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Editorial:
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Commentary:
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Research Paper:
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The International Journal of Computer Auditing(IJCA) is the official journal of the International Computer Auditing Education Association.(ICAEA) The journal aims to provide a multidisciplinary platform for the advancement of knowledge in the areas of computer auditing. Due to the advance in information technology and the high demand of analytics skills of accounting major students, universities are under the pressure to help students better prepare for the ever changing accounting profession. The increasing need brings challenges to the recruiting of domain expert professors, to the design or redesign of programs, to the development of courses, among others.

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INTERNATIONAL JOURNAL OF COMPUTER AUDITING
Editorial

Computer Auditing: The Way Forward

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Welcome to the International Journal of Computer Auditing (IJCA), which is sponsored by the International Computer Auditing Education Association (ICAEA). We are very excited to see the launch of this journal. It is our great honor to serve as the first editors-in-chief.

We broadly define computer auditing as any audit practices that may rely on information technology (IT). Such skill has long been argued and considered to be an important capability for both external and internal auditors for more than two decades though its applications were relatively limited in the past. In recent years, with the advance of information technology, what auditors can achieve with IT has dramatically changed. For example, auditors are now be able to perform both descriptive and predictive analyses, process both numeric and textual data, and apply such capability from assertion testing to compliance and risk assessments. This evolving capability has also brought the new term "audit analytics" to practices. Specifically, analytics focuses more on the business decisions and processes while the traditional computer auditing is mainly about audit. This improved capability and expanded scope have attracted a lot of attention with a wide range of applications. For instance, the PCAOB's new strategic plan (PCAOB 2018) has highlighted that "[i]nnovations in data analytics and technology have great potential to improve the efficiency and effectiveness of financial reporting and the audit process" (p.9). Audit firms and internal audit functions have also engaged in the development and the use of analytics in external and internal audit processes (e.g., Forbes 2018; Deloitte 2016; KPMG 2016), which have potentially changed the role of internal auditors to internal consultants.

Despite of its importance, a search of keywords including "computer auditing," "computer assisted auditing techniques," "CAATs," "audit analytics," "continuous auditing," "robotics," "audit innovation," and "audit automation," in the major accounting journals in the past 20 years, from 1997 to 2018, suggest that studies in this field in major accounting journals are very limited though there seems to be an increasing trend in recent years. These journals are *The Accounting*

Review, Contemporary Accounting Research, Journal of Accounting Research, Journal of Accounting and Economics, Accounting, Organizations and Society, Review of Accounting Studies, Journal of Information Systems, International Journal of Accounting Information Systems, Journal of Emerging Technologies in Accounting, Behavioral Research in Accounting, Journal of Accounting and Public Policy, and Auditing: A Journal of Practice and Theory. These studies cover a wide range of topics such as solutions (e.g, Perols et al. 2016; Cleary and Thibodeau 2005), potential research directions (e.g., Wang and Cuthbertson 2014), conceptual or framework, (e.g., Moffit et al. 2018; Kogan et al. 1999), teaching resources (e.g., Weidenmier and Herron 2011), and determinants or consequences (e.g., Dowling 2009; Janvrin et al. 2009; Dowling and Leech 2014; Rikhardsson and Dull 2016; Vasarhelyi et al. 2012). This limited understanding gives us opportunities to contribute to the development of this field and to provide more implications for professionals, regulators, and educators. Possible future research directions are, but not limit to,

(1) Adoption: First, it is still not clear what tool, e.g., analytics, artificial intelligence, data mining, etc., has been adopted for different business units (i.e., audit, tax, advisory services) or for different tasks. There are some higher-level descriptions but a more detailed understanding can at least set the stage for future works. Second, the adoption processes by audit firms or audit functions are valuable to be documented, which provide insightful information to provide practical implications or a theoretical process model for future audit innovation implementations. Last, the challenges and the corresponding technical solutions are also helpful for future studies.

(2) Solutions: studies can provide solutions and proof of concepts for auditor teams to further leverage the capability and can reduce the burden of adoption.

(3) Audit quality: it has been discussed that the use of these new techniques may help auditors focus more on judgement and assessment issues, which would improve audit quality. However, given the challenging processes to adopt such techniques due to talent and cultural issues, can it really improve audit quality is still an open question.

(4) Robotic process automation, artificial intelligence, and emerging issues: we have started to observe the proposition and the use of robotic process automation and artificial intelligence. However, how can these tools be used in the audit context and what are the corresponding impacts? Furthermore, there have been a wide range of emerging issues that can bring challenges to the field, such as drone, blockchain, fintech, regtech, etc. The interactions between these emerging issues and computer auditing worth investigating in order to provide insightful implications for professionals and regulators.

(5) Teaching materials or instructor training materials: Talent has been identified to be one of the critical factors that limit a wider adoption of these capabilities. It can be our joint efforts to develop instructor training materials and teaching materials to

In light of this trend and the challenges brought by big data and emerging technologies, this journal aims to provide an outlet to support and to advance our knowledge in this field. We welcome studies with different methodologies and from either a theoretical or practical perspective. We look forward to receiving your submissions, suggestions and services. Thank you all in advance.

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INTERNATIONAL JOURNAL OF COMPUTER AUDITING

Invited article: Commentary

Big Data: Ideology vs. Enlightenment

Hartmut Will[1,2]

"Big Data" is a technological term with a seemingly cognitive connotation that masks an ideological orientation of those attempting to be benevolently, criminally of even "innocently" in control of our knowledge and subsequent actions. Without an epistemological foundation "small" and especially "big" data are a myth. When "the truth" becomes "what's on a digital screen" under the control of those in charge of "the cloud" we are clouding our cultural heritage voluntarily to an extent that exposes us to the whims of those screening and displaying our data even in so-called "post-truth" fashion. Subsequent information and knowledge cannot be critically and rationally assessed for lack of evidence. All lessons learned during the last four centuries of enlightening efforts seem to be forgotten or ignored by us. Our preference for "cognitive ease" can be easily abused by those in control of modern information technology. We remain in "self-imposed immaturity" (Kant) while they can act primarily for their own economic, political, and social benefits and may even feel "justified" by the big-data-ideology. Knowledge must remain relevant to, testable and rationally believable by the legitimate recipients of any public data and information. An enlightened framework for data governance is overdue in the "digital big data age!"

KEYWORDS

Audit theory,big data, data governance, information systems theory

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Aude! (Dare to know!)

Horace, quoted by Immanuel Kant

Men must think for themselves.

Charles Sanders Peirce

1 | INTRODUCTION

"Big Data" is a technological term with a seemingly cognitive connotation that masks an ideological orientation of those attempting to be benevolently, criminally or even "innocently" in control of our knowledge and subsequent actions. Without an epistemological foundation "small" and especially "big" data are a myth. When "the truth" becomes "what's on a digital screen" under the control of those in charge of "the cloud" we may be clouding our cultural heritage voluntarily to an extent that exposes us to the whims of those screening our data in so-called "post-truth" (David Roberts) fashion. Subsequent information and knowledge cannot be critically and rationally assessed for lack of evidence.

All lessons learned during the last four centuries of enlightening efforts seem to be forgotten or ignored by us. Our preference for "cognitive ease" (Kahneman) can be abused by those in control of modern information technology. We remain in "self-imposed immaturity" (Kant) while they can act primarily for their own economic, political, and social benefits and may even feel "justified" by the "big-data-ideology.'

> Ideology is defined as "the body of doctrine, myth, belief, etc., that guides an individual, social movement, institution, class, or large group… and such a body of doctrine, myth, etc., with reference to some political and social plan, as that of fascism, along with the devices for putting it into operation." (Google)

To unmask the big-data-ideology requires a review of information systems concepts as we have known them for at least 25 years: Observations are not yet data; data are not yet information; information is not yet knowledge; and wisdom is still something quite different.

Figure 1 illustrates the relationships between these concepts and constructs as part of an information systems paradigm within a frame of reference or knowledge context. (Will 2000, Fetzer 2000) as a cognitive data-to-knowledge hierarchy.

If we limit our understanding of reality *(r-world)* to digital monitoring, coding, processing and display of data and to their algorithmic manipulation by means of modern computer technology then we may be trapped in our own digitized myths *(e-world)* without concern for and reference to contexts, ethics, privacy, rationality, security, transparency and truth. Therefore, this framework needs to be extended into its meta-dimensions, i.e., *beyond* observations, data, information, and knowledge to provide the respective knowledge context for these intellectual efforts as illustrated in Figure 2. (Will 2000, 2006).

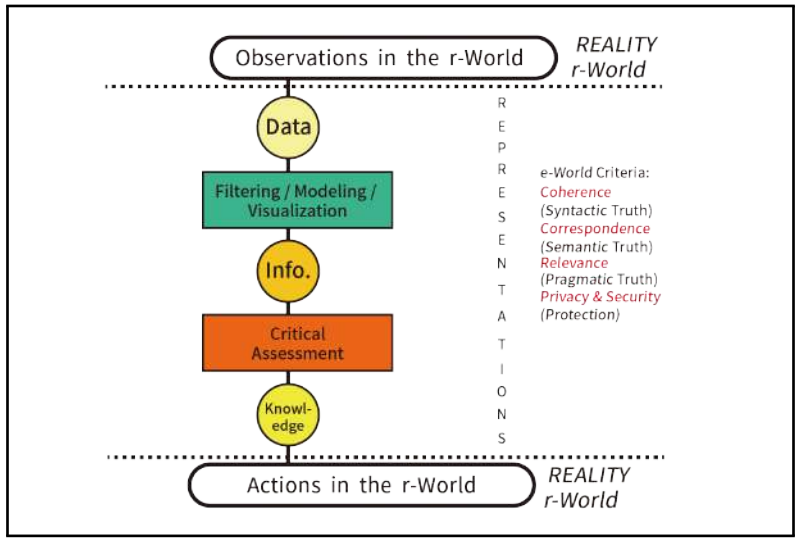


FIGURE 1 Information Systems Paradigm

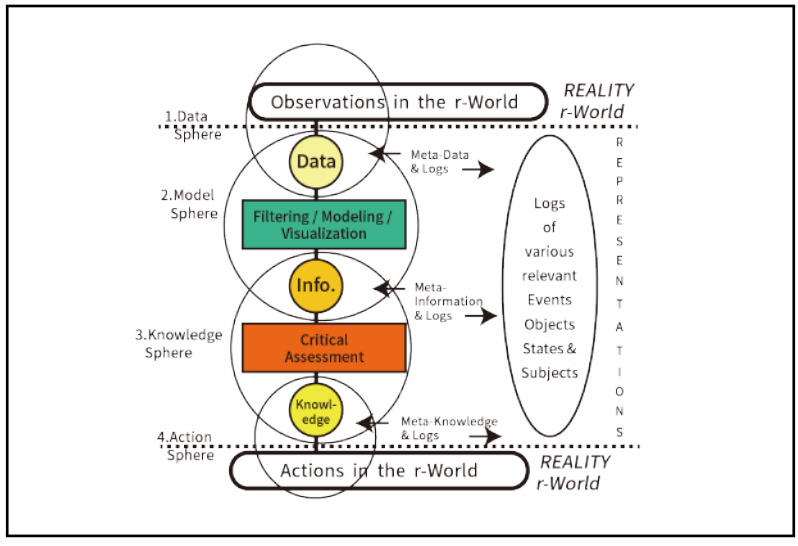


FIGURE 2 Information Systems Concepts and Constructs

Logs represent evidence about the kinds of data processing, information processing and knowledge processing performed within a specific frame of reference. They facilitate assessments and critical re-assessments of any procedures applied. While we make observations with our senses, controlled by our brains and minds, pre-programmed electronic sensors of various kinds may measure and monitor selected aspects of reality while missing others which attentive and critical observers would notice. Not only the collected data need to be understood (or ignored) in their respective context, but any further processing with algorithms and models must also make sense and be explainable to the recipients of derived and displayed information. To process data without an enlightened attitude misses our cultural and intellectual heritage since the enlightenment, defined broadly as

> a European intellectual movement of the late 17th and 18th centuries emphasizing reason and individualism rather than tradition. It was heavily influenced by 17th-century philosophers such as Descartes, Locke, and Newton, and its prominent exponents include Kant, Goethe, Voltaire, Rousseau, and Adam Smith (Wikipedia).

More enlightening and profound is Immanuel Kant's famous definition:

> *Enlightenment is man's emergence from his self-imposed immaturity. Immaturity* is the inability to use one's understanding without guidance from another. This immaturity is *self-imposed* when its cause lies not in lack of understanding, but in lack of resolve and courage to use it without guidance from another. *Sapere Aude* ! " Have courage to use your own understanding!" – that is the motto of enlightenment. (Kant 1784).

If electronic sensors and monitors are automatically coupled with pre-programmed checks then their programmers are in control rather than any of the affected people. Before the information can be believed it must therefore be possible to assess it rationally and critically in its respective context. How else can it be accepted, ignored or rejected by the recipients on rational grounds? We need accessible meta-data, meta-information and even meta-knowledge (understood as wisdom) and use them courageously, critically, freely, and maturely rather than merely "with cognitive ease."

When the providers of the knowledge elements and objects are different from any of the sign users at each level of the cognitive hierarchy depicted in Figure 1 and 2, then we are faced with potentially conflicting objectives and purposes as illustrated in Figure 3. (Will 2000, 2006) They can only be rationally reconciled with respect to a common understanding of the truth rather than what has recently been called the "post truth." (see below).

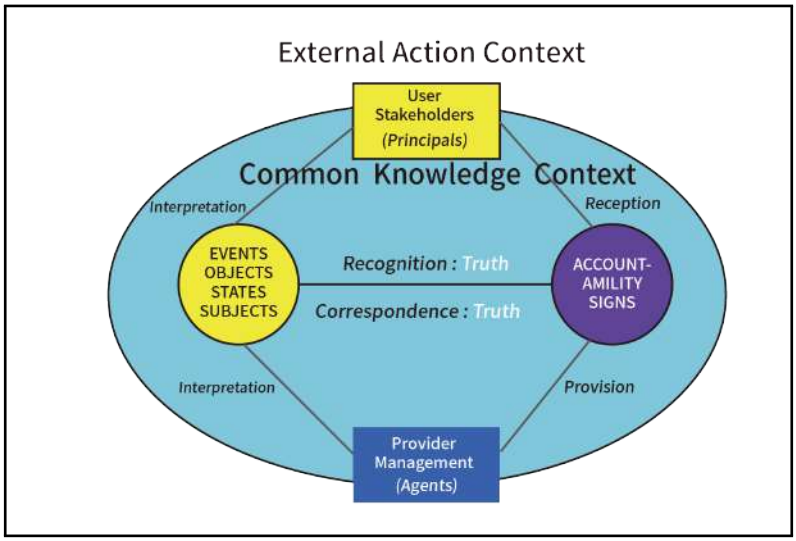


FIGURE 3 Double-Semiotic Perspective

What is processed and displayed as "computer screen reality" at each level in the cognitive hierarchy may not meet the recipients' expectations; may cloud their perceptions and inferences; or may even deliberately mislead them. It is therefore important to distinguish various levels of knowledge, understood as justified belief, to recognize the different degrees of certainty associated with each, and to assess their effect on our actions:

> Knowledge of laws of nature which cannot be violated and cannot be changed, takes predictive primacy over knowledge of relative frequencies that have obtained in the past. When we possess knowledge of single-case propensities, therefore, they ought to determine the values of corresponding degrees of belief for inference and decision. When knowledge of single-case propensities is unavailable, however, then degrees of belief should be determined by beliefs about corresponding relative frequencies. In cases where neither knowledge of single-case propensities nor knowledge of relative frequencies happens to be available, however, then decision making depends upon hypothetical reasoning or educated guesswork, where rationality of action tends to be decoupled from rationality of belief. Actions under conditions of this kind are not only extremely risky but are subject to the influence of psychology and ideology. (Eells and Fetzer (eds.), 2010: xxxiii)

Relying naively or uncritically on anonymous computer screen contents implies self-imposed immaturity and unintelligent action. If there is only one world-view on display without reference to logs backing it up, then not even an independent auditor can provide assurances for lack of evidence. Worse still, providing one's own private data without knowing what is done with it – and even giving up all ownership rights as part of Terms of Service (ToS) agreements - is an abdication of responsibility for the truth about oneself, i.e., for one's own identity! How else would "identity theft" be possible?

When human behavior is automatically monitored and subsequently used to identify or to typify persons for such purposes as exposing them "automatically" to "personalized" news feeds and tailor-made advertising; to fraudulent collection, payment or phony reward schemes; and to other illegitimate and criminal activities, then those in control of the digital screens and their contents can direct the world to their own advantage rather than according to a fair, legal

and negotiated (social) contract. In fact, the lengthy ToS for using various internet services seem to be designed and written to be confusing and incomprehensible for a normal person. They are therefore exploitative rather than "moral" contracts between equal and respecting parties. This way, not only numbers and text, but images and voice recordings and the users' various locations by GPS coordinates are being monitored. Even various rhythms such as gestures, heart beats, key-strokes, voice inflections, and other behavioral attributes can be measured and recorded for (yet) unknown and possibly dubious purposes.

Once these data are openly or surreptitiously collected and stored in special "big-data- formats" in modern computer "memories" and in "the cloud" they become un-accessible, un-erasable and no longer (easily) traceable for the data subjects themselves and for authorized outsiders like auditors as agents of enlightenment. Their data structures and storage structures are hidden below the information structures derived from them and then displayed selectively on computer screens. To question these information contents becomes difficult and is often impossible without accessible meta-data and meta-information and yet, knowledge must remain relevant to, testable and rationally believable by the legitimate recipients of any public data and information. An enlightened framework for data governance is overdue in the "digital big data age!"

2 | OBSERVATIONS, MEASUREMENTS, AND SIGNS

Living observers are always curious with respect to "anything of survival interest" that is noticeable, measurable, pleasurable, satisfying or threatening - even without a formal purpose and specific hypothesis. This may involve recording of the observations or measurements as signs which can be stored for subsequent uses and listened to or read as digitized messages. While our senses allow us to make all kinds of observations that may be relevant to our success or survival, our minds evaluate these findings in their respective context. We may also communicate our insights and exchange ideas about them with others to assess and share our findings critically or even uncritically. The "internet of people" falsely assumes communication between critical intelligent people, possibly supported by artificial intelligence, but it does not guarantee enlightened intelligence! (Fetzer, 1990). To what extent can we depend on guidance from (networks of) other people or even from "networks of things" for enlightenment in various knowledge contexts?

Evidently, Kant's *sapere aude!* does not apply to "things" that we employ or "allow" to guide us and to control our thoughts and actions; however, computer-monitored observations about or measurements of "things" may be evaluated automatically by means of control systems that trigger the execution of programs as single actions or complicated processes, delayed or immediately. This situation is often referred to as "the internet of things" which implies "artificially intelligent" interconnected objects. It would be obviously too daring to rely on such "things" unless all such observations and measurements are identifiable, traceable, understandable and correctible in their respective contexts.

When describing the context and purpose of observations generally as *data signs*, i.e., syntactically, semantically, and pragmatically, we can identify their cognitive effects (awareness, correspondence, purpose); their uses (perception, recognition, interpretation); and their semiotic properties (causation, ground, *interpretant*) as illustrated in Figure 4. (Fetzer 1990, 2000, Will 2006).

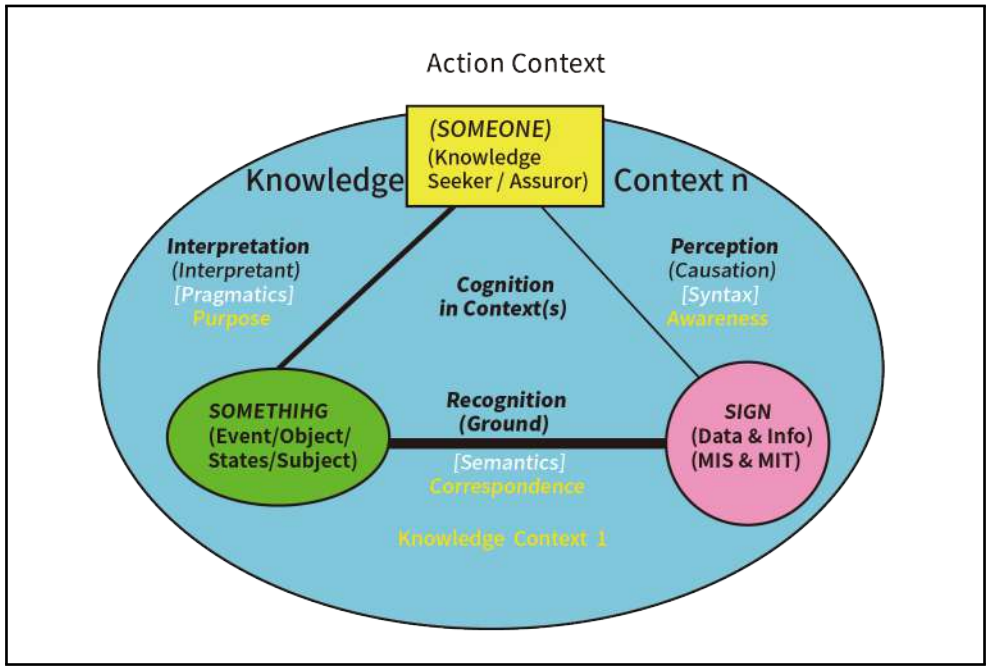


FIGURE 4 The Semiotic Perspective (Detail)

As signs in a semiotic sense data are therefore made up syntactically of symbols of and in a language. They have a meaning in that language which is understood (semantically) by all competent users of that language; and they have a pragmatic purpose beyond their meaning both for the originators and the recipients, although these purposes may be contradictory. It is therefore important to understand the true meaning of data as signs from the perspectives of both their originators and their users and whether they are private and protected, or publicly available and technically accessible.

syntactically correct expression may have different meanings and can therefore be semantically ambiguous at best and false at worst. Similarly, a syntactically and semantically correct expression may be used for legitimate and legal or for illegitimate and illegal purposes. One-sided semiotic depictions of data by their originators need to be avoided since identical data can have different meanings and different purposes for the recipients of the data as illustrated in Figure 5 in an accountability context. (Will 2006, 2015). After all, the recipients of the accountability signs need to have confidence in and ideally trust the provider.

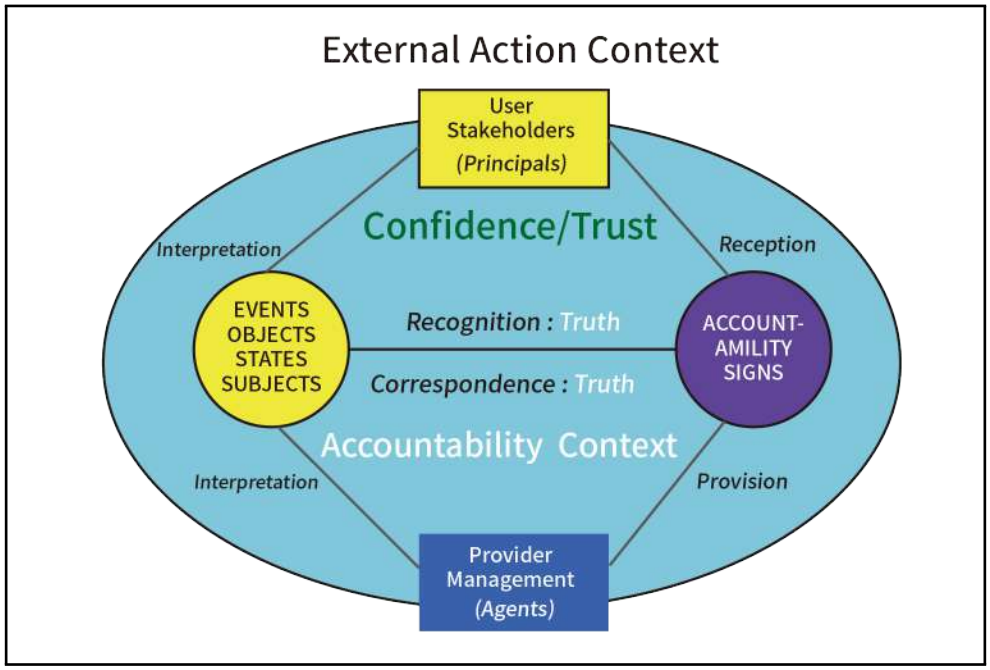


FIGURE 5 Accountability

For example, accounting transactions describe the observed or automatic (pre-programmed) exchange of goods or services for monetary resources between economic agents at specific dates (and times) in specific markets; however, the recorded economic history may be erroneous, incomplete or even deliberately misleading. Syntactically correct "debit" or "credit" entries in the accounts can have different meanings either as actual and true economic transactions or as hypothetical adjustments to the accounts in recognition of depreciation, receivables, shrinkage or theft and various effects on asset and liability values and economic performance. Each adjustment can have different purposes depending on its effect on calculated profit or loss and the expected reactions of the intended recipients of the information. Thus, accounting transaction data need to be (and are commonly) auditable by a third party to determine their linguistic structure, their true meaning and their evident (or hidden) purpose(s) both for the collectors and the recipients of derived information.

