (e.g. numeric financial information), and unstructured data (e.g. textual information). This expansion of scope enables accountants to incorporate new information sources, such as newspapers and social media posts, in analytical process, affording decision makers more comprehensive insight into an organization’s financial situation (Vasarhelyi and Moffitt, 2013).

Accounting researchers also attempt to apply artificial intelligence techniques, such as expert systems, to build decision aids that can emulate human learning and decision-making processes, and ultimately provide advice for decision makers (Gal and Steinbart, 1987). These systems make choices based on formalized processes, and, therefore, provide objective guidance. However, the extent to which decision makers should rely on these aids is a controversial issue. In some circumstances, decision aids may generate biased choices because of unexpected events. Wheeler et al., (2014) investigate how individuals react when they realize that the decision aids being used are biased and that they need to accordingly adjust their decision processes. The authors find that, in such circumstances, individuals are reluctant to make adjustments to biased decisions. This finding suggests that accountants should reconsider the methods of developing, testing, and improving accounting decision aids.

Data analysis technologies bring even more challenges to auditors. For example, modern data analysis technologies, along with the digitization of business information, enable auditors to analyze the entire population of transactions, rendering some traditional audit procedures (e.g. sampling) obsolete. In today’s big data environment, the application of sophisticated data analysis routines may still result in a large number of abnormal transactions that require substantive investigation. To control audit cost and timing, some research efforts (Issa, 2013) have been devoted to prioritizing these abnormal transactions. In this issue, Kim and Kogan (2014) propose a multi-step fraud detection model that screens transactions at various levels, leading to a manageable number of events to be investigated. To that end, a broad screening criterion is applied at the highest level of abstraction, while more detailed criteria are used at the lowest level.

With the assistance of these advanced data analysis technologies, the role of the accountant is changed from manual calculation and manipulation of transaction data to the selection of preferable techniques for automatic selection and analysis of business data. Based upon this, the future skill set requirements for accountants will include, among other things, proficiency in the usage of sophisticated data analysis techniques.

***New Analytical approach***

To cope with real-time reporting requirements, organizations will need automated assurance capabilities, such as continuous monitoring of business processes, to assist with ensuring the accuracy of financial statements. In these circumstances, human interventions would only be needed when exceptional transactions are identified. This would require that embedded audit tests are able to identify both known and unknown risks. However, current control and monitoring mechanisms used in auditing only focus on validating predefined audit objectives. This data analysis approach, called confirmatory data analysis (**CDA**) (Tukey, 1977), doesn’t accommodate today’s quickly changing business environment, wherein new risks emerge in an ongoing manner. To identify new and emerging risk areas, auditors can apply exploratory data analysis (**EDA**) (Tukey, 1977). This approach investigates data groups in an effort to detect abnormal trends or hidden patterns, thus identifying unrecognized risks and anomalies. .

Combining CDA and EDA would allow auditors to simultaneously verify existing audit objectives and explore other risks that emerge subsequent to formulation of the initial audit plan. Newly identified risks can be added as new audit objectives and directly tested in the next audit cycle. Liu (2014) proposes a framework to systematically incorporate CDA and EDA in audit tests, and provides a demonstrative real data case study. This integrated approach can continuously improve audit quality and efficiency.

Accountants can also benefit from EDA. For example, applying EDA to sales data enables accountants to identify emerging business opportunities. Also, by using EDA in cost data, accountants can detect hidden trends in expense history, thus assisting managers with expense control initiatives.

Many data analysis techniques, such as clustering and social network analysis, can serve exploratory purposes. Some of these techniques have been proposed as audit tools (Kirkos et al., 2007; Alles et al, 2009; Phua et al., 2010; Jans et al., 2011, Thiprungsri and Vasarhelyi, 2011). However, the accounting literature is sparse relative to the use of EDA. Possible future research areas include demonstrating the benefits of EDA to accountants, exploring the application of EDA techniques in various accounting cycles, and integrating EDA into continuous auditing systems. Furthermore, issues concerning formalization of EDA technology within automated systems are largely not examined, suggesting that further research in this area is necessary.

Another novel analytical approach, the predictive audit, could fundamentally change the audit approach from detective to preventive (Kuenkaikaew, 2013). In the preventive audit, auditors can estimate a transaction’s future status by analyzing its current features. Based on estimation, auditors can reject potentially problematic transactions, thus reducing risk. The predictive audit is also an emerging research area. Several research questions, such as how to apply this method in various auditing scenarios and how it will affect other audit procedures, need to be addressed.

In summary, the application of sophisticated data analysis technologies can significantly improve the productivity of accounting practitioners. In this context, several traditional, labor-intensive procedures become obsolete, thereby improving efficiency. Also, emerging data evaluation techniques can expand the scope of accounting service offerings to include an array of both financial and non-financial services. Finally, the nature of accounting work can be fundamentally changed through implementation of exploratory and predictive data analysis approaches.

### Reporting

Accounting ultimately is delivered through **reporting**: How will information be delivered? Who will be the recipients? How will disseminated information be used?

#### Delivery

Technology is available for on-demand, ready-made reports for management, with detailed segment reporting that is able to be disaggregated to the transaction level if necessary. As mentioned above, the main technical frequency limitation relates to the time granularity of base data.

Furthermore, as much of management intervention could occur on the basis of alerts, it would be of little cost to provide similar alerts to corporate stakeholders. Statutory accounting rules create a dated, infrequent, and rigid report. These are very far from alternative reporting approaches. Online real time (continuous) reporting would allow for a constantly updated set of accounting statements. Also, on demand reporting would facilitate discretionary extraction of pre-set reports, and selective content reporting would allow for tailor made reports focused on the needs of generic or specific stakeholders. Several of these types of reports are now available internally to leading organizations.