3 | DATA AND META-DATA

Evidently, to understand data requires knowledge about their structure (syntax), their meaning (semantics), and their purpose (pragmatics) as illustrated above in Figure 4. Meta-Data are therefore required if anyone but the originator needs or wants to understand the data. For example, accounting data refer to the types of objects traded, produced and inventoried and the corresponding kinds of payments made or received at specific times in various degrees of detail for processing by human accountants or machine accounting programs.

Thus, accountants describe their data by means of formal symbols and references to accounts and ledgers within their double-entry language such as "debits" and corresponding "credits" to be able to trace them and to control their accuracy. The familiar charts of accounts, journals, ledgers, sub-ledgers and trial balance provide structural meta-data in financial accounting. We can therefore understand accounting data as records of real transactions; however, understanding the hypothetical adjustments made by accountants requires meta-data of a different kind, namely about the age and (ab)use of machinery, the shrinking of inventories, the cash collection experience in general and with respect to individual customers, exchange rates of different currencies at various times, market conditions in different markets, etc. Not to recognize these differences in terms of data and meta-data will cloud the derived information that may appear on accountants' screens as their "legally required financial statements." To recognize the difference between bookkeeping and accounting is an enlightening experience.

Critical data reviews are therefore the cognitive foundation of modern auditing of private and public sector financial and tax accounting. Auditors must be able to trace both the transaction data to their real origins and the adjustment data to the assumptions made. The data structures employed must be accessible and understandable, regardless whether operated in manual or electronic modes. (Not too long ago auditors even advocated "auditing around the computer"!) To structure data electronically, various data models have been used to organize small data: linear lists, hierarchic and network structures and relations. All of them are transparent with modern audit software which allows them to be read "in the original," selected and connected in various ways and renamed for more understandable audit logs and reviews (see also www.acl.com).

New methods and technology have provided opportunities to centralize and arrange small data into even more complex data structures, now known as "big data;" however, little consideration seems to be given to their transparency and even less to their auditability and critical review by enlightened persons. Audit technology is, of course, also advancing, but without a commitment to truth (see below) we remain in cognitive limbo about both the *r-world* and the *e-world* (see Figures 1 and 2).

4 | BIG DATA AND LACK OF BIG-META-DATA

The modern term "big data" implies, of course, that there exist also "small data" as we have known and stored them since Babylonian clay tablets, papyrus and paper records, on punch cards and more recently on magnetic tapes, discs, computer chips and now even in "the cloud." So, what is so mythical or even mystical about big data and why do we lack a convincing definition?

Figure 6 is a modification of Figure 2 to illustrate that the data, model, and knowledge spheres are now conflated without reference to any of the respective logs and their meta-features. By offering only provider-designed information screen images without appropriate references, even the knowledge and action contexts are indistinguishable. Preferred action may be immediately suggested to the unenlightened information user. Moreover, without knowledge about the meaning, origin and size of the available or searched data base, such "suggestions" by monopolistic providers may be not only biased in favor of the respective provider, but be deliberately designed to confuse users or to eliminate competition.

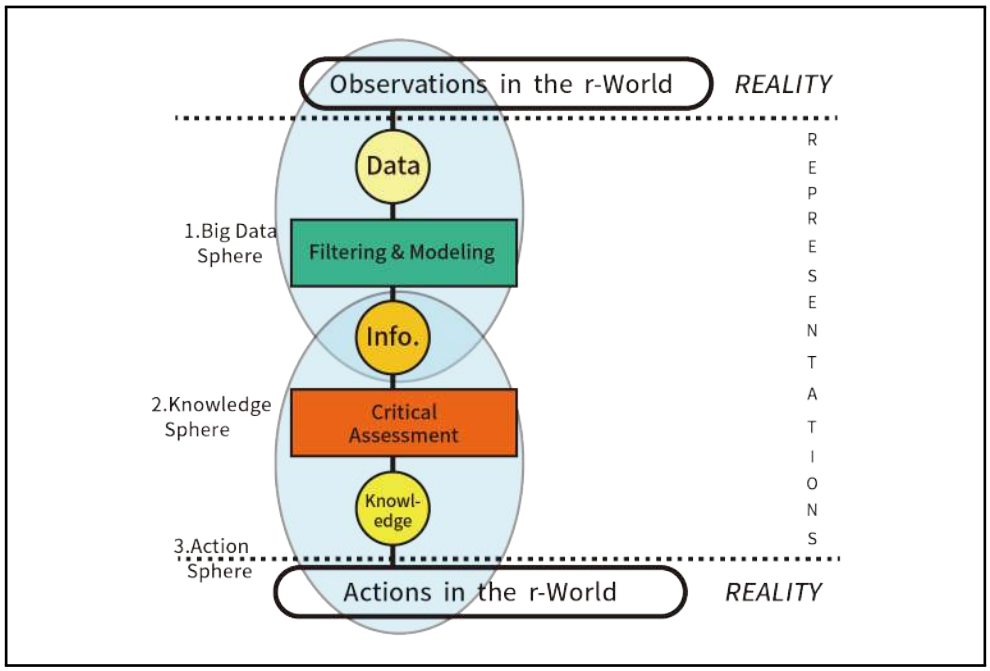


FIGURE 6 Big Data Sphere

The following definitions from Wikipedia allude to the connection between small and big data; however, they are unfortunately neither enlightening nor illuminating:

> Big data can also be defined as "Big data is a large volume unstructured data which cannot be handled by standard database management systems like DBMS, RDBMS or ORDBMS". (Wikipedia)

Such "definitions" of big data conflate the data structural problems of information administration (organizationally) and the storage structural issues of information management (technologically) and side-step the related data processing issues encountered:

> Big data is an all-encompassing term for any collection of data sets so large and complex that it becomes difficult to process using traditional data processing applications. (Wikipedia)

Since when have data processing applications been "difficult to process using traditional data processing applications"? - The IT industry has been constantly evolving and innovative during the last half-century (as some of us can still vividly remember). Are these challenges now more easily overcome by mythical big data analyses?

> The challenges include analysis, capture, curation, search, sharing, storage, transfer, visualization, and privacy violations. The trend to larger data sets is due to the additional information derivable from analysis of a single large set of related data, as compared to separate smaller sets with the same total amount of data, allowing correlations to be found to "spot business trends, prevent diseases, combat crime and so on." (Wikipedia – footnotes omitted).

Another definition of big data from Wikipedia addresses even some of the epistemological issues faced in the modern digitized world; however, as we will see, to no enlightening and intellectual avail:

> "Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization." (Gartner). Additionally, a new V "Veracity" is added by some organizations to describe it. (Wikipedia – Footnotes omitted)

If big data is explained information-technologically as „high volume, high velocity and/or high variety information assets" although one wants to answer epistemological questions such as „enhanced decision-making," „insight discovery," „process optimization" und most recently also „veracity" then we are required to consider, ask, and answer more profound questions such as:

1. Who or what is depicted by the data: animate single or collective subjects or inanimate objects – and what rights are associated with each?
2. Who owns the data?
3. Which features of data subjects or data objects are observed, measured, monitored, collected and stored why, by whom, how, when and where?
4. How are the data structured, and are these structures standardized and publicized for critical audit, review, security, and transparency purposes?
5. Who uses the data for what purposes, how, where and when?
6. How are the data protected against abuse, misuse and illegal access?
7. Do necessary and sufficient legal rights and obligations exist for data or are new ones needed to guide and protect owners, users and auditors?
8. What would a data governance regime look like and how might it work?

Answers to these questions would not only demystify and demythologize the big-data-ideology as a possibly grandiose IT scam, but also provide the basis for an overdue comprehensive and enlightened data governance framework. (Hua 2013). Another attempt to distinguish the concepts of "big data" and "business intelligence" with respect to statistical methodology matches and mixes different cognitive categories – an epistemologically inadmissible method:

> If Gartner's definition (the 3Vs) is still widely used, the growing maturity of the concept fosters a more sound difference between big data and Business Intelligence, regarding data and their use:
>
> - Business Intelligence uses descriptive statistics with data with high information density to measure things, detect trends etc.;
> - Big data uses inductive statistics and concepts from nonlinear system identification to infer laws (regressions, nonlinear relationships, and causal effects) from large sets of data with low information density to reveal relationships, dependencies and perform predictions of outcomes and behaviors. (Wikipedia – Footnotes omitted).

As we all know, even descriptive statistics are inductive; statistical laws are not laws of nature that cannot be violated (although many statisticians seem to believe in their equivalence); correlations are not causations; and clusters may improve „information density," but they do not represent single-case propensities to improve on relative frequencies that where observable in the past.

„Revelation of relationships and dependencies" is based on specific purposes such as advertising and marketing to specific types of persons who belong to various clusters such as „people, who are most likely to be African American or Hispanic, working parents of teenage kids, and lower middle class and shop at discount stores" or „Caucasian, high-school educated, rural, family oriented, and interested in hunting, fishing and watching NASCA." (Goodman, 2015: 67) – Of course, whether the members of these clusters behave really as expected must be ascertained or audited independently.

„Predictions of outcomes and behaviour" are possible if people in such clusters can be monitored and compared with each other in similar situations such that their behavior becomes predictable according to specific laws of nature (e.g., caused by birth defects, diseases, handicaps, etc.); according to specific propensities (e.g., various kinds of addictions or typical consumer behavior); and with relative frequencies. This means that the more we know about a person's attributes, behavior and possessions in various situations and locations the easier it becomes to predict and control her or his behavior. The data privacy questions have therefore become the central issue.

A whole industry has evolved to condense „free" small data into profitable „proprietary" big data for initial sale to and subsequent marketing by data brokers for profit:

> The goal of Acxiom and other data brokers is to provide what is alternatively called „behavioral targeting," „predictive targeting," or „premium proprietary insights" on you and your life. In plain English this means understanding you with extreme precision so that data brokers can sell the information they aggregate at the highest price to advertisers, marketers, and other companies for their decision-making purposes. (Goodman, 2015: 67)

Big data have also been circumscribed (self-servingly?) as both a major information-technological "challenge" and a privacy concern by Eric Schmidt, Executive Chairman of Google, and one of the most powerful and successful entrepreneurial information technocrats from Silicon Valley:

> This is the „big data" challenge that government bodies and other institutions around the world are facing: How can intelligence agencies, military divisions and law enforcement integrate all of their digital databases into a centralized structure so that the right dots can be connected without violating citizens' privacy? (Schmidt and Cohen, 2014:174)

Notice that creating one or more centralized and integrated super-data-structures for „intelligence agencies, military divisions and law enforcement" bureaucracies does not necessarily protect the citizen's privacy without proper and accessible big-meta-data that can be used for legally required audits and compliance tests! (See below)

Interestingly and surprisingly, even someone very much aware of the risks associated with modern information technology and its uses and abuses in the digital age does not define big-data either, but circumscribes it with an almost pious belief in its "promise" and refers to their economic uses uncritically and almost naively as follows:

> The promise of big data is that long-standing complex problems become quantifiable and thus empirically solvable... Across all industries, whether retail, transportation, or pharmaceuticals, there will be tremendous economic value realized as a result of big data, so much so that the World Economic Forum recently dubbed it „the new oil." (Goodman, 2015:85).

The world's "wise" people who met in Davos seem to have overlooked that data – big or small – need to be transformed into information which can serve numerous purposes, some beneficial and some detrimental. Since we can observe more differences between undefined big data and unrefined oils, the analogy does not seem to hold, unless either is viewed as an exploitable resource for those who possess and treat it in a capitalistic sense. Although oil can also be mined (cracked) and refined in various ways, it makes some people enormously rich and others dependent, disadvantaged and poor. The environmental, ethical and social dimensions of the use of these resources remain conveniently ignored by those in control.

One of the most serious issues is the lack of legal, rational and technological control over data collectors such as Facebook, Google, Twitter, and Yahoo and over subsequent data brokers:

> Today's modern data brokers, unlike credit reporting agencies, are almost entirely unregulated by the government. There are no laws, such as the Fair Credit Reporting Act, that require them to safeguard a consumer's privacy, correct any factual errors, or even reveal what information is contained within their systems on you and your family. (Goodman 2015: 68).

Of course, if the users of search engines, social media and various apps give up all rights to their behavioral data (heart beats, measurements, pictures, temperatures, text, voice, and words in various ways) "voluntarily" by signing complicated, lengthy and incomprehensible terms of service agreements (ToS) such as the ones demanded by Google then we may become "transparent" and "objectively" known, but lose practically all control over our own identity:

> When you upload or otherwise submit content to our services, you give Google (and those we work with) a worldwide license to use, host, store, reproduce, modify and create derivative works, such as those resulting from translations, adaptations or other changes and license to communicate, publish, publicly perform, publicly display and distribute such content. (Quoted in Goodman, 2015:59)

Data seem to have lost their value for those who provide them ignorantly, naively, and voluntarily – with the Hippie mentality of "couch surfing" or "sharing everything without protection?" – solely for the convenience of surfing the internet and searching the world- wide web at various levels. By connecting "freely available" small data into centralized and integrated big data sets as targeted information, the collectors of data about our behavior, the data brokers, and their customers have not only become immensely wealthy but also dangerously powerful and uncontrollable. They are the modern oracles – not of the Delphi kind, but of the Silicon Valley variety – and that after centuries of enlightenment efforts: Instead of consulting an "oracle" we are now "googling" the humongous and still ill-defined big data resources for information.

5 | INFORMATION AND META-INFORMATION

A proper understanding of information systems as both a cognitive challenge and a technological construct (way beyond the initial and traditional accounting applications) has led to modern forms of (organizational) data administration, (technological) data management, and sophisticated computer programming of filters and models in terms of algorithms. It is useful to remember the admonition of one of the leading scholars of computer programming and his definition of an algorithm before we fall for a mystical explanation related to big data:

> An algorithm must be seen to be believed, and the best way to learn what an algorithm is all about is to try it… The modern meaning for algorithm is quite similar to that of recipe, process, method, technique, procedure, routine, except that the word "algorithm" connotes something just a little different. Besides merely being a finite set of rules which gives a sequence of operations for solving a specific type of problem, an algorithm has five important features: … Finiteness…Definiteness… Input…Output…Effectiveness. (Knuth, Vol. 1, 1973: 4-9).

When data are aggregated, condensed, filtered or modeled into information structures of less detailed forms, then the semiotic dimensions illustrated in Figures 4 and 5 still apply. Informative signs such as data need to be perceived by someone who is causally and syntactically aware of them in a knowledge context; they are grounded in real or well-defined hypothetical events, objects, states or subjects and recognized as such semantically in languages that represent this correspondence; and they are pragmatically interpreted by an enlightened knowledge seeker for specific purposes.

Big data complicate the issues since we have hardly any meta-big-data available to enlighten us. Not knowing the algorithms used to generate such information profiles as the mentioned clusters for targeting advertising or marketing nor the actual data and meta-data applied ought to make us hesitant to believe the information. Also, not knowing the providers of the information (such as search engine and social network suppliers or data brokers) and their reasons for processing the variously connected and centralized data is no basis for belief in any of it, much less reason for providing even private small data voluntarily. As Goodman suggests, it would be much less risky to pay for the use of such products and services and to protect our privacy and security legally, accountably, and auditably in an enlightened fashion.

Already the annoyance felt when we use the internet and are bombarded with targeted advertising should make us hesitant to share our behavioral data voluntarily on the one hand. On the other hand, "hits" recorded on cluster-based-selected advertisements around an internet user's screen image may not be causally related to purchases; however, as long as the advertisers believe the big-data-mystique, they will continue to pay for the "refined" data, but at our initial "cost" or generous "donation" of the small data.

Although the traditional audit trail details consisting of financial data and relevant meta-data may be still commonly available and relatively easily retraceable, we cannot assume that the information automatically derived from big data is believable as such (knowledge) and provides a rational basis for subsequent action.

> The problem is that we are leading lives fully intermediated by screens and other technologies that, although they give the appearance of transparency, are in fact programmed, controlled, and operated by others. Worse, none of us have a freaking clue as to how any of it works. (Goodman, 2015: 165)

To forget or ignore the knowledge interests of the users of information systems while concentrating on the economic advantages for the providers and those maintaining them administratively and technically means to abdicate our responsibility for critical, enlightened, ethical and rational thinking about the truth associated with information derived from any data and especially un-auditable big data.

6 | KNOWLEDGE AND WISDOM

At least since the classical Greek period in the fourth century B.C. do we know the distinction between Mythos and Logos. Rather than asking the Oracle of Delphi, we now seem to wait for the oracles of Silicon Valley to provide instant answers to our frequently trivial questions; however, while viewing electronic screens filled by algorithmic and digital wonders we may forget to ask enlightened questions.*Where is the Socrates of the digital age? What would be his treatment today?*

When confronted with insights based on big data and displayed on electronic screens we seem to suppress doubts and ignore critical thinking due to our "self-imposed immaturity" (Kant 1784) and preferences for "cognitive ease" (Kahneman 2011). What can be "googled" is seldom sufficiently reflected, as if it were intellectually overwhelming or even superfluous when viewed against the mythical dogma of "overwhelming big-data-evidence:"

> It is as if we have transformed into an "in screen we trust" culture. If something is on a screen, whether it be a computer, iPad, industrial control system, street sign, GPS device, radar installation, or mobile phone, our first inclination is to trust what we see before us. However, we have shown time and time again that everything from our friends on Facebook to the numbers we dial on our mobile phones can be rigged to deceive us. (Goodman, 2015: 165)

We seem to have forgotten to think about knowledge as the result of critical thinking and logical reasoning applied to data and information to assess their relevance, validity and truth.

> If we identify "thinking" with the context of discovery and "reasoning" with the context of justification, then it is indeed correct that logical reasoning is not sufficiently flexible to serve as a foundation for thinking. But it certainly does not follow that logical consistency and deductive closure are therefore properties that are neither available nor desirable within contexts of reasoning in general. (Fetzer, 1990: 231-232)

While we can formulate hypotheses and theories without concern for completeness and consistence, their rational appraisal is dependent on it:

> An expert whose knowledge could not possibly be true because it was inconsistent would not be worth the bother. An expert whose knowledge was consistent but unsupported by the available evidence would hardly be worth utilizing. Perhaps the underlying moral that emerges from this discussion, therefore, that the most important decisions confronting those working in this field [of artificial intelligence] involve determining exactly what "knowledge" is worth presenting. (Fetzer 1990: 232).

To believe information derived from data without sufficient meta-data as evidence to assess their completeness, consistency, relevance and truth would be irrational when modern audit software applied by critical and logical minds

can help quite a bit in analyzing computer-based data and filling gaps of belief (e.g., www.acl.com). To believe information "with cognitive ease" without sufficient meta-information about the algorithmic structures and procedures employed and unable to reproduce them meta-linguistically with the available data as evidence would not only be irrational and unenlightened, but also unwise as an assessment of the results.

Wisdom is the final stage in our depiction of the cognitive data-to-knowledge hierarchy:

> It has been defined as the quality or state of being wise; knowledge of what is true or right coupled with just judgment as to action; sagacity, discernment, or insight. (Google).

It may be wise not to apply logical conclusions derived from big data to action since logical consistency and deductive closure may not be certain. It takes wisdom to see through the big data ideology, to de-mystify and to de-mythologize it sufficiently to create a legal framework analogous to corporate governance incl. financial auditing which can be called data governance (Hua 2013). It may also be wise to give up providing "free" data and information to the various operators of internet services and of the internet of things to protect our personal authenticity, privacy, property, protection and security.

The ultimate irony with respect to big data and modern information technology is the following definition and equation:

> ***Internet + Internet of Things = Wisdom of the Earth.***
> (Wen Jiabao, Chinese Premier, quoted in Goodman, 2014: 259).

7 | AUDIT AND EPISTEMOLOGICAL CHALLENGES

Auditing by third parties, understood as critical analysis of information provided by someone (or some computer system) to someone else as a legitimate user, is only possible if the underlying observations, data and information are properly documented within a frame of reference such as manual or electronic financial accounting and data governance in various fields such as medical and pharmaceutical research treatment, to name just a few. There should not be a secret or tacit disconnect between legitimate suppliers and users of data and derived and displayed information with respect of the truth. Although most accountants can be trusted by the users of their information, historical experience has shown that deception and fraud cannot be excluded in accounting either, although the accounting algorithms and models are "fairly" transparent and accounting data can be traced reliably through such systems. While accounting has a tradition of transparency with respect to real transactions, adjustments made to the data prior to sharing them with others have often been secretly motivated and unexplained with respect to their veracity.

The audit situation is illustrated in Figure 7 in the context of discovery and justification where the audit opinion, understood as true belief and assurance, is derived from accountability signs (see Will 2000, 2006, 2015). For example, in the context of discovery within the financial accounting frame of reference auditors try to identify and to find misrepresented assets, liabilities and net worth or misrepresented revenues, expenses and profit or loss within the "small" data bases. What is contained in the "big data base" is still not officially or publicly known and can therefore be confusing rather than enlightening for those trying to formulate hypotheses to be tested independently.

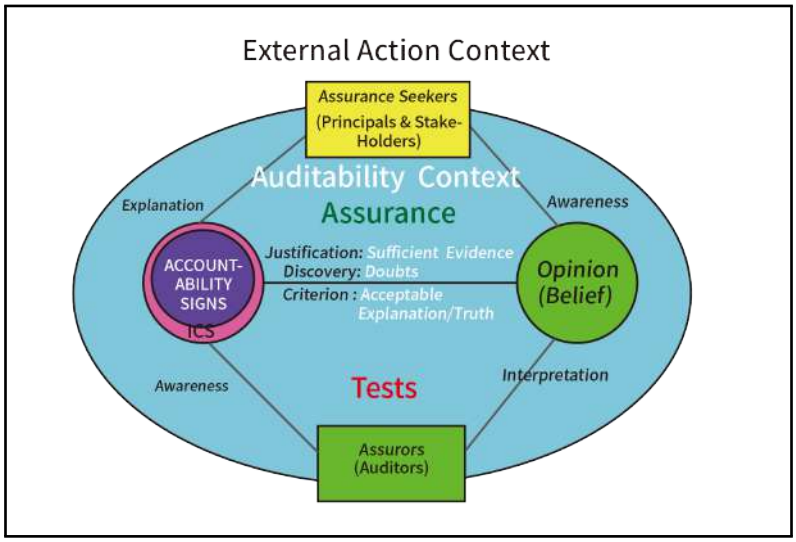


FIGURE 7 Auditability

The context of justification allows us to examine the semiotic (syntactic, semantic and pragmatic) foundations of the small data and to re-compute the accounting information trying to falsify it or to corroborate it when we cannot falsify it. (see Karl Popper 1965, 1968). When there is no frame of reference for the big data; no standard filter, model or algorithm to (re)compute any expected results; and no legal framework to authorize audits by critical thinkers, then no enlightened and independent opinion can be sought and justified.

In contrast to this depiction of the activities of auditors as agents of enlightenment, the "American bible of auditing" defined the nature of auditing by conflating the context of discovery and the context of justification as follows:

> Auditing is analytical, not constructive; it is critical, investigative, concerned with the basis for accounting measurements and assertions. Auditing emphasizes proof, the support of statements and data. Thus auditing has its principal roots, not in accounting which it reviews, but in logic on which it leans heavily for ideas and methods. (Mautz and Sharaf, 1961: 14)

Whereas the financial accounting context is part of a relatively well-defined frame of reference within which auditors can discover violations of the truth and justify their rational assessment of the truth, the *big data frame of reference* remains often a myth because neither the respective contexts of discovery nor the contexts of justification can be (or have been) well enough defined. Moreover, the kind of truth to be pursued – if at all - remains unclear.

Besides the *redundant theory of truth* which acknowledges merely different perspectives on reality – now associated with the so-called *post-truth world* (The Economist 2016) - there exist at least five different theories of truth (as convincing beliefs based on methodological rules). They ought to be known to all enlightened persons to make them cognizant of the dimensions and the kinds of intellectual contributions in any data, information and knowledge context: The *coherence theory*, the *correspondence theory*, the *semantic conception*; the *pragmatic conception*, and the*collective theory of truth*. Each of these are epistemologically explained and their insights can be clearly expressed and demonstrated:

> [The coherence theory of truth] defines „true" as a property of sets of beliefs that are mutually reinforcing (or „hang together") while satisfying conditions of logical consistency (where it is not the case that, for any belief *b* , both *b* and its negation, not- *b*, are accepted at the same time) and of deductive closure (where, if the truth of belief *b1* logically requires the truth of belief *b2*, then *b2* must also be accepted whenever *b1* is accepted). Since one person at two different times and two persons at the same time are entitled to completely different beliefs as long as their beliefs are coherent, the coherence theory does not entail the correspondence theory. [Fetzer and Almeder, 1993: 134]

What seems coherent from a data collector's point of view (such as that of a bookkeeper, scientist or a data administrator) and that of an information provider's perspective (such as an accountant's, a programmer's or a scientist's) does not have to be „automatically so" from a user's point of view. In fact, it may merely confirm certain biases or prejudices of individuals or like-minded communities and groups with cognitive ease.

Whereas the coherence theory describes „subjective truths," the *correspondence theory of truth* is oriented on „objective facts:"

> [The correspondence theory of truth] defines „true" as designating the property of a declarative sentence when what it asserts to be the case is the case. Such a sentence („John is a bachelor") is true when the world (or **reality**) is the way it is thereby described as being or when that sentence „corresponds" to the world (because, in this case, John is a bachelor). The semantic theory of truth is a refinement of the correspondence theory. [Fetzer and Almeder, 1993: 135]

In the big-data-environment the objective view of reality may not be self-evident or undisputed. This aspect of the correspondence theory may even be used to reinforce the coherence theory, as suggested in the context of global warming:

> Should the public come to believe that the scientific issues are settled, their views of global warming will change accordingly. Therefore, you need to continue to make the lack of scientific certainly a primary issue in the debate. [Frank Lutz, quoted in The Economist, 2016, p. 18].

Since we are dealing with digital data (small or big) that are described not only by means of various bit and byte conventions for graphic, linguistic, numeric and voice expressions, but also by means of different programming languages with various conventions for data descriptions, **the semantic conception of truth** is also relevant here:

> [The semantic conception of truth] maintains that truth ought to be interpreted as a metalinguistic predicate in order to avoid various semantic paradoxes (such as the sentence that asserts of itself, „This sentence is false," which is true if it is false and false if it is true)). Truth is viewed as a predicate that occurs in a **metalanguage** to describe sentences that occur in an **object-language**. Truth ascriptions are relative to a language and require adequate translations in the language in which they are expressed. The sentence, 'Schnee ist weiss' is true in German if and only if snow is white," thus specifies necessary and sufficient conditions of truth for the sentence „Schnee ist weiss" in German provided that it is properly tranlated within the meta-language of English by the sentence „Snow is white." [Fetzer and Almeder 1993: 136].

For example, if we want to test expressions in the object language of accounting (accountese) such as „profit is 1 million," then we must translate it correctly in to a meta-language such as ACL (*Audit Command Language* – www.acl.com) and can then express the truth (or falsity) of the *accountese* statement by the ACL expression „profit is (not) 1 million." - The meta-language has to be syntactically and semantically at least as powerful as the object language. In other words, an audit language must be able to represent all small and big data understandably to allow an enlightened auditor or critical reviewer to discover the truth of object language expressions and statements.

If the truth depends on expressions referring to convictions that the available evidence is sufficient to justify the conclusions or to accept them as false or true then we are dealing with the *pragmatic truth theory*:

> [The pragmatic theory of truth] defines „true" as designating the property a declarative sentence has when its assertion (or acceptance) is fully warranted. This requires that the available evidence is sufficient to justify its assertion (or acceptance). Yet it differs from the correspondence theory insofar as sentences whose assertion is fully warranted might not describe (or „correspond to") the world. (Fetzer and Almeder, 1993: 135-136]

To believe uncritically in the dogma: „big data provides or will eventually provide sufficient evidence," seems to eliminate any audit and review requirements; however, professional auditors and other reviewers are not normally naïve „believers" of this kind and ought to speak up when critical thinking is (to be) replaced by dogma, ideology or myth. – We are all (at least potential) agents of enlightenment!?

If we are dealing with more than one data or information user incl. auditors, then the truth may depend on the convictions of more than one member of a „guild." A variation of the pragmatic theory of truth is the *„ collective theory of truth"* by Charles S. Peirce, the "father of American pragmatism:"

> The Peirsean theory of truth] defines „true" as a property of those beliefs that the community of inquirers is ultimately destined to accept or to agree upon in the long run (that is the opinion that they will share in common as a result of applying scientific methods to answerable questions concerning the world forever). Alternatively, it is the opinion that they would share if they were to apply scientific methods to answerable questions concerning the world forever. In either formulation, those beliefs are thought to „correspond" to the world. Strictly speaking, truth in Peirce's sense does not guarantee correspondence, in the meanwhile, rational beliefs are those whose acceptance is suitably warranted by the available relevant evidence. [Fetzer and Almeder, 1993: 135]

Truth implies evidence of the circumstances and the context of knowledge. When the frame of reference is not known to the providers nor to the recipients of the information; when the data elements and their description in a computer language are hidden; and when the filter, model or algorithm applied to the data are unspecified, then IT personnel arrogates to itself the monopolistic use of computer technology under the guise of the big data mystique and algorithmic omnipotence. Nobody seems to be able to question them critically, intelligently and seriously. - Truth seems to be redundant in the digital big-data-age, but should we really be recognized as living in the post-truth world when we stand intellectually on the shoulders of enlightened giants!

If data is collected by monitoring the users of IT in terms of potential economic value as marketing "fodder" to be sold to, and further manipulated by, data brokers, then naïve IT users are "on display" in more than one sense in the "big-data-zoo." The majority does not yet care, seem, or want, to know why they are so "observed" provided they are "cognitively at ease." Consequently, we are "bombarded" with seemingly relevant advertising and master-tailored news whenever we open our computers… only to be observed and manipulated further!

The prime criterion for collecting information about users of technology (e.g. by social media) and for claiming all rights to the information forever and irrevocably is evidently to sell these data for a profit to data brokers. They can manipulate them further and sell them for another profit to advertisers and marketers who try to influence the behavior of the data subjects. Thus, the social contract between IT suppliers and IT users is completely one-sided and fully in favor of those in control of IT. In an enlightened world, their responsibility could and should be the protection of the privacy, property, and security of their users by providing relevant, protected, traceable and true data and understandable software to enlightened information and knowledge seekers.

8 | CONCLUSIONS

Big data are not believable if there is no ethical and legal basis for providing original small data (incl. meta-data) and more informative big data (incl. meta-big-data) to enlightened and autonomous users:

> We allowed ourselves to be monetized and productized on the cheap, giving away billions of dollars of our personal data to new classes of elite who saw an opportunity and seized it. We accepted all their one-sided ToS (Terms of Service) without ever reading them, and they maximized their profits, unencumbered by regulation or oversight. To be sure, we got some pretty cool products out of the deal… [b]ut now that we've given all these data away, we find ourselves at the mercy of powerful data behemoths with near-government-level power who do as they please with our information and our lives. (Goodman, 2015: 79)

Sharing data naively ("nothing to hide") and freely for mere IT convenience and "cognitive ease" means sacrificing one's criticality, freedom, individuality, maturity, privacy and security out of lack of courage or intellectual laziness. The result is exploitation by technologists and those in absolute and possibly criminal control of data and their use to the possible detriment of by now rather "transparent" data subjects.

The issues are more profound than monopolistic tendencies of search engine and social network providers! To hope for improved objectivity, transparency and trust with (ill-defined) big data is also an illusion (Will 2015). – We need a major societal effort to establish a rational data governance framework as part of a comprehensive new social contract between data and information providers and their users in the digital age (Goodman 2015).

As agents of enlightenment, all of us need to think critically, speak up courageously and fearlessly, and be heard clearly since so much is at stake in the digital age that could be the age of unlimited enlightenment instead of the ideologically limited "post-truth world."

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INTERNATIONAL JOURNAL OF COMPUTER AUDITING

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General Supply Warehouse: A Case Study in Internal Control Assessment and IT Auditing Software

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Technology is changing the auditing paradigm. As such, future accounting graduates are expected to have substantial technological skills. The proposed case provides students with an authentic scenario in which to apply such skills. Revenue and expenditure processing procedures are described for General Supply Warehouse, and several pertinent data files are also included. Students are required to conduct a thorough analysis of internal controls, identify associated weaknesses and utilize either ACL or IDEA to perform substantive testing. Data provided with the case have been engineered to produce measurable results from the prespecified audit tests. The instructor's section of the case contains comprehensive solutions and a suggested implementation plan.

KEYWORDS

Risk, Internal Control, Substantive Tests, Database, Fraud, ACL, IDEA, IT Auditing

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1 | THE FUTURE OF COMPUTER AUDITING EDUCATION

It is news to very few in the accounting profession that a technology revolution is reshaping the audit process. The drivers of this transformation include technologies such as data analytics tools, artificial intelligence (AI), and blockchain. Not only are these technologies promising to change how future audits will be conducted but also how public accounting firms will be structured in the near future. By automating entry-level audit tasks, the classical pyramid shape of the CPA organization will be transformed into a diamond-shaped structure. With fewer entry level positions to be filled, firms will focus on hiring experienced staff and domain experts. Although the audit function will continue into the future, it will change significantly. Successful future university graduates will be those who emerge from their educational programs in possession of salable technical skills and the business acumen to analyze results and make appropriate decisions (Stough, 2018).

The future of computer auditing education must reflect the direction the auditing profession is taking. The auditing paradigm is shifting drastically to require the use of technology. Where traditional accounting courses may not provide this connection with technology, there is an opportunity for accounting information systems (AIS) or IT Auditing courses to embrace relevant technology to better prepare our students.

It is not enough, however, to simply demonstrate relevant auditing software to students. Rather, they need extended time to master the technology and apply the given functionality in a meaningful way. The GSW case, described in its entirety below, is an authentic, risk-based approach to auditing and internal controls that creates a unique opportunity for accounting students to learn and apply accounting concepts with technology to make deeper, more meaningful connections.

2 | INTRODUCTION TO THE GSW CASE

To address the need for authentic and hands-on computer auditing instruction, we have designed a realistic internal control and IT audit case for a hypothetical company called General Supply Warehouse (GSW), which supplies a line of commercial products to industrial customers. The case has the following learning objectives:

- To reinforce the students understanding of the relationship between internal controls, accounting risks, and substantive tests.
- To develop hands-on skills with ACL or IDEA software in the design and execution of common audit tests.
- To deepen the students understanding of data structures within a relational database environment, which is central to many IT audit and data analytics issues in accounting.

The intended audience for the case is students who are currently enrolled in or have completed an accounting information systems (AIS) course and are familiar with common business processes and internal control principles.

The case scenario describes GSW's revenue cycle and expenditure cycle business processes. Based upon this description and the data files that accompany the case the goal is to perform certain tasks related to IT auditing. First among these is to conduct an analysis of GSW's internal controls. To assist students in this task, the *GSW Case Appendix A* provides a

description of internal control issues and examples that will serve as a framework for applying them. In addition, the case requires students to design and conduct several audit tests on the included data files using either ACL or IDEA software. In preparation for this part of the case, therefore, students should become familiar with the basic commands and operation of ACL or IDEA through the tutorials that accompany the educational versions of those products.

Additional resources, including a PowerPoint presentation outlining common ACL and IDEA commands, are available at the GSW Website: https://sites.google.com/view/gsw-case/.

Reviews of relevant accounting and auditing education literature (Apostolou, Dorminey, Hassell and Rebele, 2013, 2014, 2016) indicate that most internal control and audit teaching cases have focused on the application of the Committee of Sponsoring Organizations of the Treadway Commission (COSO) internal control framework in an isolated rather than integrative manner. An exception to this trend is the TJX case presented by Cereola and Cereola (2011), in which students are asked to apply COSO with a focus on computer controls, data security, and privacy legislation. Guo and Eschenbrenner (2018) also presented a case focused on internal control considerations within the broad context of risk management. These cases, however, do not push students past the theoretical point of internal control analysis. In contrast, the GSW case challenges students to go beyond this analysis to include the design of substantive tests based on identified control weaknesses and unmitigated risks.

Beyond creating deeper connections to important computer auditing concepts such as internal controls and substantive testing, students completing the GSW case will also obtain hands-on experiential learning in the execution of such substantive tests using industry-relevant software packages. Specifically, the GSW case was designed and written using the ACL and IDEA software packages. ACL offers an audit management software that incorporates integrated analytics ("ACL Solution," n.d.). Similarly, IDEA, supported by CaseWare Analytics, is a data analysis tool designed to support audits ("IDEA," n.d.). While other data analysis tools may be used to solve the GSW case, instructions and case solutions are provided only for ACL and IDEA.

A review of published case studies identified one similar to the GSW case that also utilizes IDEA software to complete the assignment. Students are tasked with using IDEA to identify red flags of potential management fraud that may have been perpetrated in the preparation of manual journal entries by overriding existing internal controls (Fay & Negangard, 2017). Although both cases use industry-relevant software, the GSW case differs from the Fay and Negangard (2017) case in two material ways. First, the GSW source data files contain detailed transaction data, rather than summary journal entries. Second, the case presented by Fay and Negangard presumes a system of otherwise effective internal control, which management overrides. In contrast, the GSW case describes a system of weak controls that students analyze in terms of unmitigated risks that could result in errors in specific account balances and increase the potential for fraud. Based on their analysis, students then design and implement substantive tests using IDEA or ACL. Through the presentation of a flawed system of internal controls, students experience a meaningful and unique opportunity to practice authentic auditing skills, while also learning about an industry-relevant audit technology solution.

An important educational consideration, especially related to the incorporation of technology within instruction, is whether an assignment elicits meaningful learning. Described by Howland, Jonassen, and Marra (2012), tasks that elicit meaningful learning are characteristically active, constructive, intentional, authentic, and cooperative. In general, relevant technology can help achieve more meaningful learning by supporting these characteristics. Considering the GSW case as it relates to the characteristics of meaningful learning:

1. Active:The case requires that students are completely active. Rather than describing the COSO Framework, internal control objectives and realistic examples from business, students are provided with detailed descriptions of a current system of internal controls. They are tasked to apply prior knowledge of internal controls and business processes in order to assess the control environment of the hypothetical company as well as perform the required substantive testing.
2. Constructive:The GSW case allows students to individually apply accounting concepts that they have learned in order to address a common goal. This process allows students to create meaning for themselves and make direct connections between concept and application. Unlike traditional accounting cases that are based on structured, aggregated general ledger data, the GSW case requires students to analyze flat transaction data files and draw out intelligence from the information held within them.
3. Intentional: Although the GSW case guides the audit that students are asked to complete, students may find that there is more than one way to approach each requirement.
4. Authentic: The GSW case uses realistic details and financial data. The challenges presented for each business cycle require that students design and complete real substantive tests. This provides an authentic opportunity that students would have previously only read about. Further, IDEA and ACL are examples of data analysis and audit-support software that are used by accounting firms ("ACL Solution," n.d.; "IDEA," n.d.). Incorporating these software packages into the case provides students with an authentic auditing experience similar to one they may be tasked with after graduation.
5. Cooperative: Although students should complete assignments individually, they are encouraged to collaborate with their peers, professor, and teaching assistant(s). There is more than one way to solve each assigned problem, and as such, they may find that they have taken a different approach than someone else. Also, depending on the experience level of students, an instructor may choose to assign them to audit teams and offer the case as an open-ended team project rather than assigning the specific questions that come with the case. This modification would allow teams to assess GSW control weaknesses, design relevant substantive tests and implement them accordingly.

3 | GENERAL SUPPLY WAREHOUSE CASE STUDY

3.1 | Background

With a product line that ranges from sump pumps to safety glasses, General Supply Warehouse (GSW) has established a reputation as a reliable vendor of quality commercial products at competitive prices. GSW's customer base consists of industrial businesses throughout the United States and Canada with corporate offices situated in its Los Angeles warehouse. The company purchases inventories directly from the manufacturers.

GSW currently employs a client-server networked accounting system, which it purchased from Flybynite Custom Applications (FCA), Inc., in 2014. FCA's lead systems designer, James Smith played a central role in implementing and customizing the system to GSW's specific needs. GSW subsequently hired Smith to oversee system operations and ensure a smooth transition from their old legacy system. Six months after a successful implementation GSW's CEO promoted Smith to Warehouse Operations Manager.

GSW is currently undergoing its annual audit and you are the in-charge auditor responsible for assessing GSW's revenue

and expenditure cycle controls, and related accounts. The following describes GSW's business processes:

3.2 | Sales and Cash Receipts Procedures

All sales to customers are net/30, FOB shipping point. The flowchart in Figure 1 and the record layout in Figure 2 illustrate GSW's sales and cash receipts procedures.

Sales Department

The sales department receives customer orders by hard copy mail or fax. Upon receipt of the order, a member of the sales staff accesses the customer record and reviews the available credit before creating a Sales Invoice record. For customers with insufficient available credit, the clerk refers the order to Sally Kwan, the credit manager, for approval. If granted, then Sally verbally authorizes the clerk to increase the customer's line of credit. For approved sales, the clerk creates a record in the Sales Invoice file via his terminal in the department. The system automatically assigns an Invoice Number, which is the primary key for the record, however, it does not facilitate automated data entry. The clerk must therefore manually enter the transaction details into the Sales Order record including Product Number, Sales Price, Quantity, Amount Due, and Sales Date.

Warehouse

Triggered by the sales invoice the system automatically prints a stock release document on the warehouse terminal, which a member of the warehouse staff uses for picking the goods. The clerk then sends the goods, along with the stock release document, to the Shipping Department. Once the goods leave the warehouse, the warehouse clerk adjusts the Quantity on Hand field of the respective record in the inventory file to reflect the units sold.

Shipping Department

The shipping department clerk receives the stock release and the inventory, prepares them for shipment, selects a carrier and prints the packing slip and bill of lading (BOL). The clerk then adds a record of the shipment to the Shipping Log file and physically hands over the goods to the carrier. Assuming no unusual circumstances, sales orders received by 2 PM are shipped the same day. Items received by shipping after 2 PM are shipped the following day.

Billing

At the end of the day, the system automatically searches the Sales Invoice file for records added to the file that day and prints hard copy customer invoices and remittance advices, which a clerk mails to the customers. The system automatically calculates due dates based on net/30 terms of trade and places them in the Due Date fields of the respective Sales Invoice records.

Cash Receipts

Maria Perez, the cash receipts clerk, receives the customer checks and remittance advises directly from the customer. She begins by creating a record in the Cash Receipts file to which the system automatically assigns a Remittance Number as the primary key. Then, using the invoice number (taken from the hard copy remittance advice) as a search key she locates the appropriate invoice in the Sales Invoice file and manually adds the remittance Number to a field in the record. This closes the invoice and marks it paid. Maria also adds the Invoice Number from the invoice record to the cash receipts record as a cross reference. She then manually adds the customer number, amount, and payment date to the Cash Receipts record. At the end of the day, she prepares a deposit slip and sends the checks to the bank. She files the remittance advices in her office. The Sales Invoice file serves to calculate both total sales for the period and

accounts receivable. The total of the Amount Due field for all items that have been shipped by the end of the period constitutes total sales. Invoiced items shipped, but not paid (still open) by period end are accounts receivable.

3.3 | Purchasing and Payment Procedures

All purchases from suppliers are FOB destination. The flowchart in Figure 3 and the file structure diagram in Figure 4 illustrate the purchasing/payment procedures at GSW.

Warehouse

Each morning James Smith reviews an automatically generated inventory status report from his office terminal. He determines the items that need replenishing and selects suppliers from the Vendor file, which he maintains. Smith then adds a record to the purchase order file. The system assigns each new record a unique number (PO Number) as the primary key. Smith manually enters the date, the product to be ordered, order quantity, expected unit cost (the extended cost is automatically calculated by the system), and the ID (Ven-Num) of the selected vendor. Smith then prints the purchase orders from his terminal, signs them, and has his secretary mail them to the respective suppliers.

Receiving

The warehouse receives supplier orders directly where Smith, or one of the warehouse employees, counts and inspects the items and reconciles the order with the attached packing slip. The receiving clerk then adds a record to the Receiving Report file from the warehouse terminal. The system assigns a unique key (RR Num) to each record. The clerk manually enters the purchase order number, product number(s), quantity received, vendor ID number, and the date of receipt. The clerk then files the packing slip in the warehouse. Finally, the clerk updates the quantity on hand filed in the inventory subsidiary ledger to record the receipt of the goods.

Accounts Payable

James Jefferson, the Accounts Payable clerk receives the vendor's hard copy invoice and, using the PO number from the invoice as a search key, he matches the invoice with the corresponding purchase order. James then creates a record in the Voucher Payable file. The system assigns a unique key (Voucher Number) to each record. The clerk enters manually the following data directly from the supplier's invoice: purchase order number, vendor number, supplier invoice number, full amount due, discounted amount due, and due date. Finally, Jefferson files the hard copy vendor invoice in the office filing cabinet.

Cash Disbursements

Each day, Greg Orlando in the Cash Disbursements department reviews the Voucher Payable file for items due for payment that day. For each item due, he adds a record to the Check Register file. The system assigns it a unique key (Chk Num) and Greg manually adds the following data to the Check Register record: voucher number, vendor number, amount of payment, and date. The system automatically places the check number in the appropriate Voucher Payable record to close the voucher and mark it paid. The checks are printed in Greg's office and then sent to the vendor.

Data in the Voucher Payable file is the basis for calculating both total purchases for the period and accounts payable. The total of the Full Amount field constitutes total purchases for the period. Items in the file that are unpaid (still open) at period end are accounts payable.