The economy is on the verge of having the Internet of Things (Atzori et al., 2010, Kopetz, 2011), where Internet enabled devices will exchange information for providing utilitarian functionalities. The only hindrances to accounting data joining this wave are standards, regulation, and corporate reluctance to disclosure. Accounting devices could communicate with manufacturing devices to control production, drive effort in collections, choose Web interfaces, redirect customer support, or automatically purchase raw materials. These devices could also identify abnormalities, auto correct errors (Kogan et al, 2013), and drive auditor activities (Issa, 2013). All of these functionalities would encompass some form of automatic delivery and acquisition of information.

#### Recipients

The current disclosure model is theoretically “one size fits all”, and XBRL has demonstrated the ease of data transmission. Still, there are many types of disclosures that fall outside this domain. Insurance companies, governments, banks, and others receive special statutory or economic reports, often containing parallel and unnecessary information. Some governments have developed standardized reporting[[6]](#footnote-6) to decrease inefficiency. With modern technology, the cost of creating parallel repetitive reports is small, but the capture of disperse and uncommon information, often outside the information structures of companies, is large.

In a more advanced setting, companies could be required to open their databases to stakeholders with a set of tailored reports that could be drawn with variable time frames and with differing account structures. These could also have some protection measures in place (Gal, 2008) for confidential information (e.g. vendors, clients, and salaries) through controlled aggregate disclosure a la US Census.

#### Usage

Usage in the 21st century will focus on automated exception reporting and sophisticated business models for valuation. For efficiency, models would be developed that feed into automated trading, analyst reports, and the concerns of stakeholders such as investors, suppliers, clients, banks, insurance companies, and the government. If detailed transaction and line of business information is not made available, usage would not be adequately facilitated, as current accounting variables have low explanatory value for market valuation purposes.

Reporting and delivery will be performed by providing electronic data for access. This data will be accessible / pushed out through either some XML derivative (e.g. XBRL) form or the provisioning of easy access databases. There will be demand for keys that link this information to unstructured data and rapid access if relevant information is provided. The major recipients would not be individuals, but partnering analytic devices that will constantly scan the sources of information in some form of machine to machine interaction. By contrast, humans will be primarily occupied with discrepancy resolution and the construction of new analytic models.

### Conclusions

This editorial examined a set of major questions relative to AIS research, including accounting data, information processing, business measurement, data analysis, and reporting. It concluded that, with increasing accessibility of *accounting data*, a substantive increase in attention to security and privacy issues will permeate the accounting world. In *information processing*, many unintended consequences will occur. The nature of data processing will go towards massive block automation with accountants focusing on exception treatment and model development. A plethora of feed forward effects are anticipated.

The locus and method of data capture, variables being collected, analytic information being incorporated, and frequency of reporting will undergo paradigmatic change, thus altering the method of business *measurement*. The pace and adoption of these changes in external reporting is unpredictable due primarily to the rigidity of regulatory mechanisms and the strong aversion to usable accountability and disclosure by organizations.

The application of sophisticated *data analysis* technologies will bring great efficiency and support to accounting work and render some traditional procedures obsolete. Accountants will be able to expand service scope from financial to non-financial process measurement by using emerging data analysis technologies. The implementation of exploratory and predictive data analysis approaches will bring fundamental changes to the work of the accountant as well.

*Reporting* will change by benefiting from big data, machine to machine communications, emerging analytic tools, and an increasing symbiosis between man and machine.

These inferences in relation to the big questions assume a world of great change as described in Figure 4, where the cloud and big data create a different context to be progressively utilized by the AIS environment.

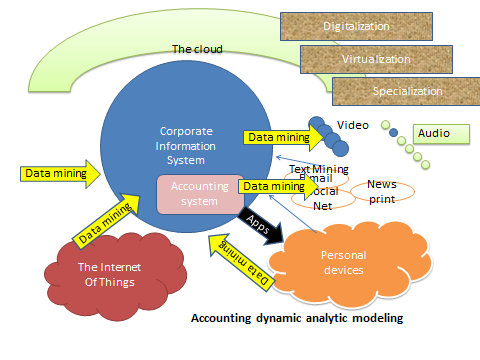
.

Figure 4: The evolutionary environment

In this environment, there is progressive integration of accounting measurement with business technologies that are changing archival measurement to predictive measurement, and using these models to drive exception reporting as well as machine to machine information provisioning. Ultimately, socio-technical system adaptation is the major resistance force to the evolution of AIS. Social systems, often through anachronistic regulation, are very resistant to change and the progress of business processes. These may however, provide the necessary time for the human element to adapt to the new environment.

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1. The authors are appreciative for the comments and suggestions of Profs. Michael Alles, Paul Eric Byrnes and J.P. Krahel. [↑](#footnote-ref-1)
2. “Technology consulting opportunities for accounting professionals will increase. Data management, compliance, security, and privacy consulting opportunities will be particularly strong.” (Intuit, 2013) [↑](#footnote-ref-2)
3. De Hass, J. private communication. [↑](#footnote-ref-3)
4. RFID – Radio Frequency Identification (chip), http://en.wikipedia.org/wiki/Radio-frequency\_identification [↑](#footnote-ref-4)
5. IoT (Internet of Things), http://en.wikipedia.org/wiki/Internet\_of\_Things. [↑](#footnote-ref-5)
6. For example. The Netherlands has developed a standardized reporting effort (Burg et al., 2007)) [↑](#footnote-ref-6)