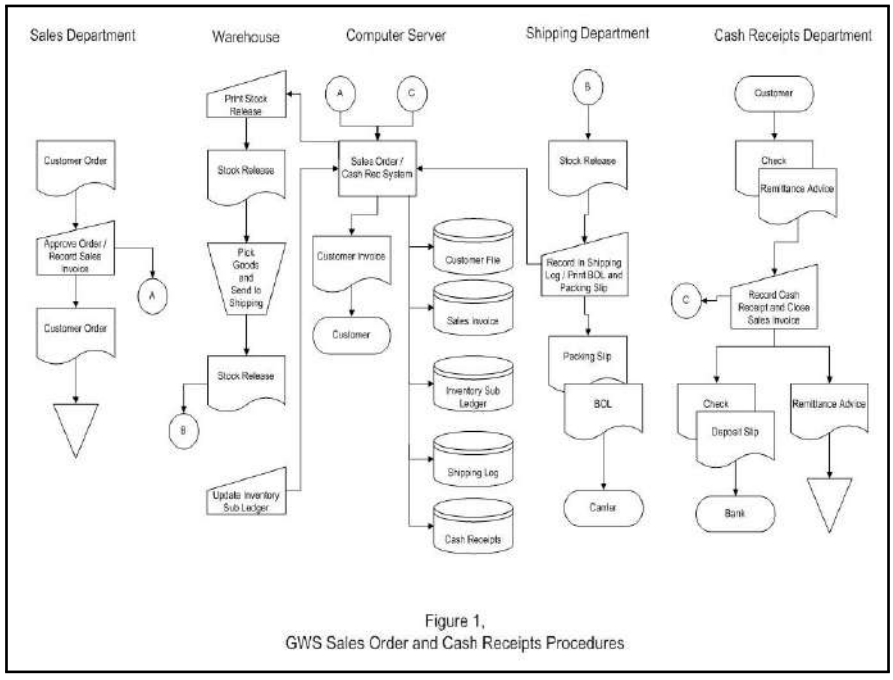


FIGURE 1 GWS Sales Order and Cash Receipts Procedures

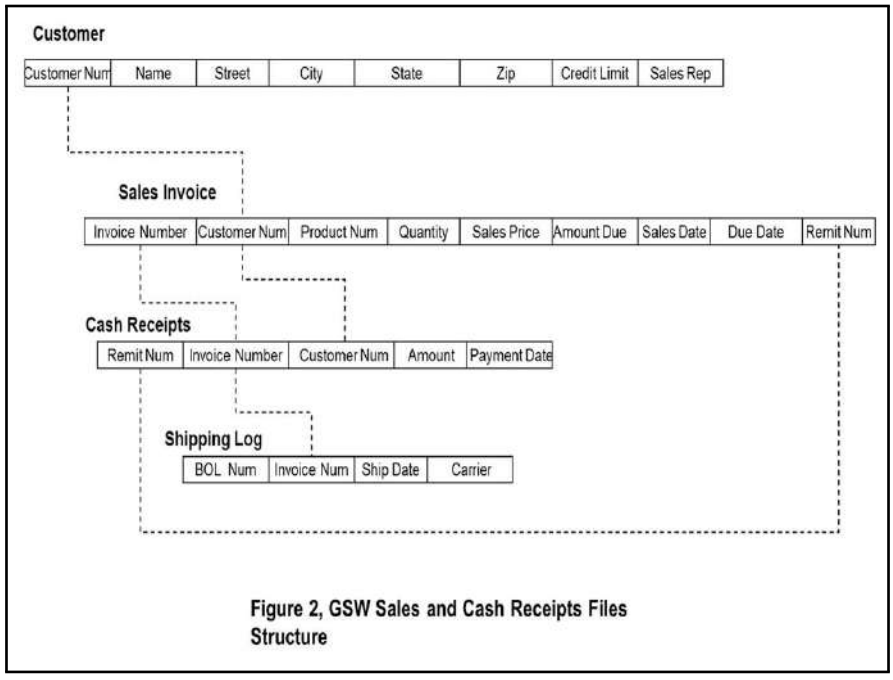


FIGURE 2 GSW Sales and Cash Receipts Files Structure

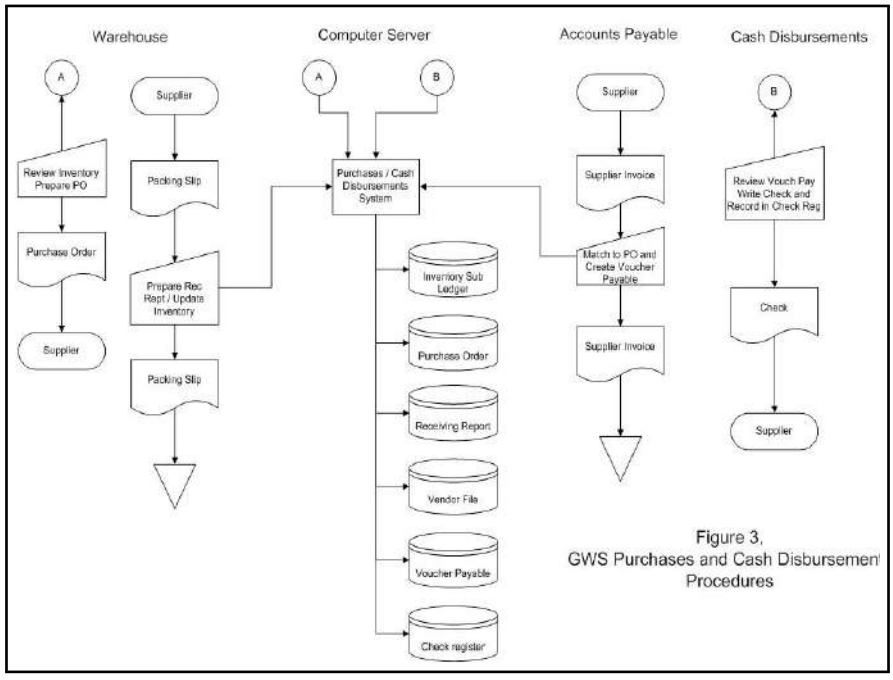


FIGURE 3 GWS Sales Order and Cash Receipts Procedures

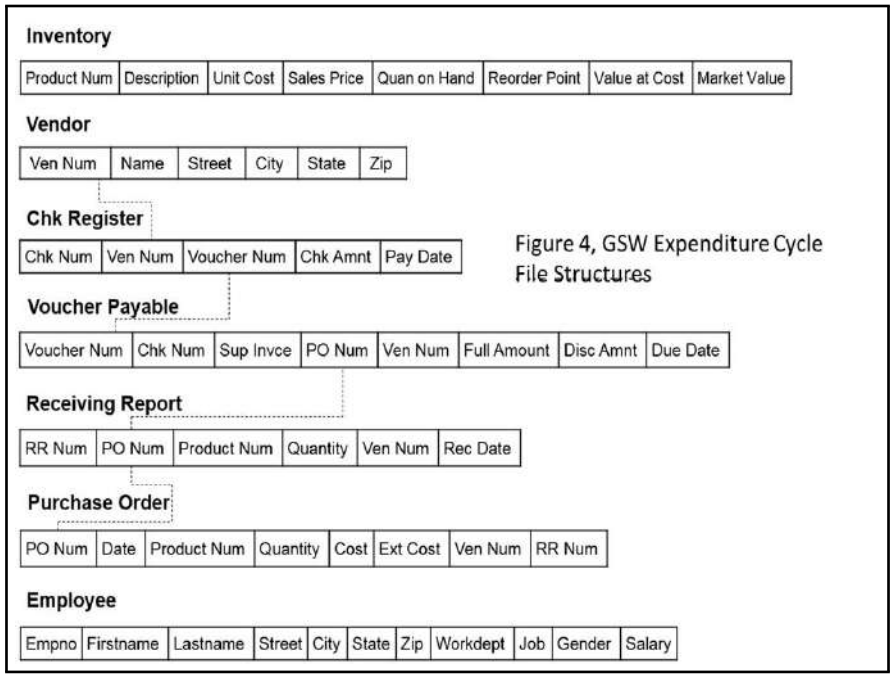


FIGURE 4 GSW Sales and Cash Receipts Files Structure

4 | REVENUE CYCLE REQUIREMENTS

4.1 | Internal Control and Risk Assessment

Based on the case description and the revenue cycle flowchart (Figure 1):

(a) Discuss GSW's internal control weaknesses.
(b) Describe the unmitigated risk(s) associated with each control weaknesses.
(c) Comment on the possible misstatement in specific accounts due each control weakness.

Use the six control activities described in the Appendix as a framework for your responses.

4.2 | Substantive Tests and Risk Assessment

First, download the Excel source data files to create an ACL or IDEA project. These files are available on the GSW Website: https://sites.google.com/view/gsw-case/. From the "Source Files" page, you can find detailed instructions for converting the source files into an ACL or IDEA project. The data contained in these source files correspond to the file structures depicted in Figures 2 and 4.

Using relevant revenue cycle data files and selected financial data provided below, perform the following substantive tests and prepare a report of your findings (including screenshots from ACL or IDEA).

(a) Verify the reported sales figure.
(b) Recalculate AR.
(c) Perform an Aging of AR and assess the reasonableness of the Allowance for Doubtful Accounts.
(d) Verify that Sales and related customer cash receipts are accurately recorded.

Selected GSW Financial Data	
Sales	21, 519, 987.84
Accounts Receivable	19,009,030.80
Allowance for Doubtful Accounts (.02 x Sales)	(430,399.75)
Net Accounts Receivable	18,578,631.05

5 | EXPENDITURE CYCLE REQUIREMENTS

5.1 | Internal Control and Risk Assessment

Based on the case description and the expenditure cycle flowchart (Figure 3):

(a) Discuss GSW's internal control weaknesses.
(b) Describe the unmitigated risk(s) associated with each control weaknesses.
(c) Comment on the possible misstatement in specific accounts due each control weakness.

Use the six control activities described in Appendix A as a framework for your responses.

5.2 | Expenditure Cycle Substantive Tests

Using relevant expenditure cycle data files as well as financial data provided below, perform the following substantive tests and prepare a report of your findings (including screenshots from ACL or IDEA).

(a) Identify unrecorded liabilities.
(b) Verify that the inventory balance is reported at net realizable value.
Reported Financial data: Inventory Balance at 12/31/2017 = 6,321,164.32
(c) Verify that payments to vendors accurately reflect the amounts that were owed.

6 | FRAUD DETECTION REQUIREMENTS

Based on your analysis of GSW's internal controls, and the data files in the GSW project, design and perform tests to reveal the potential for fraud in the company. To assist you in this task, *GSW Case Appendix B* provides a review of common fraud schemes and corresponding ACL and IDEA techniques that can be used to detect them.

Prepare a report of your findings including screen shots of your test results.

7 | NOTES FOR INSTRUCTORS

7.1 | Case Structure

The case is comprised of the three sections. First, detailed description of the revenue and expenditure cycle business processes is provided for GSW. This description includes a written narrative, system flowcharts, and record structures for the data files that are included with the case. Seeded within the description are material internal control weaknesses. Students are required to evaluate the documentation provided, identify the internal control weaknesses, and assess the unmitigated risks associated with them. *GSW Case Appendix A* provides a review of internal control objectives and techniques based on the COSO internal control model, as a framework to assist in this task. A comprehensive copy of this description (including both appendices) are available from the "General Supply Warehouse" page on the GSW case website (https://sites.google.com/view/gsw-case).

Next, students are required to use common features of ACL or IDEA software including joins of multiple tables, Benford's analysis, tests for gaps and duplicate records, as well as other analytic tools to perform specified substantive tests and tests for fraud. To accomplish these tasks, source data files in Excel format accompany the case. Students will convert these flat data files into an ACL or IDEA project. The "Source Files" page on the GSW case website (link provided above) provides detailed instructions for conversion and 11 Excel files containing GSW transaction and master data.

Finally, comprehensive solutions (in the form of PowerPoint presentations) for the internal control and the ACL or IDEA related questions accompany the case. Simplified versions of both the IDEA and ACL solutions are included in this article. They are also available for download from a Google Drive folder (https://goo.gl/5GFjaV) as well as a secure area on the case website (link provided above). Use the top navigation bar to access the "Solutions" page of the website where you may request access to the case solutions through a Google Form. Within a day or two of your request, you should receive access privileges for both the ACL and IDEA versions of the case.

7.2 | Proposed Instructional Plan

Preparation for the GSW Case

For Instructors. Before implementing the GSW Case in a computer auditing course, instructors should choose which software package the students will use to complete the audit process. As mentioned previously, we suggest either ACL or IDEA audit support packages. Once a particular technology is chosen, instructors should check the install and licensing process specific to their institution. Case completion works best when students can install the software locally onto their computers and work at their own convenience. If this is not an option due to licensing constraints, we suggest that students are provided suggested lab time to meet and work on the project using public sites computers (where the software is provided). Although inconvenient, this would not affect the effectiveness of the case.

Instructors should also familiarize themselves with the technology by completing guided tutorials. There are many resources available on both the ACL and IDEA websites to utilize. We finally suggest that instructors should complete the GSW case to understand the steps required to solve each problem. This may also help identify and anticipate struggles that their students may encounter.

For Students. Before the GSW Case is assigned, students should set up their computer auditing environment as directed by the course instructors. Once students have either IDEA or ACL available to them, we suggest that they next complete a guided tutorial to introduce them to the software package. We have found that best results are achieved when implementation is preceded by a guided tutorial and/or a short introduction to the software intended to highlight important commands and features. Before asking students to complete the GSW case in its entirety, it is important to provide them with adequate information about the technology itself. The intention is that using an unknown technology should not hinder the learning process. Students should be required, or at least strongly recommended, to walk through a guided tutorial for the software. Tutorial exercises that accompany the educational versions of IDEA and ACL are an excellent means for familiarizing students with the software.

Following a guided tutorial, we next recommend that instructors introduce students to the basic functionality of the software being employed as well as small examples of its use in the conduct of an audit. Towards this end, the GSW website contains PowerPoint presentations of common ACL and IDEA commands with examples of their application. We have found that this helps students contextualize the functionality they learned through the tutorial and apply it in an authentic audit scenario.

Beyond the audit technology, other important content knowledge pertinent to student success with the GSW case includes a basic understanding of the following AIS concepts:

- Business Cycles: Students should understand how both the revenue and expenditure cycles should function. They should understand the role of standard functions and departments such as sales, billing, accounts payable, and receiving, as well as the accounting information (documents) that trigger these activities. Students should also be familiar with common risks associated with the revenue and expenditure cycles such as selling to non-creditworthy customers or false payments to vendors because of fraud or errors.
- Internal Controls: Students should understand basic internal control techniques employed by management to mitigate the risks above such as the need for credit checks to control customer sales and a three-way-match to control cash payments to vendors.
- Relational Databases: Although students are not presented with a relational database and are not asked to create an entity-relation diagram for GSW, they will use relational knowledge to complete substantive testing. For example, to verify that a three-way-match was performed on cash disbursements students need to understand the relationship between the Purchase Order, Receiving Report, and Vendor Invoice and how to join these tables on a common attribute (PO-NUM).
- Flowcharts: For this case, students should understand how to interpret system flowcharts. Within the case, there is both a textual description of GSW's procedures as well as a visual depiction of each business cycle in the form of a system flowchart. Further, students are provided with a diagram of the data files structures that depict important relationships between the files.
- Common types of fraud: Students should understand common types of fraud. To support this content (as well as the questions specifically related to this topic), we have included GSW Case Appendix B, which summarizes several common fraud schemes and outlines ACL and IDEA commands and techniques used for fraud detection.

At this point, students are ready to be introduced to the case. They should review the case description and also download the source data Excel files and create an audit package in either IDEA or ACL. As described in the case requirements, instructions to do this are available on the case website (https://sites.google.com/view/gsw-case/) on the "Source Files" page.

Implementing the GSW Case. After following the preparation guidelines described above, instructors should be ready to facilitate the case and students should be ready to complete it. Here, we describe a suggested plan of implementation. First, following the short introduction to important functions in either ACL or IDEA (as described above), instructors will introduce students to the basic details and purpose of the GSW case. We suggest that instructors require students to read the case description before this discussion.

Next, the instructor should assign the Revenue Cycle as the first GSW assignment. If deemed necessary, the instructor may consider reviewing important supplemental accounting knowledge required to complete the questions. Relevant concepts may include principles of revenue recognition as well as how to identify accounts receivable for a given period. A more complete description of these concepts is provided in the *Instructor's Appendix A*.We suggest allowing students three to five days to complete each part.

After students submit their responses to the Revenue Cycle requirements of the GSW Case, instructors might consider reviewing the solutions during class. This may help address any questions or concerns that students had related to the case or technology. Next, the instructor should assign the Expenditure Cycle as the second GSW assignment. Again, the instructor may consider reviewing important supplemental accounting knowledge required to complete the questions. Relevant concepts may include defining unrecorded liabilities and identifying accounts payable for a given period. A more complete description of these concepts is also provided in the *Instructor's Appendix A.* We suggest allowing students three to five days to complete this assignment.

Following student submissions of the Expenditure Cycle requirements of the GSW Case, instructors might consider reviewing the solutions during class. This may help address any questions or concerns that students had related to the case or technology. Next, the instructor should assign the Fraud Cycle as the third and final GSW assignment. *GSW Case Appendix B* provides students with supplemental content defines common fraud schemes and identifies detection techniques that may be used during an audit. Instructors may choose to review these concepts, or if previously covered during lecture, they can simply provide the appendix to the students. We suggest allowing students three to five days to complete this part also.

Following the final submission of the Fraud assignment, instructors may again review solutions during class. At this point, we have found an open class discussion to be useful in obtaining student feedback regarding the audit process and lessons learned related to the case scenario, requirements and the ACL or IDEA technology.

Teaching Tips for the GSW Case

Versions of this case have been classroom tested in both undergraduate-level Accounting Information Systems and graduate IT Auditing courses. As suggested in the instructional implementation plan above, we have found that the case is most effective when assigned to students in three separate parts. Further, it helps most if the timing of the case is such that each assignment (Revenue, Expenditure, and Fraud) is assigned soon after students learn about each topic in lecture. If this is not possible, we suggest waiting until after all three areas are covered before introducing the case to the students.

Qualitative feedback from students regarding the rigor of this case has typically reflected their difficulty in reconciling the classical accounting concepts that underlie the case with the physical data structures and file types found in computer-based accounting systems. Depending on the structure and student makeup of the class, scaffolding the GSW case with supplemental accounting information may or may not be required. We have found that for most students, especially younger undergraduate students, reviewing accounting concepts and file structure conventions presented in *Instructor's Appendix A.* prior to assigning the case is beneficial in helping students navigate the case.

Other feedback from students has indicated that the learning curve required to use a new software, such as IDEA or ACL, may be steep. We have found success with through dedicated lab time or office hours that are held either by the instructor or a qualified Teaching Assistant. With "real-time" technical assistance available, students typically quickly become comfortable with the new technology and are able to focus more specifically on the case content. Another technique that we use to improve the effectiveness of the case is to encourage students to plan out the steps they will use to complete each substantive test *before* they take to ACL or IDEA. Rather than clicking aimlessly or just guessing-and-checking solutions, this strategy helps students apply accounting concepts first, before having to implement in the software.

Only after an adequate risk-based discussion of important internal control considerations within each transaction processing (business) cycle should students be assigned the case. It is important not to overwhelm the students with new material, and to specifically keep the assignment within a student's zone of proximal development (ZPD). Originally developed by Vygotsky, the zone of proximal development is defined as:

> […] the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (as cited in Bransford, Brown and Cocking, 2000, p. 81).

Essentially, the idea is that assignments should be challenging but not overwhelming. The use of realistic and detailed financial information for GSW guarantees that assigned tasks are challenging enough. Consequently, scaffolding in the form of timing of assignments, presentation of supplemental material, dedicated lab time or office hours, as well as suggested planning procedures for each substantive test will help ensure that students are not overwhelmed by the assignment. Within their zone of proximal development, students are provided with the best opportunity to apply concepts in order to make meaningful connections and gain saleable skills in IT Auditing.

8 | GENERAL SUPPLY WAREHOUSE SUGGESTED GRADING RUBRIC

8.1 | Revenue Cycle Responses

1. **10 points**: Discussion here should include physical controls as described in the COSO Framework, including transaction authorization, segregation of duties, access, etc.
   a. Full Credit if there is a thorough discussion of the revenue cycle internal controls.
2. **20 points**: Each part in this section (a-d) is worth 5 points.
   a. **5 points**: Students should join sales invoice and shipping log and filter out records that were shipped after the end of the year.

   i Actual sales is 21,269,881.44.
   ii **Full credit** if their sales amount is +/- 100,000 and they described the fact that the reported sales were overstated.

b. **5 points**: To the previous table, students join cash receipts.
   i Students should find that the AR value Is 18,936,407.
   ii Students should also recalculate AFDA based on the new sales figure found in part a, and subtract this value from 18,936,407 to find the net AR value of 18,511,010.
   iii **Full credit** it the AR/AFDA/Net AR values are within +/- 100,000 and the student finds net AR.
   iv **Half credit** if student only finds gross AR.

c. **5 points**: Students should perform aging on the AR table created in part b.
   i A large percentage of GSW AR are more than 90 days past due (i.e. more than 0.02); If the auditor acknowledges that these accounts are likely uncollectible, he/she would question the reasonableness of the current AFDA percentage.
   ii **Full credit** if the student draws a reasonable conclusion based on some assumption about bad debts. (For example, if they say that GSW would consider all debts 120 days outstanding uncollectible, the current AFDA value seems reasonable).
   iii **Half credit** if the student just says that the AFDA value is unreasonable without any explanation.

d. **5 points**: The student should find at least 6 entries with a discrepancy in payment.
   i **Full credit** if the student explains that the discrepancies may be from fraudulent activity OR user error in data entry.
   ii **Half credit** if the student says that all discrepancies represent fraud.

8.2 | Expenditure Cycle Questions

1. **10 points**: Discussion here should include physical controls as described in the COSO Framework, including transaction authorization, segregation of duties, access, etc.
   a. Full Credit if there is a thorough discussion of the expenditure cycle internal controls.
2. **15** : Each part in this section (a-c) is worth 5 points.
   a. **5 points**: There are 13 unrecorded liabilities, valued at 43,908.88.
      i **Full credit** if student finds total of unrecorded liabilities within +/- 10,000.
      ii **Half credit** if student goes through the correct steps, but the answer is off by more than 100,000.
   b. **5 points**: Net realizable value is defined as the lower of cost or market value for each item in inventory. NRV is 4,422,554.
      i **Full credit** if student finds the correct NRV value, or a value within +/-100,000.
      ii **Half credit** if student goes through the correct steps, but the answer is off by more than 100,000, or if they don't conclude that the reported inventory value is overstated.
      iii **Partial Credit** (-3) if the student finds NRV by finding the lower of cost or market overall rather than per item.
   c. **5 points**: To verify payments to vendors, students should at least search for checks written for incorrect amounts. They may also find duplicate payments.
      i **Full credit** if the student finds at least the two entries in which the check amount differed from amount due (both discount and full).

ii **Partial credit** (-1) if the student only finds one of the two entries of inaccurate payments to vendors.
iii **Half credit** if the student only finds the two duplicate payments.

8.3 | Fraud Responses

1. **10 points**: Benford's Analysis.
   a. **Full credit** if the student performs Benford's analysis on sales invoice and finds that the invoice values do not fall in the expected ranges.
   b. **Half credit** if the student performs a Benford's analysis on other tables (not including sales invoice).
2. **10 points**: Testing for Vendor Fraud.
   a. **Full credit** if the student at least compares the vendor and employee tables to find possible sources of fraud.
   b. **Half credit** if the student only summarizes the voucher payable table to find one vendor is owed significantly more than other vendors (but does not compare the employee and vendor tables).

9 | GSW COMPREHENSIVE SOLUTION

s mentioned previously, instructors may access PowerPoint presentation of the GSW solutions from the case webpage or through Google Drive. Both versions of the solutions are presented in the following pages.

9.1 | Revenue Cycle Internal Control and Risk Assessment Solutions

Based on the case description and the revenue cycle flowchart (Figures 1):

(a) Discuss GSW's internal control weaknesses.
(b) Describe the unmitigated risk(s) associated with each control weaknesses.
(c) Comment on the possible misstatement in specific accounts due each control weakness.

The enumerated responses on the following pages correspond to the numbered circles in the flowchart below:

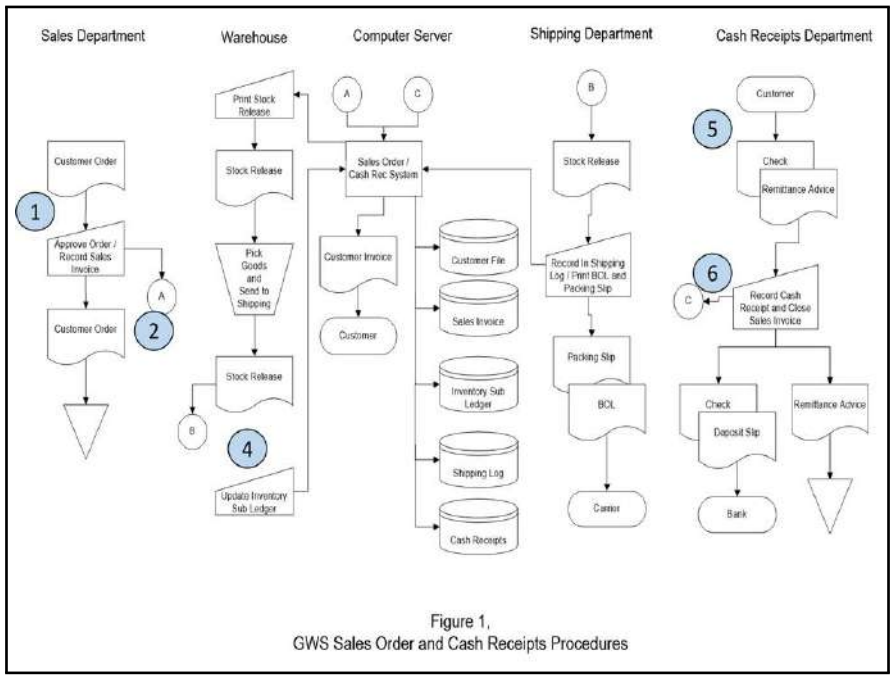


Figure 1,
GWS Sales Order and Cash Receipts Procedures

FIGURE 5 GSW Sales Order and Cash Receipts Procedures

1) Inadequate Credit Check Process

- **a. Internal Control Weakness**: There is a lack of transaction authorization here. Credit approval of customers is provided verbally and informally. Under the current procedures, a sales clerk could extend credit without management approval.
- **b. Unmitigated risk**: Sales may be made to non-creditworthy customers, which results in excessive bad debts.
- **c. Possible account misstatements**:
  - AR is overstated.
  - Allowance for Bad Debts is understated.
  - Bad Debt Expense Understated.
  - Revenue is overstated.

2) Lack of Computer Controls over Creation of Sales Invoice

- **a. Internal Control Weakness**: Due to inadequate system functionality and computer controls sales clerks are required to manually enter sales transaction details including sales prices, quantities, and calculate the amounts due.
- **b. Unmitigated Risk**: This environment lends itself to clerical errors in the creation of sales invoice records.
- **c. Possible account misstatements**:
  - Sales is incorrectly recorded
  - AR is incorrect recorded.
  - Bad Debt Expense incorrect.

3) Potential Errors in Recognizing Sales

a. **Internal Control Weakness**: The system prepares hard copy sales invoices based only the existence of a record in the Sales Invoice file without verification that the ordered products were actually shipped.
b. **Unmitigated Risk**: Recognizing sales before they are shipped (realized) is contrary to accounting theory and may result in the following end of period errors.
c. **Possible account misstatements**:
   . Sales are overstated.
   . AR is overstated.
   . Allowance for Bad Debts is understated.
   . Bad Debt Expense is understated.

4) Warehouse Asset Custody
a. **Internal Control Weakness**: Segregation of duties are lacking here. The warehouse staff have custody of inventory and record keeping responsibility for updating the inventory subsidiary ledger.
b. **Unmitigated Risk**: Because the warehouse clerks have access to the accounting records they may conceal inventory losses and thefts.
c. **Possible account misstatements**:
   . Inventory understated.
   . Cost of Goods Sold (COGS) overstated.

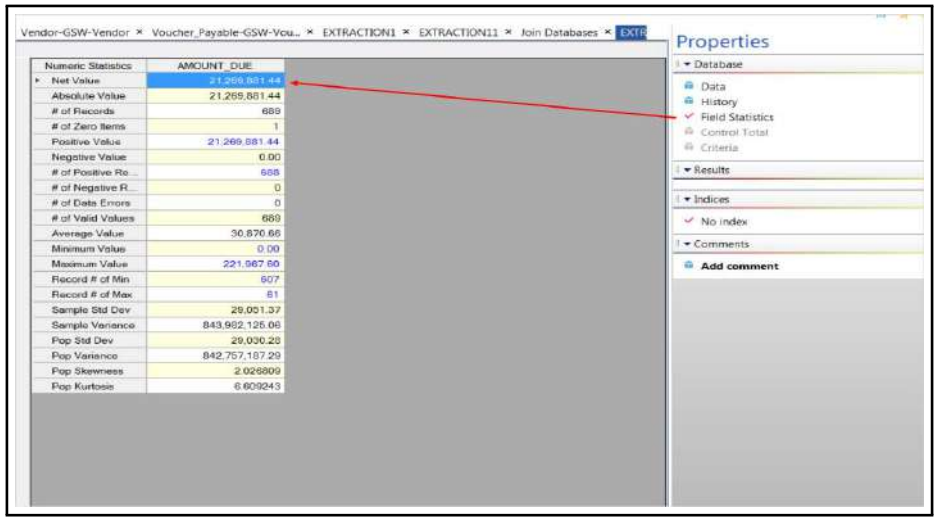
5) Custody of Cash Assets
a. **Internal Control Weakness**: There needs to be better segregation of duties here. The cash receipts clerk has custody of cash and record keeping responsibility for posting payments to open invoices.
b. **Unmitigated Risk**: The current transaction processing procedures increase the risk of errors such as posting incorrect amounts or posting to the wrong invoices. The risk of frauds such as skimming or lapping also exist.
c. **Possible account misstatements**:
   . Cash Receipts understated.
   . Accounts receivable overstated.

6) Lack of Computer Controls over Recording Cash Receipts
a. **Internal Control Weakness**: Due to inadequate system functionality and computer controls the cash receipts clerk is required to manually enter cash receipts transaction details including Remittance Num, Customer Num, Amount, Payment Date to the Cash Receipts record.
b. **Unmitigated Risk**: This environment lends itself to clerical errors in the creation of cash receipts records.
c. **Possible account misstatements**:
   . Discrepancies between customer amounts owed in Sales Invoice records and remittance amounts recorded in corresponding Cash Receipts records.

9.2 | Revenue Cycle Substantive Tests Solutions (IDEA)

A. Verify Sales Figure (21, 519, 987.84)
a. Students will join Sales Invoice and Shipping Log on Invoice Number, selecting "Matches Only." This will remove sales invoice records that have not yet been shipped.
b. Next, filter out records shipped after 12/31/2017 with the following equation: Ship-Date < '20180101'.
c. Field Statistics on Amount-Due = 21,269,881.44 (screenshot below).

Result: Sales are overstated by 250,106.40.



B. Verify Reported AR Balance (18,578,631.05)

- **a.** To the previously joined Sales Invoice and Shipping Log files, join Cash Receipts on Invoice Number, including "All Records in Both Files".
- **b.** To obtain AR as of the cutoff date, create a filter to include only invoices that are yet unpaid for the audit period (as of 12/31/17) and those paid after 01/01/18. To do this, use the following expression: Remit-Num == "0" OR Payment-Date >='20180101'.

Field Statistics on Amount-Due to obtain the AR balance	18, 936,407
Allowance for Doubtful Accounts (.02 x Sales)	(430,399.75)
Net Accounts Receivable	18,578,631.05
Result: AR is overstated by	67,621

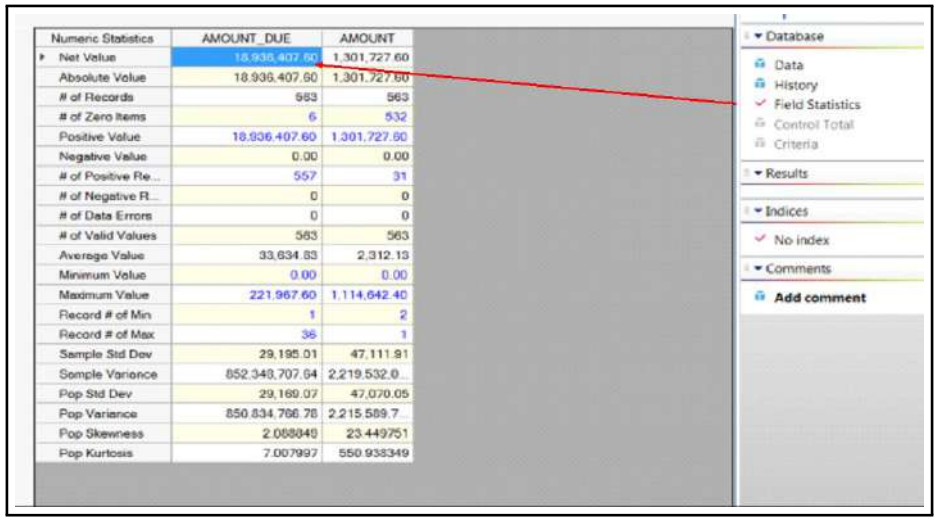
C. Perform Aging of AR

- **a.** Using the Aging feature on the newly calculated AR table, you will see that a large percentage of GSW Accounts Receivable are more than 90 days past due (screenshot below).
- **b.** Red Flag: Further Investigation is needed. Auditor would likely question the collectability of these accounts and the appropriateness of the allowance for doubtful accounts (bad debt).

D. Test the Accuracy of Sales and Cash Receipts Transactions

- **a.** oin Sales Invoice, Shipping Log and Cash Receipts on Invoice-Num, selecting "All Records in Both Files".
- **b.** Search for discrepancies between amount due and amounts paid using the following expression: Amount > 0 AND Amount <> Amount-Due.

Result: Six records reveal discrepancies between amounts due and the amounts paid.



9.3 | Revenue Cycle Substantive Tests Solutions (ACL)

A. Verify Sales Figure (21, 519, 987.84)

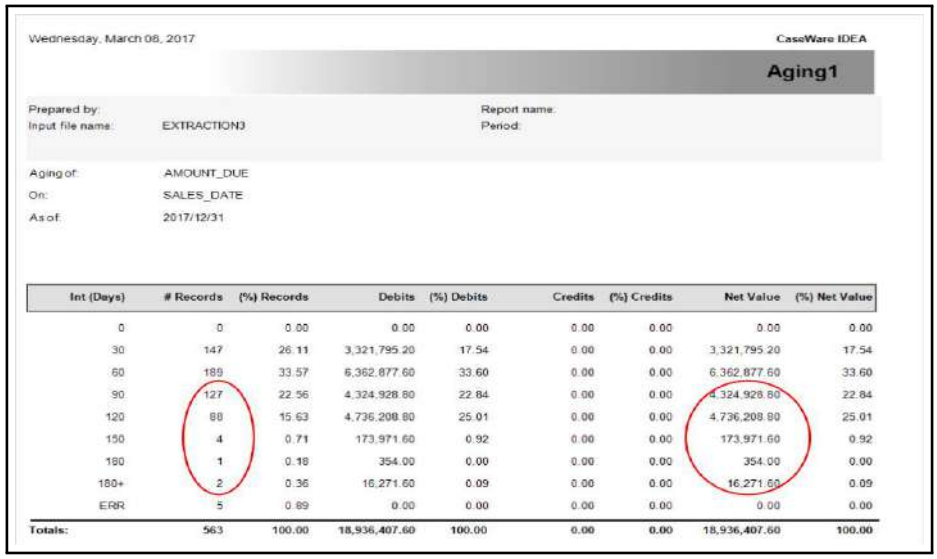
- **a.** Students will join Sales Invoice and Shipping Log on Invoice Number.
  - **i.** Primary Table: Sales-Invoice, Secondary Table: Shipping Log.
  - **ii.** Primary and Secondary keys: Invoice Num.
  - **iii.** iii. Primary and secondary fields: "Add all".
- **b.** Next, filter out records shipped after 12/31/2017 with the following equation: Ship-Date < '20180101'.
- **c.** Field Statistics on Amount-Due = 21,269,881.44 (screenshot below).

Result: Sales are overstated by 250,106.40

B. Verify Reported AR Balance (18,578,631.05)

- **a.** To the previously joined Sales Invoice and Shipping Log files, join Cash Receipts on Invoice Number.
  - **i** Primary and Secondary keys: Invoice Num.
  - **ii** Matched Primary records: Include all primary and secondary records.
- **b.** b. In the new table, change Remit-Num type from ASCII to Numeric.
  - **i** Edit > Table Layout > double-click on Remit-Num.
- **c.** To obtain AR as of the cutoff date, extract or filter to include any invoices that are yet unpaid for the audit period (as of 12/31/17) and those paid after 01/01/18. To do this, use the following expression: Remit-Num == 0 OR Payment-Date >='20180101'.

Analyze > Total Fields on Amount-Due to obtain the AR balance	18,936,407
Allowance for Doubtful Accounts = .02 * 21,269,881 (0.02 of recalculated sales) =	(425,397)
Net Accounts Receivable	18,511,010



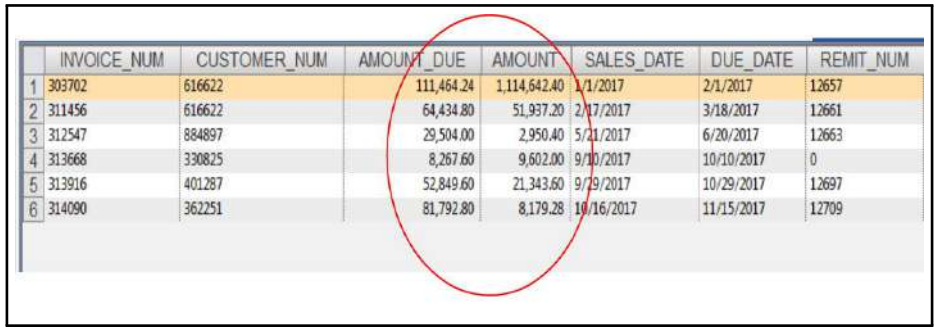
Wednesday, March 08, 2017 CaseWare IDEA

Aging1

Prepared by:
Input file name: EXTRACTION3
Report name:
Period:

Aging of: AMOUNT_DUE
On: SALES_DATE
As of: 2017/12/31

Int (Days)	# Records	(%) Records	Debits	(%) Debits	Credits	(%) Credits	Net Value	(%) Net Value
0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	147	26.11	3,321,795.20	17.54	0.00	0.00	3,321,795.20	17.54
60	189	33.57	6,362,877.60	33.60	0.00	0.00	6,362,877.60	33.60
90	127	22.56	4,324,928.80	22.84	0.00	0.00	4,324,928.80	22.84
120	88	15.63	4,736,208.80	25.01	0.00	0.00	4,736,208.80	25.01
150	4	0.71	173,971.60	0.92	0.00	0.00	173,971.60	0.92
180	1	0.18	354.00	0.00	0.00	0.00	354.00	0.00
180+	2	0.36	16,271.60	0.09	0.00	0.00	16,271.60	0.09
ERR	5	0.89	0.00	0.00	0.00	0.00	0.00	0.00
Totals:	563	100.00	18,936,407.60	100.00	0.00	0.00	18,936,407.60	100.00

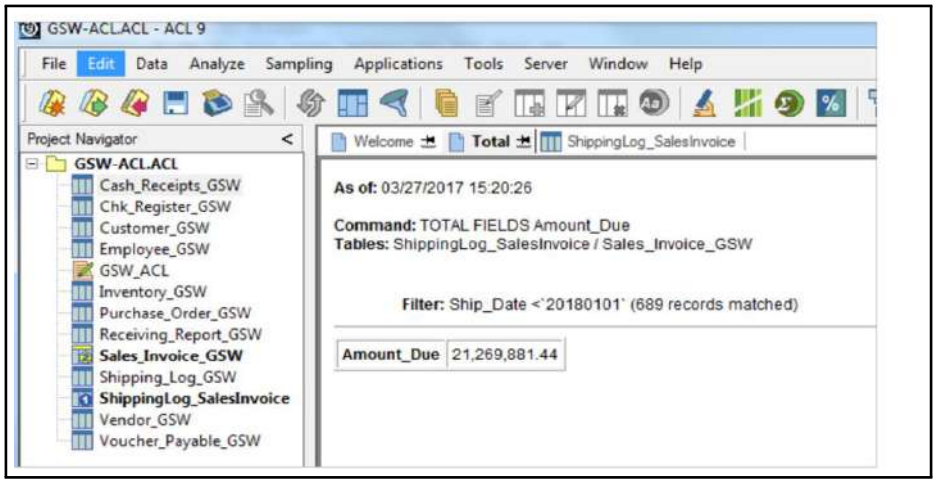


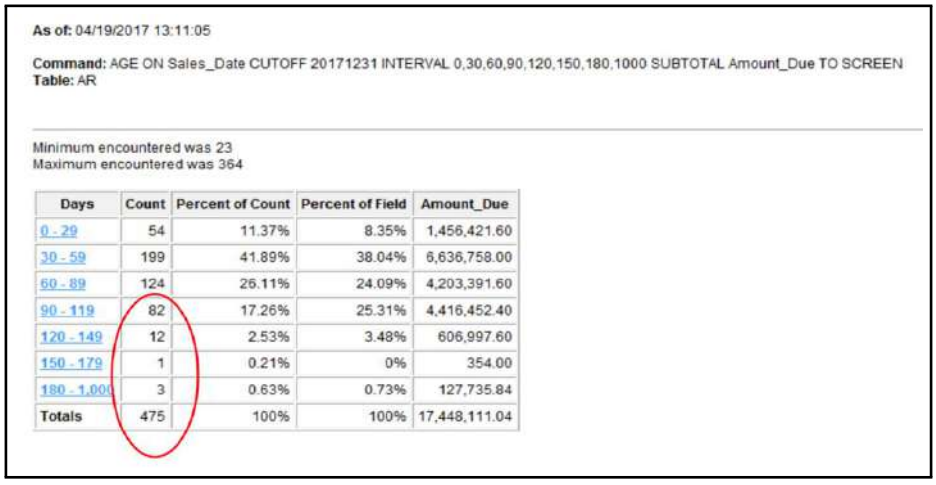
	INVOICE_NUM	CUSTOMER_NUM	AMOUNT_DUE	AMOUNT	SALES_DATE	DUE_DATE	REMIT_NUM
1	303702	616622	111,464.24	1,114,642.40	1/1/2017	2/1/2017	12657
2	311456	616622	64,434.80	51,937.20	2/17/2017	3/18/2017	12661
3	312547	884897	29,504.00	2,950.40	5/21/2017	6/20/2017	12663
4	313668	330825	8,267.60	9,602.00	9/10/2017	10/10/2017	0
5	313916	401287	52,849.60	21,343.60	9/29/2017	10/29/2017	12697
6	314090	362251	81,792.80	8,179.28	10/16/2017	11/15/2017	12709

Result: AR is overstated by 67,621

C. Perform Aging of AR

- **a.** Using the Aging feature on the newly calculated AR table, you will see that a large percentage of GSW Accounts Receivable are more than 90 days past due (screenshot below).
- **b.** Red Flag: Further Investigation is needed. Auditor would question the collectability of these accounts and the appropriateness of the allowance for doubtful accounts (bad debt).
- **c.** Using Sales-Invoice table, Analyze > Age
  - **i** Age on Sales-Date.
  - **ii** Change cut-off date to 12/31/17.
  - **iii** Subtotal fields on Amount-Due.
  - **iv** iv. Change intervals to include 30, 60, 90, 120, 150, 180, and 210.





As of: 04/19/2017 13:11:05

Command: AGE ON Sales_Date CUTOFF 20171231 INTERVAL 0,30,60,90,120,150,180,1000 SUBTOTAL Amount_Due TO SCREEN
Table: AR

Minimum encountered was 23
Maximum encountered was 364

Days	Count	Percent of Count	Percent of Field	Amount_Due
0 - 29	54	11.37%	8.35%	1,456,421.60
30 - 59	199	41.89%	38.04%	6,636,758.00
60 - 89	124	26.11%	24.09%	4,203,391.60
90 - 119	82	17.26%	25.31%	4,416,452.40
120 - 149	12	2.53%	3.48%	606,997.60
150 - 179	1	0.21%	0%	354.00
180 - 1,000	3	0.63%	0.73%	127,735.84
Totals	475	100%	100%	17,448,111.04

D. Test the Accuracy of Sales and Cash Receipts Transactions

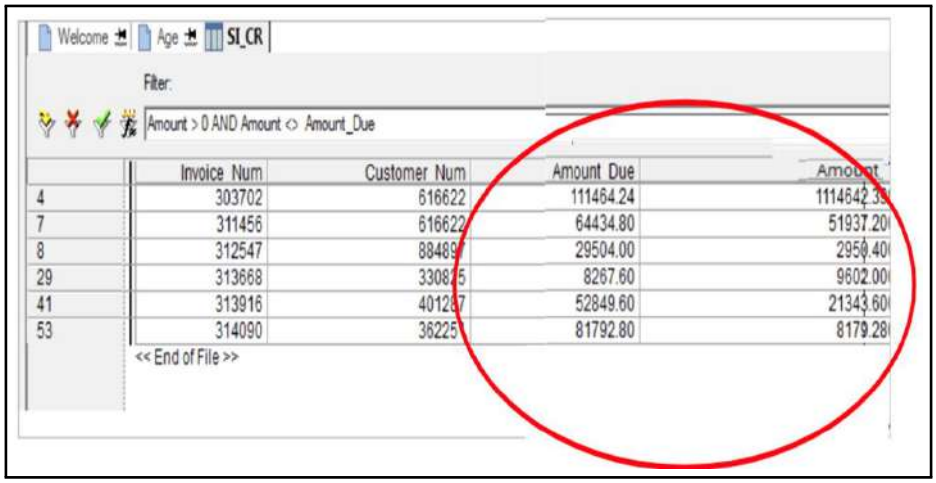
a. Join Sales Invoice, Shipping Log and Cash Receipts on Invoice-Num.

i Primary and Secondary keys: Invoice Num.

ii rimary and Secondary fields: "Add All".

b. Search for discrepancies between amount due and amounts paid using the following expression: Amount > 0 AND Amount <> Amount-Due

Result: Six records reveal discrepancies between amounts due and the amounts paid.



9.4 | Expenditure Cycle Internal Control and Risk Assessment Solutions

Based on the case description and the expenditure cycle flowchart (Figures 3):

a) Discuss GSW's internal weaknesses.
b) Describe the unmitigated risk(s) associated with each control weaknesses.
c) Comment on the possible misstatement in specific accounts due each control weakness.

The following enumerated responses correspond to the numbered circles in the flowchart below:

1) No Purchase Requisition
- **a) Internal Control Weakness:**There is a lack of transaction authorization regarding James Smith. He is responsible to authorize and execute transactions. He determines the items that need replenishing and selects suppliers from the Vendor file, which he maintains.
- **b) Unmitigated risks**.
  - . May order items that are not needed.
  - . Ordering from non-approved vendors at higher than market prices.
  - . Opportunity for fraud such as kickbacks and pass through fraud.
- **c) Possible account misstatements:**
  - . Inventory overvalued.
  - . Purchases excessive.

2) No blind copy of the Purchase Order
- **a) Internal control Weaknesses:**Here, GSW lacks segregation of duties. There is no formal receiving function to count and inspect inventory receipts. Also, no blind copy of the PO is created to control receiving process.
- **b) Unmitigated risk:**Because the clerk used the packing slip instead of a blind copy he may avoid actually counting or inspecting items being received:

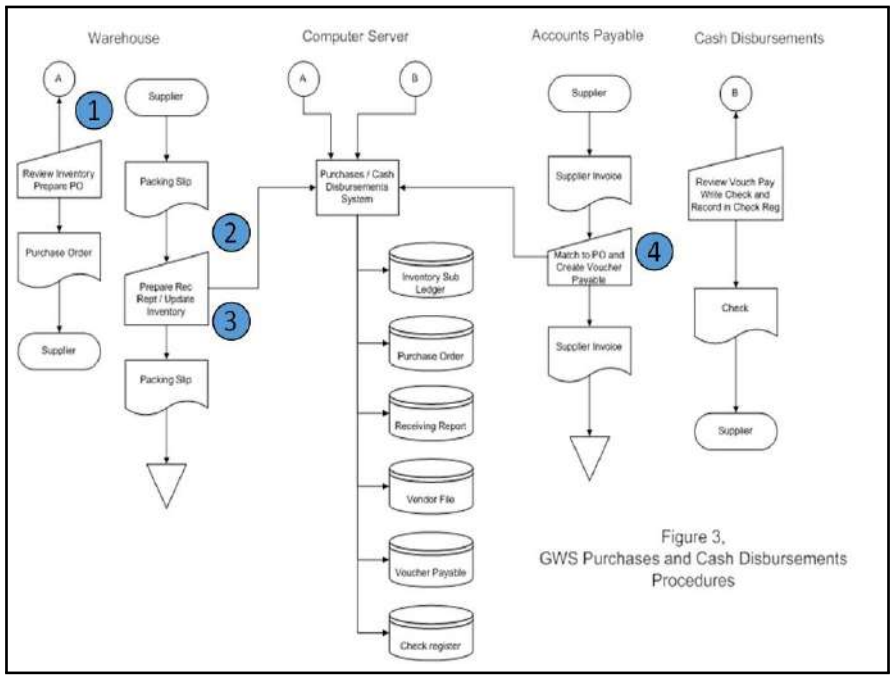


Figure 3,
GWS Purchases and Cash Disbursements Procedures

- May receive items not ordered or incorrect quantities.
- May receive and accept damaged goods.

c) Possible Account misstatements:

- Inventory overvalued.

3) Inventory Custody

a) Internal Control Weakness: The Warehouse staff have inventory custody and record keeping responsibility (previously discussed in revenue cycle).

b) Unmitigated Risk: Because the warehouse clerks have access to the accounting records they may conceal inventory losses and thefts.

c) Possible account misstatements:

- Inventory understated.
- Cost of Goods sold overstated.

4) Three-way match

a) Internal Control Weaknesses: There is no independent verification. The accounts payable clerk does not perform a three-way-match, which reconciles the vendor invoice against the purchase order and the receiving report. This verifies that the company is only responsible for goods that were ordered and received.

b) Unmitigated Risk: Because the clerk does not reconcile the invoice with the receiving report (only the PO), GSW may pay for items not received or for damaged goods.

c) Possible account misstatements:

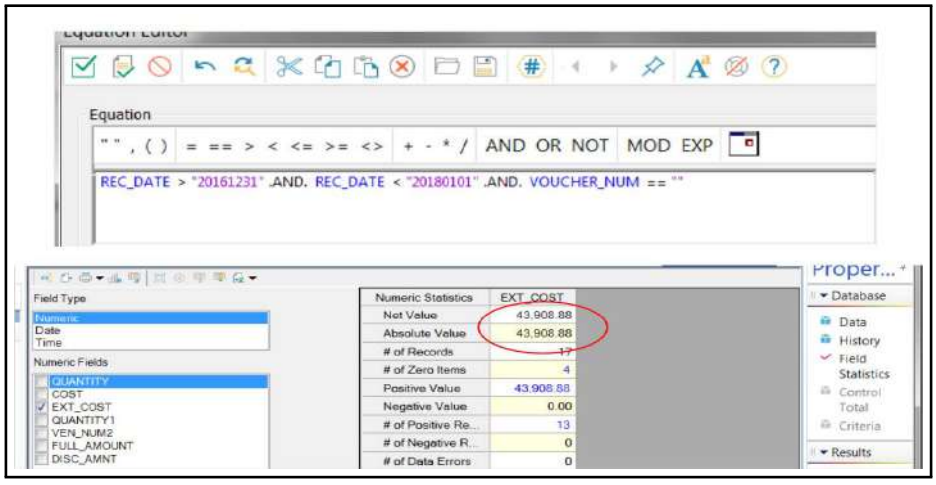
- Accounts payable misstated.
- Cash disbursement errors.

9.5 | Expenditure Cycle Substantive Tests(IDEA)

A. Test for Unrecorded Liabilities

- **a.** Join Purchase Order and Receiving Report on PO-Num, selecting "Matches Only." Since the terms are FOB Destination, only received Purchase Orders are considered liabilities.
- **b.** Next, join the above file and the Voucher Payable file on PO-Num, selecting "All Records in Both Files".
- **c.** Search for items received after 01/01/2017 and before 01/01/18 that are not included in Voucher Payable. These are unrecorded liabilities.

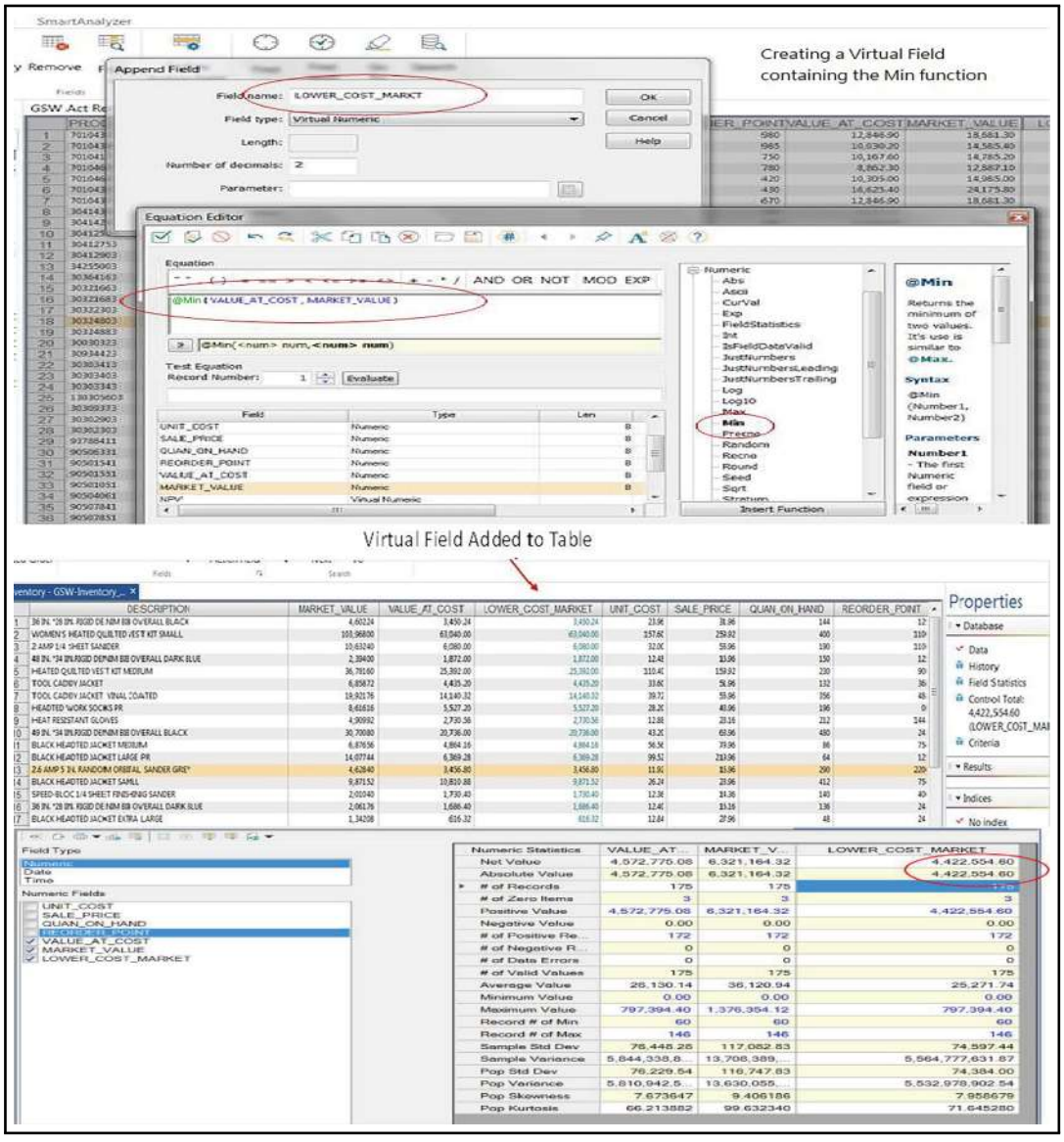
Result: The extraction returns 13 records with an Extended Cost value of 43,908.88.



B. Inventory Reported at Net Realizable Value (NRV)

- **a.** Reported Inv. Balance at 12/31/2017 = 4,572,775.
- **b.** NRV is the lower of market price or cost of a product. To calculate this, we will create a virtual field to find the minimum value between these two parameters.
- **c.** In the Inventory Table, select Append (Data tab > Fields group). Enter the following:
  - **i** Field Name: Lower-Cost-Market.
  - **ii** Field type: Virtual Numeric.
  - **iii** Number of decimals: 2.
  - **iv** Parameter: select Min() function, using Value-at-Cost and Market-Value as Parameters; Execute to add the virtual field to the table.
- **d.** Field Statistics on Lower-Cost-Market = 4,422,554.

Result: Inventory is overstated by 150,221.


Creating a Virtual Field
containing the Min function
Virtual Field Added to Table

C. Accuracy of Payments to Vendors

a. oin Chk Register and Voucher Pay on Voucher Num, selecting "All records in both files".

b. b. Testing for duplicate payments:

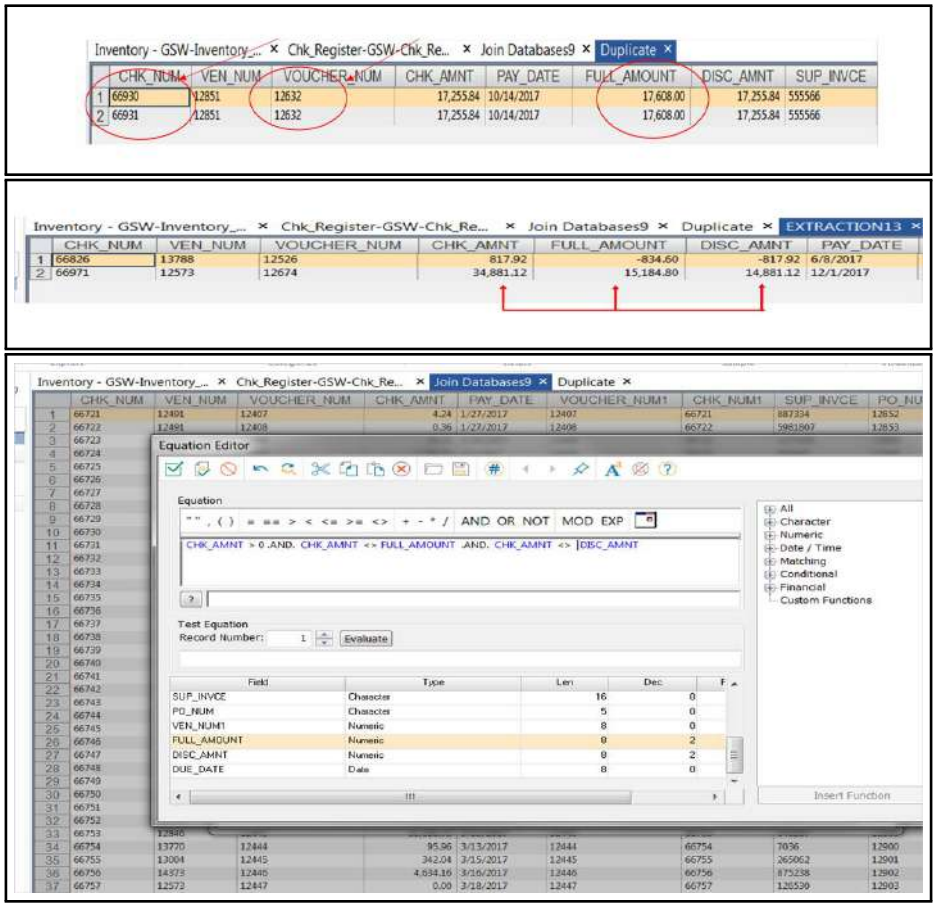
i Use the Duplicate Key option in the Explore Tab, using Voucher-Num as the selection key.

ii This should return 2 records where the Voucher-Num and Full-Amount are the same, but Chk-Num is different. This indicates a red flag for duplicate payments.

c. Checks Written for incorrect amounts.

i i. Using the joined Check Register and Voucher Payable table, extract records where Chk-Amnt > 0 AND Chk-Amnt <> Disc-Amnt AND Chk-Amnt <> Full-Amount.

ii Result: There are two vouchers with checks written for an incorrect amount.



9.6 | Expenditure Cycle Substantive Tests(ACL)

A. Test for Unrecorded Liabilities

- **a.** Join Purchase Order and Voucher Payable on PO-Num.
- **b.** Next, join the above table with Rec Report on PO Num, selecting all primary and all secondary records.
- **c.** Search for items received after 01/01/2017 and before 01/01/18 that are not included in Voucher Payable. These are unrecorded liabilities.

Result: The extraction returns 13 records with an Extended Cost value of 43,908.88.



B. Inventory Reported at Net Realizable Value (NRV)

- **a.** Reported Inv. Balance at 12/31/2017 = 4,572,775.
- **b.** NRV is the lower of market price or cost of a product. To calculate this, we will create a virtual field to find the minimum value between these two parameters.
- **c.** In the Inventory Table, select Edit > Table Layout > Add a New Expression Enter the following:
  - **i** Name: Lower-Cost-Market.
  - **ii** Default Value (click on the f(x) button): Select the minimum function and replace (number, number) with MINIMUM(Value-at-Cost, Market-Value).
- **d.** From Inventory table, right click and select "Add Columns," select Lower-Cost-Market then OK.
  - **i** You should now see the new field in the table.
- **e.** Analyze > Total Fields on Lower-Cost-Market = 4,422,554.

Result: Inventory is overstated by 150,221.



C. Accuracy of Payments to Vendors

a. Join Chk Register and Voucher Pay on Voucher Num, selecting "All primary and all secondary records".

b. Testing for duplicate payments:

i Analyze > Look for Duplicates, select Voucher-Num as the selection key.

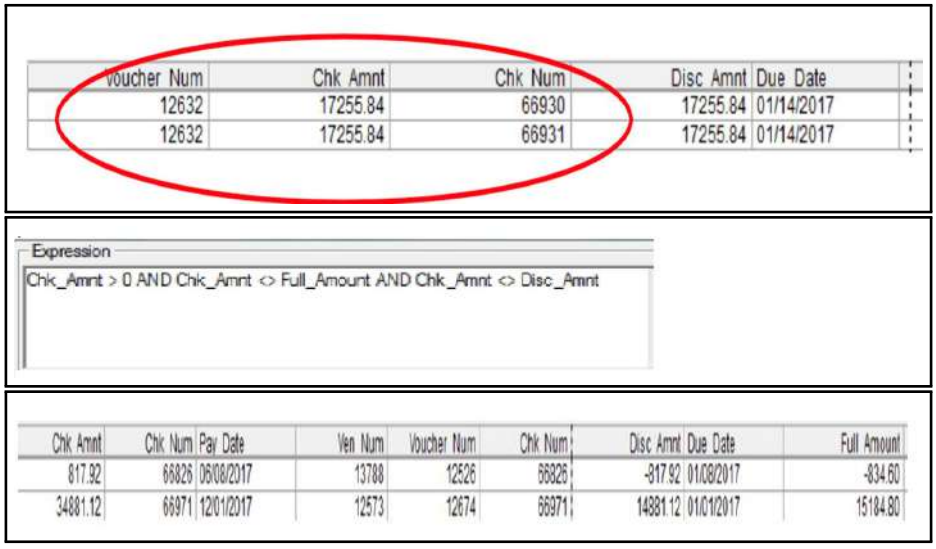
ii Select fields to display and provide a name for output file.

iii This should return 2 records where the Voucher-Num and Full-Amount are the same, but Chk-Num is different. This indicates a red flag for duplicate payments.

c. Checks Written for Incorrect Amounts.

i i. Using the joined Check Register and Voucher Payable table, Data > Extract Data to find records where: Chk-Amnt > 0 AND Chk-Amnt <> Disc-Amnt AND Chk-Amnt <> Full-Amount.

ii Result: There are two vouchers with checks written for an incorrect amount.



Voucher_Num	Chk_Amnt	Chk_Num	Disc_Amnt	Due_Date
12632	17255.84	66930	17255.84	01/14/2017
12632	17255.84	66931	17255.84	01/14/2017

Expression

Chk_Amnt > 0 AND Chk_Amnt <> Full_Amount AND Chk_Amnt <> Disc_Amnt

Chk Amnt	Chk Num	Pay Date	Ven Num	Voucher Num	Chk Num	Disc Amnt	Due Date	Full Amount
817.92	66826	06/08/2017	13788	12526	66825	-817.92	01/08/2017	-834.60
34881.12	66971	12/01/2017	12573	12674	66971	14881.12	01/01/2017	15184.80

9.7 | Audit Tests to Detect Fraud (IDEA)

A. Test for Manipulated Sales Data.

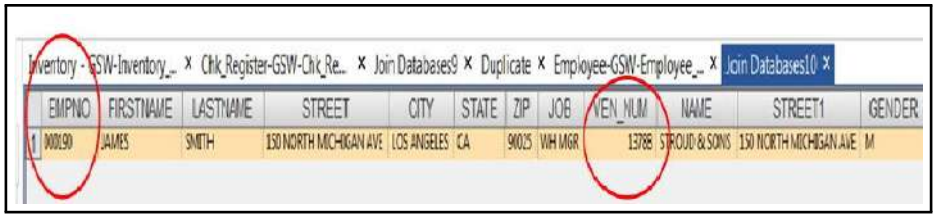
a. Perform a Benford's Analysis on Sales-Invoice.

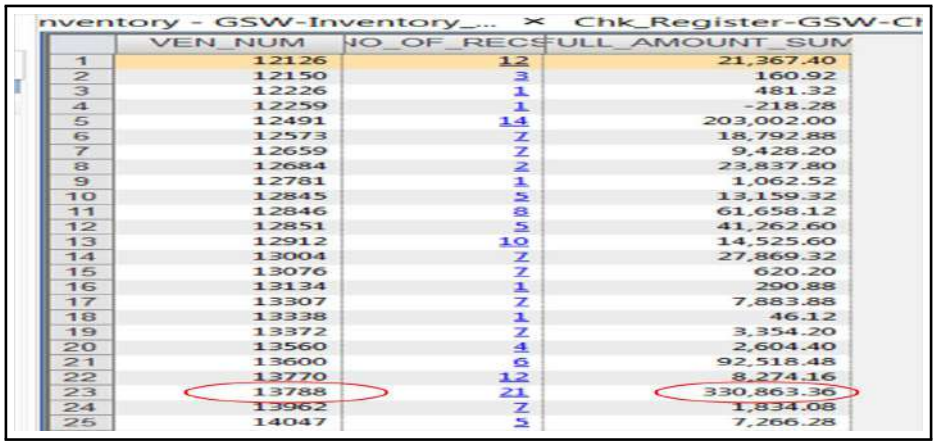
b. See results below:



B. Test for Vendor Fraud.

- **a.** a. Join Employee and Vendor on Street, State, City and Zip selecting "Matches Only".
- **b.** Results show that Employee 000190 has the same mailing address as Vendor 12788.
- **c.** Open Voucher Payable table and Summarize Full-Amount on VEN-NUM.
  - **i** This shows that Vendor 13788 has Accounts Payable in the amount of 330,863.36.

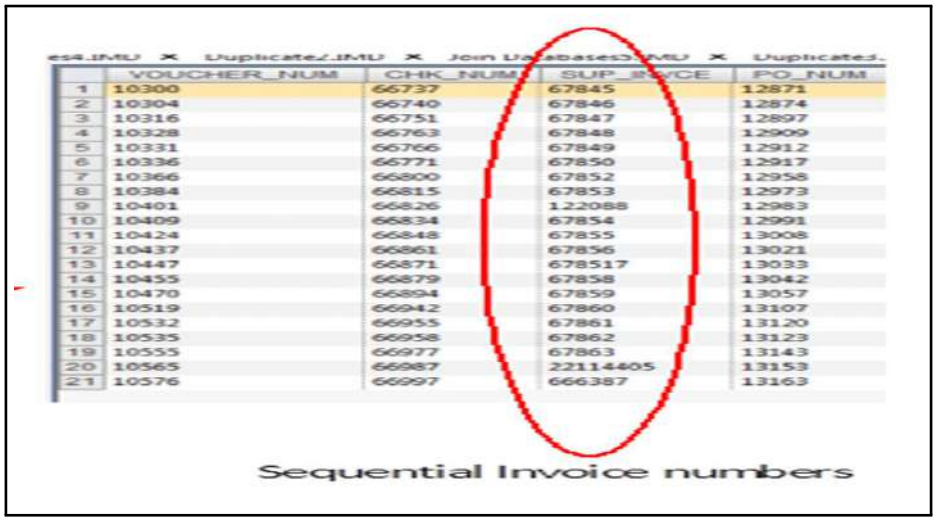




nventory - GSW-Inventory_... × Chk_Register-GSW-Ch

	VEN_NUM	NO_OF_REC	FULL_AMOUNT_SUM
1	12126	12	21,367.40
2	12150	3	160.92
3	12226	1	481.32
4	12259	1	-218.28
5	12491	14	203,002.00
6	12573	7	18,792.88
7	12659	7	9,428.20
8	12684	2	23,837.80
9	12781	1	1,062.52
10	12845	5	13,159.32
11	12846	8	61,658.12
12	12851	5	41,262.60
13	12912	10	14,525.60
14	13004	7	27,869.32
15	13076	7	620.20
16	13134	1	290.88
17	13307	7	7,883.88
18	13338	1	46.12
19	13372	7	3,354.20
20	13560	4	2,604.40
21	13600	6	92,518.48
22	13770	12	8,274.16
23	13788	21	330,863.36
24	13962	7	1,834.08
25	14047	5	7,266.28

A detailed review of the 21 invoices reveals that the supplier invoice numbers are mostly sequential. This suggests that supplier 13788 has a single customer, which is GSW. The address similarities and the sequential invoice numbers are red flags. The auditor would need to report this to management and further investigate these transactions.



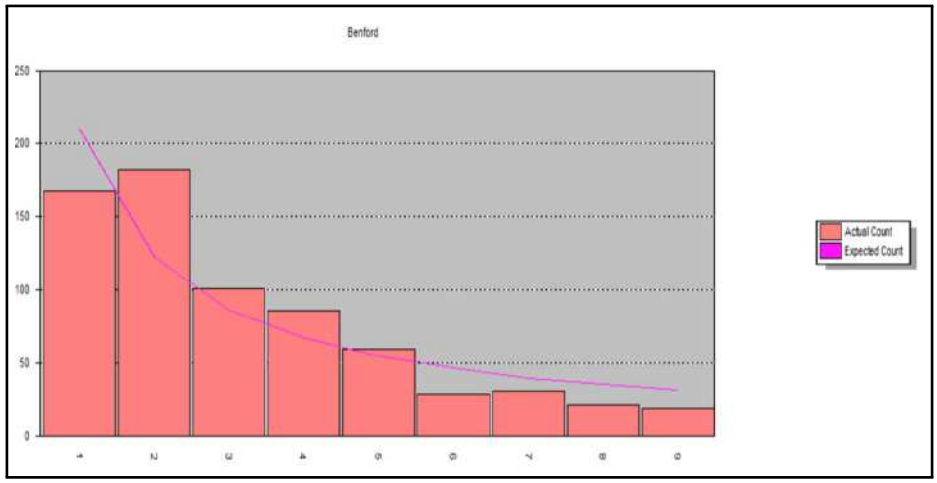
	VOUCHER_NUM	CHK_NUM	SUP_SVCE	PO_NUM
1	10300	66737	67845	12871
2	10304	66740	67846	12874
3	10316	66751	67847	12897
4	10328	66763	67848	12909
5	10331	66766	67849	12912
6	10336	66771	67850	12917
7	10366	66800	67852	12958
8	10384	66815	67853	12973
9	10401	66826	122088	12983
10	10409	66834	67854	12991
11	10424	66848	67855	13008
12	10437	66861	67856	13021
13	10447	66871	678517	13033
14	10455	66879	67858	13042
15	10470	66894	67859	13057
16	10519	66942	67860	13107
17	10532	66955	67861	13120
18	10535	66958	67862	13123
19	10555	66977	67863	13143
20	10565	66987	22114405	13153
21	10576	66997	666387	13163

Sequential Invoice numbers

9.8 | Audit Tests to Detect Fraud (ACL)

A. Test for Manipulated Sales Data

- **a.** Open Sales-Invoice Table.
- **b.** Analyze > Perform Benford's Analysis on Amount-Due.



B. Test for Vendor Fraud

a. Join Employee and Vendor on Street, State, City and Zip selecting "Matches Only".

i Results show that Employee 000190 has the same mailing address as Vendor 12788.

b. Open Voucher Payable table.

i Data > Summarize Full-Amount as field on VEN-NUM and provide a name for the output file.

ii This shows that Vendor 13788 has Accounts Payable in the amount of 330,863.36

	Ven_Num	Full_Amount	COUNT
1	12126	21367.40	12
2	12150	160.92	3
3	12226	481.32	1
4	12259	-218.28	1
5	12491	203002.00	14
6	12573	18792.88	7
7	12659	9428.20	7
8	12684	23837.80	2
9	12781	1062.52	1
10	12845	13159.32	5
11	12846	61658.12	8
12	12851	41262.60	5
13	12912	14525.60	10
14	13004	27869.32	7
15	13076	620.20	7
16	13134	290.88	1
17	13307	7883.88	7
18	13338	46.12	1
19	13372	3354.20	7
20	13560	2604.40	4
21	13600	92518.48	6
22	13770	8274.16	12
23	13788	330863.36	21
24	13962	1834.08	7
25	14047	7266.28	5

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GSW Case Appendix A

Control Activities

Control activities are policies, procedures and practices that management employs to mitigate identified risks to their organization's assets and to ensure the accuracy of accounting information. This appendix describes a class of control activities called "physical controls", which relate to human activities employed within accounting systems. These may be purely manual tasks, such as inspecting inventory receipts, or they may be computer-supported tasks, such as entering sales orders into a computer terminal for automated processing. Physical controls are classified into six subgroups: transaction authorization, segregation of duties, supervision, accounting records, access control, and independent verification (adapted SAS 109, 2006).

Transaction Authorization

The purpose of transaction authorization is to ensure that only valid transactions that are in accordance with management's objectives are processes by the accounting information system. An example of transaction authorization is the task of authorizing inventory purchases only when needed. In many cases this is accomplished by the issuance of a purchase requisition, which then triggers (authorizes) a formal purchase order. Another example is to authorize sales only to those customers who are credit worthy and have undergone a credit check. The type and degree of the credit check will depend on the nature and materiality of the transaction in question. This may be simply to ensure that the transaction in question does not exceeded the customer's credit limit or it could involve extensive review of the customer's financial situation.

Segregation of Duties

The cornerstone of physical controls is the segregation of duties to eliminate incompatible functions being performed by an individual. Depending on the specific tasks to be controlled, segregation of duties will take different forms. The following three objectives, however, provide general guidelines applicable to most situations.

Objective 1: The task of transaction authorization should be organizationally separate from the processing of the transaction. For example, the purchasing function should not initiate purchases until the inventory control function provides authorization (i.e.; a purchase requisition). If properly implemented this segregation of duties would reduce the risk of purchasing unnecessary inventory and lessen the opportunity to perpetrate certain types of fraud.

Objective 2: The tasks of asset custody and that of accounting for those assets should also be separated. For example, the department that has physical custody of finished goods inventory (the warehouse) should not also keep the official inventory records. When a single individual or department has responsibility for both asset custody and record keeping, the potential for fraud and errors increases; assets could be stolen or lost, and the accounting records falsified to conceal the event.

Objective 3: The segregation of duties should be such that the perpetration of a fraud would require collusion between two or more individuals with incompatible responsibilities. For example, no individual should have sufficient access to accounting records to perpetrate a fraud. Thus, journals, subsidiary ledgers, and the general ledger should be maintained separately.

Supervision

Some situations do not lend themselves to desired segregations of duties. This is often the case in small businesses that do not have sufficient numbers of employees to achieve adequate segregation of duties and also in larger firms where functional areas lack sufficient personnel. In such cases management compensate for poor segregation controls through direct supervision. For this reason, supervision is often called a compensating control.

*Independent Verification*Verification procedures are independent checks of the accounting system to identify errors and misrepresentations. Verification differs from supervision because it takes place after the fact, by an individual who

is not directly involved with the transaction or task being verified. In contrast, supervision takes place while the activity is being performed. Examples of independent verifications include:

- Reconciling batch totals at points during transaction processing.
- Comparing physical assets with accounting records.
- Reconciling subsidiary accounts with control accounts.

Accounting Records

Accounting records are the source documents, journals, and ledgers that form an audit trail, which plays an essential role in the financial audit of the firm. The audit trail allows internal and external auditors to trace transactions from the financial statements to the ledger accounts, to the journals, and to the source documents.

Access Control

The purpose of access controls is to ensure that only authorized personnel have access to the firm's assets. Unauthorized access can be either direct or indirect. Physical security devices, such as locks, safes, fences, and electronic alarm systems, control against direct access. Indirect access involves gaining access to the accounting records that control physical assets such as inventory or cash. For example, an individual with access to the relevant accounting records can destroy the audit trail associated with a particular sales transaction. Thus, by removing the records of the transaction, including the accounts receivable balance, the sale may never be billed and never paid.

GSW Case Appendix B

Fraud Schemes and Detection Techniques

The purchasing function is particularly vulnerable to fraud and, for many organizations, represents a significant area of risk. Billing schemes, also known as vendor fraud, are perpetrated by employees who exploit an employer's accounting systems by submitting invoices for fictitious goods or services, inflated invoices, or invoices for personal purchases, forcing the company to issue payments to false suppliers (the employees). A preliminary step in this scheme requires that the perpetrator to create a phony vendor company and establish it in the victim organization's records as a legitimate supplier. The embezzler then submits fake vendor invoices to be processed by the AP function in the victim company. Depending on the organizational structure and internal controls in place, this type of fraud may involve collusion between two or more individuals. For example, a purchasing agent prepares a purchase order for items from the fake vendor, and a receiving clerk prepares a fictitious receiving report for the items. The AP clerk then receives these documents, which appear legitimate, and matches them to the phony invoice when it arrives. A liability is then recorded, and payment is subsequently made. In smaller organizations, a single individual with the authority to authorize payments can hatch a simpler version of the scheme.

Because of the need to falsify accounting records, billing schemes leave a trail in the underlying accounting data that the forensic auditor can follow if he or she knows what to look for. Even in small businesses, finding the telltale trail of fraud from within the masses of transaction data using manual procedures is virtually impossible. Thus, data analysis tools such as ACL and IDEA are essential. The fraud profiles of several fraud schemes and the audit procedures used to detect them are described next.

Sequential Invoice Numbers

A review of invoices from a legitimate vendor should normally show wide gaps in the invoice numbers because the vendor is billing many different customers. Since the victim organization in a vendor fraud scheme is the only recipient of these fabricated invoices, the invoices numbers "issued" by a careless phony vendor may actually follow an unbroken numerical sequence. Therefore, the auditor can use ACL or IDEA to sort the records in the invoice file by both invoice number and vendor number. This will highlight sequential records, which can then be retrieved for further review.

Vendors with P.O. Boxes

Most legitimate suppliers have a complete business address, however, since fake suppliers have no physical facilities, the perpetrator of the fraud may sometimes rent a P.O. box to receive payments by mail. Using the expression builder within ACL or IDEA, the auditor can create a filter to select vendor records from the invoice file that use P.O. box addresses. Since legitimate vendors may also use a P.O. box, this is not proof of fraud, but rather a red flag for further review to verify the legitimacy of the vendor.

Vendors with Employee Addresses

Rather than renting a P.O. box, a perpetrator may use his or her home address on the invoice. Although it is possible that an employee's home-based business is a legitimate supplier, this is not typical and should be investigated. To test this, the auditor can use the join feature of ACL or IDEA to combine the Employee file and the Vendor file on the address fields as the common key for both files. Only records that "match" on these fields will be passed to the resulting joined file. These records should be reviewed further.

Multiple Companies with the Same Address

To divert attention away from excessive purchases made from the same vendor, a perpetrator may create several phony suppliers that share the same mailing address. To detect this, the auditor may use the duplicates feature available in ACL and IDEA to generate a listing of mailing addresses that are common to multiple vendors.

Invoice Amounts Slightly below the Review Threshold

Many organizations establish a financial materiality threshold to control disbursements. Payments of transactions below the threshold are automated, while those above it require a formal management review and approval. Knowing this, a perpetrator may falsify payments that fall just under the threshold to avoid detection and yet maximize his or her benefit from the fraud. The auditor can use the expression builder in ACL or IDEA to identify transactions slightly below the threshold to highlight suspicious activity.

Multiple Payment of Legitimate Invoices

The pay-and-return fraud scheme involves a clerk with check-writing authority who intentionally pays a legitimate vendor twice for the same invoice. The honest vendor, recognizing that the customer made a double payment issues a reimbursement check to the victim company, which the clerk intercepts and cashes. Evidence of such a fraud may be found by joining the Check Register file with the Voucher Payable file and searching for duplicate checks written for the same voucher number.

Manipulation of Accounting Data

Another form of fraud is to simply manufacture false transactions. This may be done to inflate revenue reported in financial statements or to inflate expenses on tax returns. A technique known as Benford's analysis can be used to detect anomalies in data that might be due to fraud or simply clerical errors. This analytical tool is based on Benford's Law, which states that leading digits in a financial string do not occur randomly. In fact, these values naturally follow a distribution in which the leading digit "1" occurs 0.3 of the time while the leading digit "9" occurs only 0.04 of the time. Benford's Law is typically used on individual transaction files such as invoices payable and sales invoices to detect the over or under use of leading digits in the financial data. Auditors can use the Benford's analysis feature in either ACL or IDEA to test the distribution of selected files for compliance with Benford's Law.

Instructor's Appendix A

Supplemental Accounting Concepts

Revenue Recognition

The GSW Sales Invoice file serves as the sales journal. As such, the total sales calculation for the period is derived from the Amount Due field of the Sales Invoice file. Not all of these invoices, however, should necessarily be included in the calculation. Since the case assumes FOB shipping point for sales transactions, only those items that have been shipped on or before the period end date constitute sales for the period. Identifying the valid sales transactions requires students to join the Sales Invoice File with the Shipping Log and screen out invoices that were not shipped or were shipped after the period end.

Accounts Receivable Calculation

Accounts Receivable are the sales invoices (captured in the "Revenue Recognition" description) that are still unpaid at the end of the period. To identify these unpaid items students must join the previously joined Sales Invoice-Shipping Log file to the Cash Receipts file and search for items that are still unpaid or paid after the period end.

Unrecorded Liabilities

The case assumes FOB destination for all purchases from vendors. Unrecorded liabilities are therefore items that were ordered (evidenced by Purchase Order record) and have been received (evidenced by a Receiving Report record), but for which there is no Voucher Payable record. Unrecorded liabilities are calculated by joining the Purchase Order, Receiving report and Voucher payable files. Those items missing a Voucher Payable record are unrecorded liabilities.

Bibliography

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INTERNATIONAL JOURNAL OF COMPUTER AUDITING
Journal Section: Research Paper

Automatic Assessment of Materiality: A Knowledge-based Approach

Mohamed A. Wahdan[1] | **Manar Hassan**[2]

This paper explores how can a knowledge–based system (KBS) be used in auditing especially when the task requires using professional judgments. It concerned with modeling, implementing and evaluating a KBS called Materiality EXpert (MEX). MEX can assess the level of planning materiality and performance materiality as professionals act. Knowledge used to build MEX is acquired from literature, international standards on auditing, and experienced auditors using questionnaire as well as unstructured and structured interviews. MEX was evaluated by 34 auditors from different audit firms in Egypt including international audit firms. The evaluation results acquired from experienced auditors in Egypt indicated that MEX successfully executes the task of assessing the level of planning materiality and performance materiality. Moreover, MEX is efficient, effective, and acceptable from auditors for assessing the level of planning materiality and performance materiality.

KEYWORDS
Planning Materiality, Performance Materiality, Knowledge-based System, Egypt

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1 | INTRODUCTION

Materiality is one of the most important and argued concepts of auditing. As it concerned with determining what is important to be disclosed or to not be misstated in the financial statements. IFRS define materiality as "information is material if omitting, mis-standing, or obscuring it could reasonably be expected to influence decisions that the primary users of a specific reporting entity's general-purpose financial statements make on the basis of those financial statements (IASB, 2017).

An important theme of materiality per professional standards is the concept of auditor judgement (Douglas, 2017). Professional judgment is a skill that the auditor acquires overtime. To assess materiality, auditors use a "personal-judgment" approach. In doing so, they heavily depend on their own experience and expertise. This approach may be ineffective and may lead to different auditors coming to different decisions, developing a personal bias, increasing/decreasing the amount of audit evidence, and/or giving misleading judgments (Wahdan, 2006). Companies, financial institutions, public entities and private entities vary in properties, environment and risks (Montoya et al., 2010). In addition, interviews with users of financial statements stated that materiality is misunderstood and its disclosure would only lead to investor misconceptions regarding the level of work provided. PricewaterhouseCoopers (PwC) similarly questioned whether disclosing materiality information could undermine investor confidence in the audit (Houghton et al., 2011; Christensen et al., 2018). Therefore, many researchers and professionals have called for a more rules -based materiality standard (Azzopardi & Baldacchino, 2009; Douglas, 2017). Moreover, auditors are in need of systems that can collect all relevant knowledge and experience needed for better assessment of materiality (Russ et al., 2009; Azzopardi & Baldacchino, 2009), and make it available wherever and whenever it is needed to improve audit processes (Manita et al., 2011; Azzopardi & Baldacchino, 2009). These systems called knowledge–based system (KBS) or intelligent techniques.

KBS capture tacit knowledge in a very specific and limited domain of a human expertise. These systems capture the knowledge of skilled employees in the form of a set of rules in a software system that can be used by others in the organization. It can provide benefits, help organizations, make high-quality decisions with fewer people. Today expert systems are widely used in business in discrete, highly structured decision-making situations (Laudon & Laudon, 2014).

Factors promoting decision aid in formulating the materiality's assessment are: (1) There are some difficulties in passing the expertise to new auditors. (2) Auditors usually use a "personal-judgment" approach, which has disadvantages as discussed above (Curtis & Hayes, 2002; O'Leary, 2003; Wahdan et al., 2009). (3) Litigation risk faced by the auditor. (4) Time pressure on auditor. And (5) Audit difficulties result from quick change in standards and the tremendous amount of transactions under auditing. Moreover, the way auditors apply and use this concept in practice is one of the most argued subjects. There are no specific rules or prescriptions that can be followed in all circumstances to assess materiality. It is the matter for the auditor to decide whether a particular item has a material impact on the financial statements or not, and auditors usually use a "personal-judgment" approach. So a computerized program for assessing materiality will be very useful. Thus, the main research questions examined in this paper are: (1) how can a knowledge-based system be developed and used for assessing materiality in the audit planning stage? And (2) to what extent is the proposed KBS for assessing planning materiality and performance materiality effective, efficient, and acceptable as an auditing tool and a training tool?

In order to construct, implement, and evaluate a KBS, which is able to assess planning materiality and performance materiality, we must investigate the auditors' relevant knowledge and reasoning method related to the task. In our investigation, a KBS was developed called Materiality EXpert (MEX), which is able to assess planning materiality and

performance materiality. MEX contains all knowledge associated with the auditor's assessment on the level of planning materiality and performance materiality. MEX is targeted in particular at the auditing practice in Egypt. This country has only a limited number of experienced auditors who are adequate in assessing the level of planning materiality and performance materiality (Wahdan et al., 2005). To develop MEX, knowledge was acquired from the literature and elicited from an appropriate set of experienced auditors from international auditing firms working in Egypt through questionnaires and in-depth interviews.

MEX is expected to increase auditor's efficiency and effectiveness. Moreover, MEX may be used as internal training tool at auditing firms to build up the experience of the novices using structured knowledge elicited from experts. Despite the area of how to assess materiality is important to the conduct of an audit, and the foundation from which audit scope decision is made, previous researches on qualitative measures such as Earnings Before Income Tax and Amortization (EBITA) are limited (CAQ, 2017).

The outline of the paper is as follows. Section 2 presents the literature review. Section 3 introduces research methodology. Section 4 illustrates planning materiality assessment. Section 5 demonstrates factors that must be considered in the assessment of PM. Section 6 presents the conceptual models of MEX. Section 7 illustrates knowledge representation and MEX implementation. Section 8 presents the evaluation of MEX, and section 9 illustrates the conclusion and points to future research.

2 | LITERATURE REVIEW

2.1 | KBS in Accounting and Finance

The area of intelligent techniques has expanded phenomenally over the last years since 1940s; both in terms of the range of techniques and number of applications where in they have provided a competitive edge (Pardo et al., 2008). KBS has been applied to an abundance of decision problems in financial, accounting and production domains, such as for supporting investments decisions (Poh, 2000), for performance measurement (Ammar et al., 2004; Khan & Wibisono, 2008; Wang et al., 2008), for formulating budget planning - which is called Knowledge-based Intelligent Decision Support System or KIDSS system (Wen et al., 2005), for supporting business in small financial institutions (Chung & Pak, 2006), for optimizing portfolio management (Bao & Yang, 2008), for measuring logistic performance - which is called knowledge-based logistics performance measurement system or K-LPMS (Choy et al., 2008), for financial knowledge management (Shiue et al., 2008; Cheng et al., 2009), for evaluating the credit worthiness of customers using balance scorecard strategic planning opinions - which is called BSC knowledge-based system or BSCKBS (Huang, 2009), for selecting supplier/customer with the consideration of benefits, opportunities, costs, and risks (Lee, 2009), for determining cost-volume-profit analysis (Yuan, 2009), for determining (pro)-performance appraisal (Chen & Chen, 2010), for obtaining customer-buying patterns (Jayanthi & Vishal, 2011) and for interpreting financial performance (Gunawan, 2012).

2.2 | KBS in Auditing

Other KBS have been applied to an abundance of decision problems in auditing domain in general, such as for formulating the auditor's opinion on financial statements- which is called Auditor Report EXpert "AREX" (Wahdan, 2006), for improving the continuous audit process (Devale & kulkarni, 2012), for increasing audit efficiency and effectiveness (Bukhsh & Weigand, 2013), for auditor's report on internal control over financial statements, which is called Auditor Report on Internal Control (ARIC) (Wahdan, 2013), for auditing risk management (Inherent, control and detection risks) (Otiento & Oima, 2013; Marand & bayaz, 2015).

2.3 | KBS for Materiality

Many KBSs have been developed for assessing materiality , such as Steinbart (1987) who proposed a rule-based expert system (called Auditplanner) for making the materiality judgments in the planning stage. The study aimed at investigating how various types of quantitative and qualitative information influence audit decisions associated with the materiality judgment. The Auditplanner recommendations were evaluated as acceptable in eight out of the thirteen company cases studied. However, it is impossible to generalize the findings and conclusions presented by Auditplanner, because the knowledge base reflected the judgments of only one audit partner (expert specific) and the study did not mention the extent to which auditors would benefit from Auditplanner. Additional research needs to be done in this area. Other study was made by Chong (1992) who explored the possibility of applying KBS to meet the needs of preparers of financial statements and auditors. Having a structured materiality guideline could mean additional confidence is given to both the accounting profession and users of financial statements. It also facilitates comparability, and regulates quality. Then Chong explained the problem of materiality faced by the auditors. Chong recommended the following materiality guidelines, an item: (1) is considered immaterial if it is < 10 percent of net profit, (2) is subject to judgmental decisions if lies between 10 and 15 percent of net profits, and (3) is considered material if it is > 15 percent of net profits. These guidelines should not be applied to those statutorily- required disclosure items. In addition, auditors should consider the qualitative factors of the items and its effects on the fair representation of the financial statements. However, the author discusses the possibility of applying KBS and does not design a KBS for materiality judgments.

Moreover, Comunale & Sexton (2005) demonstrated the application of fuzzy logic to assess materiality. The idea is to build an expert system based on fuzzy logic that assesses materiality. The researchers point out that the system differs from most expert systems in a very important way. The major difference between expert systems and fuzzy logic is that, expert systems capture tacit knowledge in the form of rules. Expert systems are most useful for problems of classification or diagnosis. Fuzzy logic is a software technology for expressing knowledge in the form of rules that use approximate or subjective values. Fuzzy logic has been used for controlling physical devices and is starting to be used for limited decision-making applications. We noted that Comunale & Sexton's system is designed to improve the performance of the expert. However, the current KBS is designed to emulate the performance of an expert. Furthermore, the proposed fuzzy expert system by Comunale & Sexton needs to be reviewed by experienced auditors to reflect the decision-making process by the auditors and it should be tested using actual auditing engagements to reflect insights gained in practical applications.

By reviewing the literature, prior studies have used KBS in many financial, accounting, auditing and business applications, but have not applied in assessing overall planning materiality and performance materiality. To the best of our knowledge,

until now no KBS was developed for assessing materiality in the planning stage of the audit process using practical expertise and experience. The current study focuses on designing a KBS able to assess materiality in the planning stage of the audit process.

3 | THE RESEARCH METHODOLOGY

This research investigates how the assessment of materiality may be improved by using a KBS. It focuses on modeling, implementing, and evaluating MEX. To achieve the research goal, a research methodology consisting of 5 phases was developed as follows: 1) reviewing the literature, 2) designing a questionnaire, 3) constructing the proposed KBS based upon practical flowcharts, 4) implementing MEX, and 5) evaluating MEX. Knowledge elicitation is the first step in building an expert system (Sagheb-Tehrani, 2009). Different ways are applicable to elicit knowledge from experts such as structured interviews, unstructured interviews, documentation analysis, case study analysis, and observation analysis (Sagheb-Tehrani, 2009). During the knowledge elicitation: knowledge problem is identified, and determines if we can use knowledge from experts, textbook and articles (Wahdan, 2006). The study was divided into five steps as follows:

1) A profound literature review was performed for acquiring knowledge to assess planning materiality. In addition to other data sources that are up to date by its nature, such as: academic materials, periodicals, and auditing standards concerning the assessment of materiality

2) The questionnaire (No.1) with in-depth interviews was used to elicit the knowledge from 30 experienced auditors from different audit firms in Egypt, including international audit firms. The auditors were selected depending on at least one of the following three factors: (i) having at least ten years of experience, (ii) their level of education, and/or (iii) their work in the international audit firms in Egypt). In order to acquire the auditors' knowledge and expertise needed to assess planning and performance materiality. The questionnaire consists of questions requiring a response on a five-point Likert-scale (always, often, sometimes, rarely, never) (see appendix). Disagreements among auditors are decreased, and if there are still disagreements, the main expert takes a decision. Example of the conflicting concept is the confusion occurs between performance materiality, as it is new and not widespread and planning materiality. Performance materiality is an alternative to tolerable error.

3) Our conceptual model structures the assessment of materiality in the audit planning stage. The conceptual model consists of assessing planning materiality and performance materiality. Flowcharts were constructed based upon the knowledge collected and elicited in the previous phases above. The arrows in flowcharts indicate that the output of one of the models is used as input for the other.

4) The knowledge acquisition process was structured according to Extensible Markup Language (XML), using the models specified in the previous step. It is remarked that reasoning systems play an important role in the implementation of artificial intelligence and knowledge-based systems. C# (C Sharpe) is a programming language that was used to build the reasoning system, which is used to achieve the conditional rule and give the user the advice as per the answers of the questions comes out from MEX.

5) After the auditors had used MEX, they were asked to answer questions formulated in the questionnaire (No. 2) in order to determine its effectiveness, efficiency, and acceptance in assessing materiality in the planning stage of the audit process. A five-point Likert-scale was used in the questionnaire (see section 8).

4 | MATERIALITY ASSESSMENT AT AUDIT PLANNING STAGE

In this section, we first set out the basic concepts of planning materiality, and then we explain how to determine overall materiality (benchmarks, threshold level) and performance materiality.

Materiality in the context of an audit takes the form of a numeric threshold which the auditors initially determines by applying a certain percentage to a chosen benchmark (IFAC, 2009), that must be interpreted in light of surrounding qualitative circumstances by applying professional judgment (Baldacchino et al., 2017). In general, auditing standards recommended that a percentage of a chosen benchmark be used as a starting point for determining the materiality threshold.

4.1 | Characteristics of materiality

ISA 320 specifics 3 main characteristics of materiality (IFAC, 2009; MIA, 2012):

1. Misstatements are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users based on the financial statements.
2. Judgments about materiality are made in context of surrounding circumstance, and are affected by the size (quantitative – monetary amount involved) and/or nature of misstatements (qualitative).
3. Judgments about materiality are based on consideration of common financial needs of users as a group.

4.2 | preliminary judgment about materiality

Auditing standards require auditors to determine the combined amount of misstatement in the financial statements that they consider material and called preliminary judgment about materiality. As it is the maximum amount by which the auditor believes that the financial statements could be misstated and still not affect the decision of reasonable users (Eilifsen & Messier, 2014). The higher the amount of preliminary judgment, the lower evidence required. As, risk is a measure of uncertainty, whereas materiality is a measure of magnitude or size. Taken together, they measure the uncertainty of amounts of a given magnitude (Eilifsen et al., 2014).

Moreover, Materiality is addressed for each reporting issue regarding the consistency, scope restriction, and accounting principles (Groomer and Heintz, 1999; Messier, 2000; Gist and Shastri, 2003; Al-Sharairi, 2013). According to Arens et al. (2014), the following three levels of materiality affect the type of opinion on the financial statements. (1) The amounts are immaterial, (2) The amounts are slightly material, and (3) The amounts are highly material.

4.3 | Bases or benchmarks in determining materiality

According to ISA 320 examples of benchmarks that may be appropriate, depending on the circumstances of the entity (entity's lifecycle, user's interest, entity's ownership structure and volatility of the benchmark) are: profit before tax,

total revenues, gross profit and total expenses, total equity or net asset value. Profit before tax from continuing operations is often used for profit-oriented entities (IFAC, 2009).

4.4 | Materiality level or threshold

Materiality level or materiality threshold is a materiality level in which an item above is considered material and in which an item below is regarded as immaterial. ISA 320 stated that (IFAC, 2009): "Determining a percentage to be applied to a chosen benchmark also involves the exercise of professional judgment"

Auditors may change this amount according to any change in the factors affecting these judgments or due to qualitative events, such as the issuance of debt that created a new class of financial statements' users. Planning Materiality or overall materiality (PM) is often determined before year-end and is based on prior years' financial statements or annualized interim financial statements information (Arens et al., 2014).

4.5 | Performance materiality

In essence, the materiality measure is subdivided into smaller amounts. This is called performance materiality. The degree of reduction from overall materiality depends on the level of risk associated with the audit, the quality of the internal control environment at the entity (Council, 2017). It is very important in determining the nature, timing and extent of audit procedures because evidence is accumulated by segment rather than for the financial statements as a whole. There is an inverse relationship between performance materiality and the amount of evidence auditor will accumulate.

Performance materiality does not affect any of the four risks (control risk, inherent risk, audit risk, detection risk), and the risks have no effect on performance materiality, but together they determine planned audit evidence. The quantity of audit evidence needed is affected by the risk of material misstatements (in the audit of financial statements) or the risk associated with the control (in evaluating the effectiveness of internal control over financial reporting) (PCAOB, 2010; Feng, 2017). Figure 1 illustrates the relationship between performance materiality and risks to planned evidence.

The one presented in the AICPA'S Audit Sampling Guide 2001 is to apply a percentage between 50-60 % of planning materiality to determine the tolerable misstatements (Chen et al., 2008). Based on interviews in big audit firms in Egypt, they use a percentage of 50-75% of planning materiality. The starting point for setting performance materiality is 50% of PM for listed entities in regulated industries, 75% of PM for non- listed entities in unregulated industries. Decision regarding whether to raise performance materiality or to lower it depending on several qualitative factors. Auditors must consider expectation about misstatements, understanding the entity and industry, past history with the entity, assessment of the risks, and the effectiveness of internal control over the financial statements. Most practitioners allocate materiality to balance sheet rather than income statement (Arens et al., 2014).

Based on interviews with auditors and investigation of some documents at one firm of the big 4 in Egypt, we found that performance materiality can vary for different classes of transaction, account balance, and disclosure according to control risk, and the inherent risk. Performance materiality amount is allocated to specific items according to the level of inherent risk and internal control evaluation as illustrated in Table 1

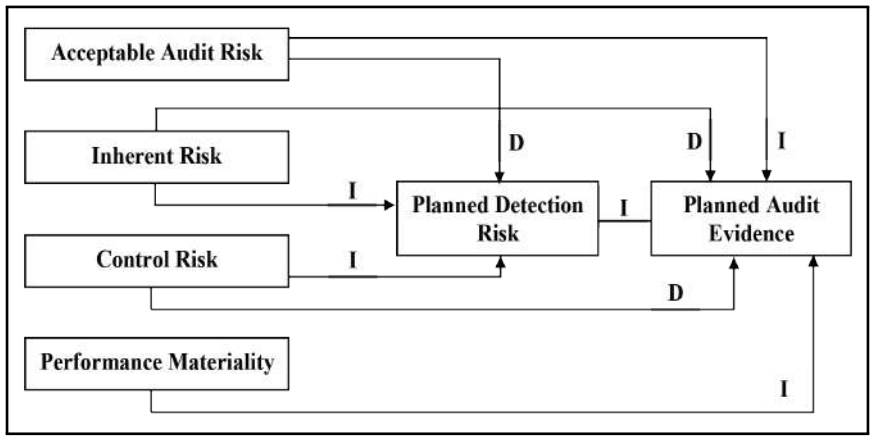


FIGURE 1 Relationship of TE and risks to planned evidence Source: (Arens et al., 2014)

5 | QUALITATIVE AND QUANTITATIVE FACTORS

Many researchers (Steinbart, 1987; Chong, 1992; Iskandar, 1996; Brennan & Gray, 2005) proposed that a guideline for materiality should be recommended for accounting and auditing professions. Absence of materiality judgement guidelines results in many problems and risks for both the profession and users of financial statements (Iskandar, 1996). Qualitative and quantitative methods are used to determine the accounts' position on the materiality of a decision making (Juma'h, 2009). Materiality tends to be considered in quantitative terms only until in the 1970s. Quantitative approach based on historical data of financial and nonfinancial variables (Juma'h, 2009). It uses a percentage of a key figure in the financial statements. These studies agreed that the size of an item as a percentage of the net profit of the current year is the most important factor influencing decision on materiality (Emil et al., 2010).

Table 1: TE for key items depending on controls and inherent risk

	Rely on controls	Do not rely on controls
High IR	• 50-75% of TE For assets / income • 15-25% of TE For liabilities / expenses	• 10-25% of TE For assets / income • 5-10% of TE For liabilities / expenses
Lower IR	• 75-100% of TE For assets / income • 25-50% of TE For liabilities / expenses	• 25-50% of TE For assets / income • 10-15% of TE For liabilities / expenses

Qualitative approach based on auditors' or accountants' own judgments depending on their experience (Brennan & Gray, 2005; Juma'h, 2009). Researchers outline the qualitative factors by reviewing literature in this area. The first category is the characteristics of the audited companies (auditee) (Emil et al., 2010). The most important determinants in this category are the characteristics of leadership, the financial situation and the internal control quality, the size and

the sector (industry) in which the companies operate (Pany & Wheeler, 1989; Steinbart, 1987; Vaassen, 1994; Iskandar, 1996; Juma'h, 2009), changes in the accounting policies and audit committee characteristics. Other factors may include management features and lifestyle. As, management has incentives for materiality levels to be as high as possible, auditors also have similar incentives. Therefore, the state of internal control, expected users of financial reports, the financial situation, management accounting policies, and whether the company participates in the stock market or not are very important factors (Iskandar, 1996; Juma'h, 2009; Emil et al., 2010). The Second category is the characteristics of the audit firm performing the audit, highlights the following factors of influence, the structure and the size of the audit firm, company's culture and its relationship with customers. The third category is the auditor's individual characteristics such as the auditor's professional characteristics (knowledge, dependence on fees), professional experience and other personal characteristics (age, innate ability, mood, and sex) considered important factors (Juma'h, 2009; Emil et al., 2010).

Manita et al. (2011) stated that several explanatory models for understanding the decision process concerning materiality judgement borrowed from the cognitive psychology. Generally, these models appeal to three explanatory dimensions: the recognition of an ethical problem, the ethical judgement and the creation of intention, which result in ethical behavior. Furthermore, The SEC introduced the notion of qualitative materiality (Brennan & Gray, 2005; Emil et al., 2010) such as illegal activities. Illegal activities are considered material, even if their financial effect is not significant. Moreover, assessing the market's reaction to the misstatements (Park, 2009) as Enron disaster continues to provide many lessons for the auditing profession (Arens et al., 2014). It is necessary to do with inherent natural features, the interior of one or more conditions of accounts, not simply their value. They will be able to see the trend of material misstatements of the financial statements (Ndreca, 2013).

For instance, we have two companies; one of them with low inherent risk and low control risk it means there is a low probability of misstatements (company B) and the other is a company with high inherent risk and high control risk so the probability of existence of misstatements is high (company A). As we define materiality level as the Egyptian pound level amount where misstatements larger than the amount that requires adjustment in the FS. Figure 2 demonstrates factors affecting materiality.

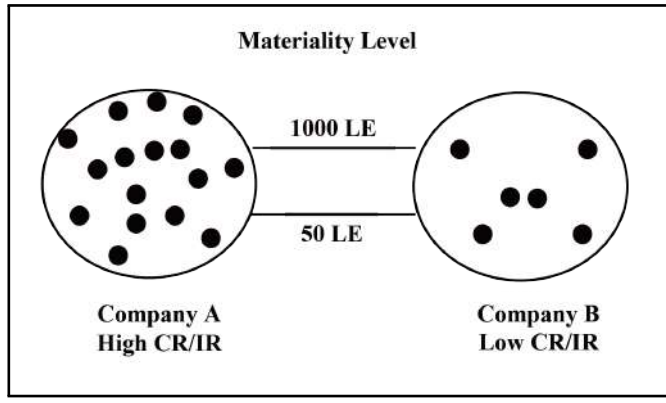


FIGURE 2 Factors affect level of materiality

There are two level of materiality high and low. If the materiality is stated at the high level for both companies, auditors will consider misstatements above this level are material and this will result in more misstatements in company (A) not

be detected and may be material. On the other hand, if the materiality is stated at the lower level. Auditors will express much more effort than needed in company (B) as the actual misstatements are not common due to the effective internal control and low inherent risk. Therefore, materiality and detection risk move in the same direction. Detection risk and inherent / control risk move in opposite directions.

6 | THE CONCEPTUAL FRAMEWORK OF MEX

MEX is a KBS to assess materiality at the planning stage of the audit process, and to determine the level of performance materiality. As, using flowcharts approach is an effective tool to improve the education (Wahdan, 2018) of assessing planning and performance materiality. The first conceptual model consists of 3 sub-models which are (1) determining the appropriate threshold category, (2) selecting the appropriate benchmark, and (3) determining the threshold level. The result of the third sub-model comes from the interaction among other 6 sub-models (control risk evaluation, management integrity evaluation, probability of the existence of financial difficulties determination, user's adoption on the financial statements, using of financial statements for special purpose, and management lifestyle) in addition to 2 direct questions. In order to comply with COSO's (COSO, 2013), it's a must to take into account the components of internal controls and called them relations that interact with each other to get conclusion about the control risk as illustrated in Figure 3.

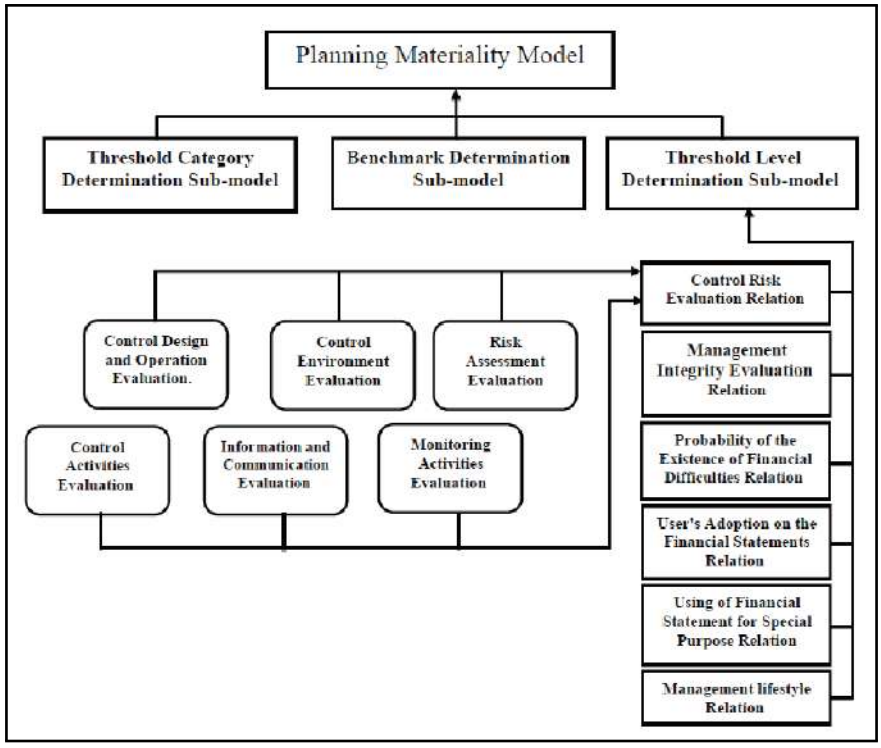


FIGURE 3 The conceptual Model for MEX

The second conceptual model (performance materiality) consists of two sub-models: (1) output of planning materiality model (result of the first conceptual model), and (2) performance materiality threshold level. The following flowcharts illustrate the process of determining threshold category, threshold level, benchmark, and performance materiality threshold level.

1) **Threshold category**:From interviews with professional auditors in Egypt, we found that auditing firms classify the auditee into three categories: new entity, old entity-listed or entities in regulated industries, and old entity non-listed in unregulated industries. Figure 4 illustrates the threshold category determination.

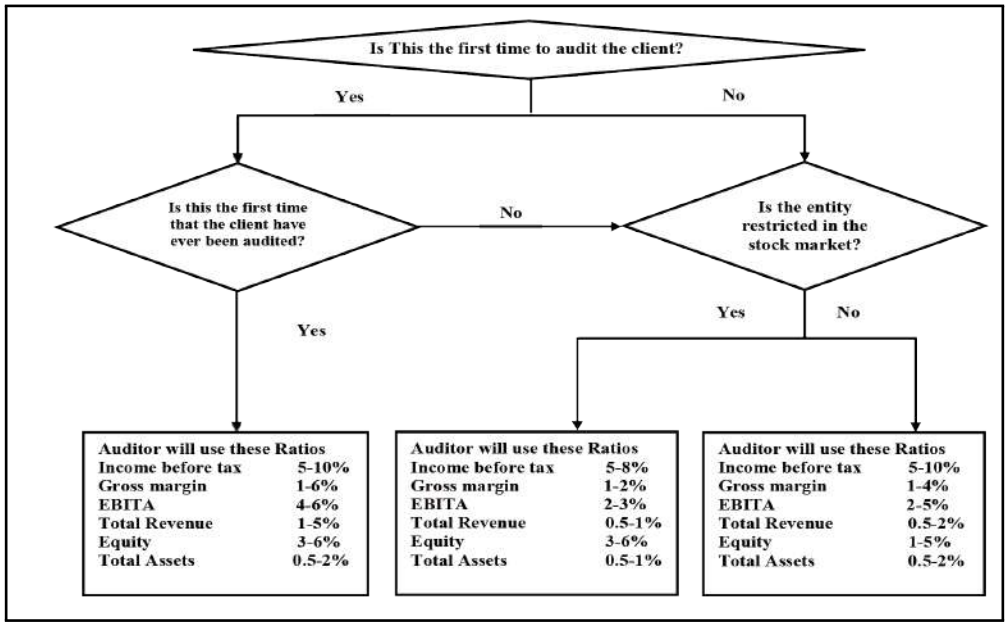


FIGURE 4 Threshold Category Determination

2) **Threshold level**:The input of threshold level determination sub-model comes from six relations, which appear in Figure 3, and four direct questions about nature of misstatement, client commitment, auditor-past experience, and materiality level last year. Answers from both (relations, direct questions) give the auditor reason to choose between the upper-end level and lower-end level. If the auditor decides that management integrity was questionable, he will reduce the threshold level to the lower end and this will affect the decision of determining the appropriate evidence to accumulate. Figure 5 demonstrates threshold level determination.

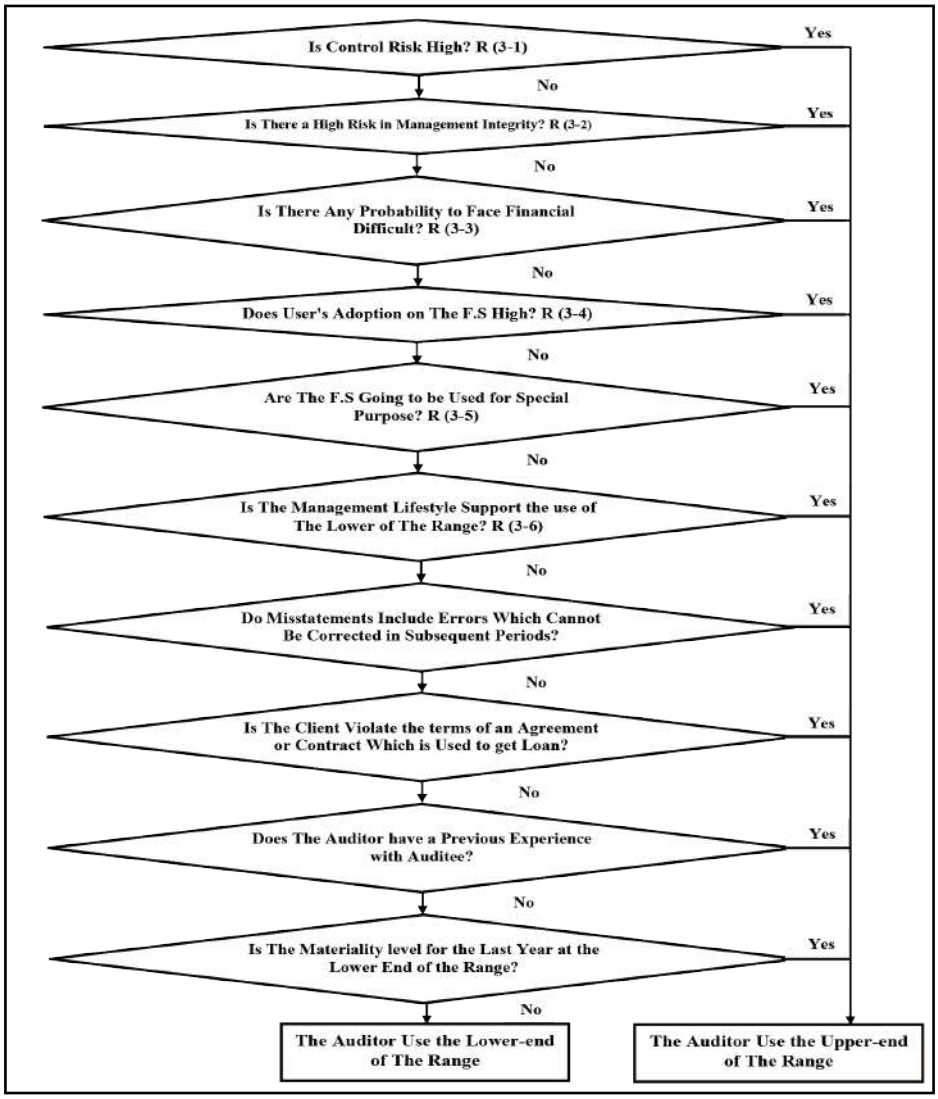


FIGURE 5 Threshold Level Determination

3) **Benchmark determination**:The choice of materiality benchmark is influenced by nature of the client (public or private; MEX focuses on private sector only and excludes financial institution), future plan of the client, needs of the user of financial statements, Income trend in the current year, and / or the entity is near to the break even or losses. Auditor may choose from several benchmarks such as gross margin, EBITA, total revenues, total assets, and equity. Figure 6 demonstrates base determination process.

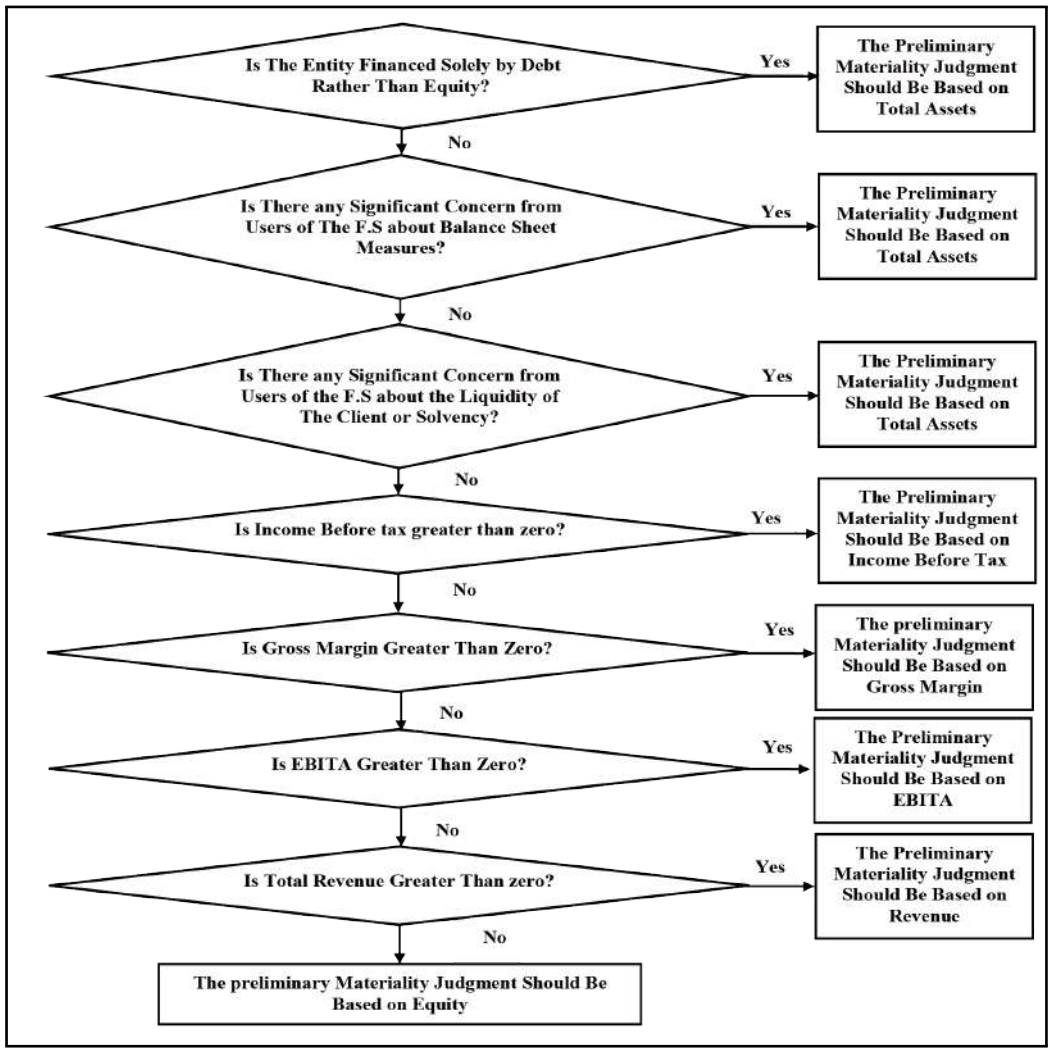


FIGURE 6 Materiality Base Determination
EBITA: Earnings before Income Tax and Amortization

4) **Performance materiality threshold level**:Auditors choose between two options, a percent of 50 OR 75 of planning materiality according to inherent risk level, control environment evaluation, and misstatements of the previous year. Figure 7 illustrate how to determine performance materiality threshold level.

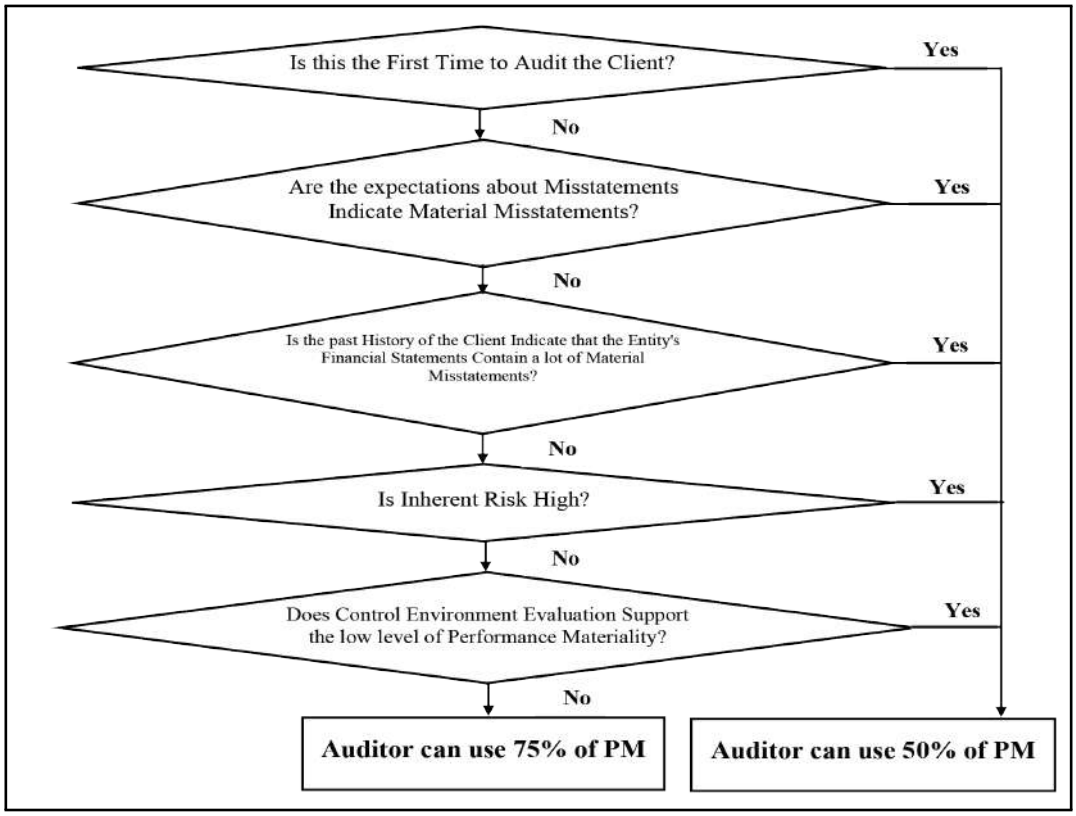


FIGURE 7 Performance Materiality Threshold Level

7 | KNOWLEDGE REPRESENTATION AND MEX IMPLEMENTATION

The main challenge is how to model expertise. Extensible markup language (XML) was used in coding and storing data in order to represent knowledge in the database.

Reasoning system is a software system that generates conclusions from available knowledge using logical techniques such as deduction and induction. C# (C Sharpe) is a programming language that was used to build the reasoning system. The total number of MEX's concepts is 72 concepts and the total number of rules is 744 rules. User can find MEX on the desktop as MEX shortcut. If he makes double click on it, he will find the start page of the software that defines the software and how it works as illustrated in Figure 8. When clicking on start, a user interface will appear as in Figure 9.

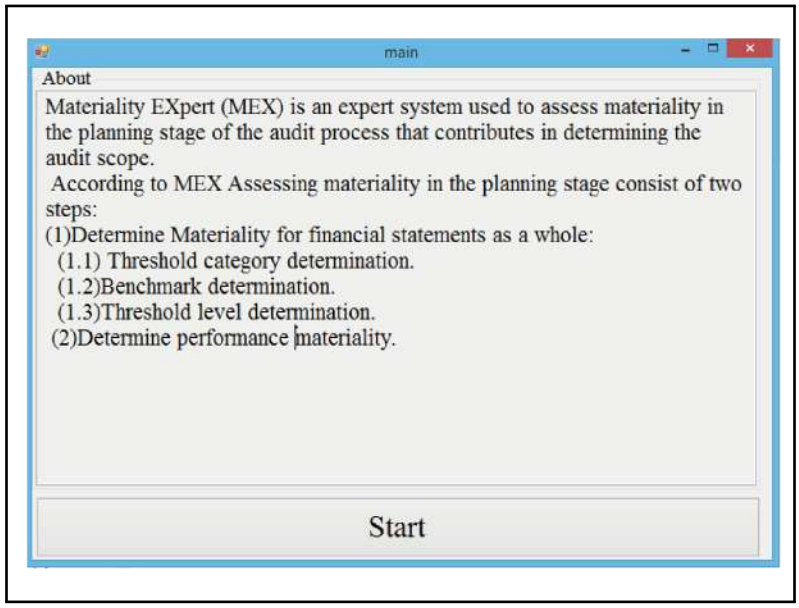


FIGURE 8 MEX start page

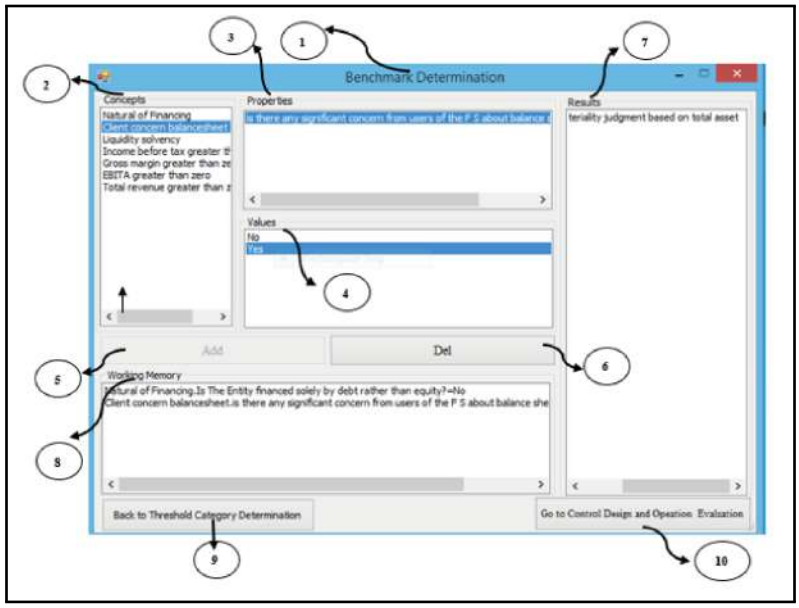


FIGURE 9 MEX start page

Where: (1) Model name, (2) Concept to be evaluated, (3) Properties represent the questions help in evaluating the concept (ex: internal control) or in making decision, (4) Values: when user clicks on specific concept and begin to answer to the questions in the property, (5) Add button: used to ensure the chosen answer, (6) Del button: is used when the user wants to delete answer of specific question, (7) Results, (8) Working memory: Store the questions that were answered in addition to its answers, (9) Back to threshold category determination button: to return to the previous screen in MEX, (10) Go to the next screen in MEX.

8 | EVALUATION OF MEX

After the auditors had used MEX, they were asked to answer questions formulated in the questionnaires in order to determine its effectiveness, efficiency, and acceptance of MEX in assessing materiality in the planning stage of the audit process. A five –point Likert scale was used in the questionnaire. The mean value of responses determines the level of the auditor's evaluation of the effectiveness, efficiency, and acceptance of MEX. As the mean values of less than 3 indicate that MEX failed in achieving the auditor's expectation. Also values more than 3 indicate that the proposed program meets the auditor's expectation. And values equal 3 indicate that MEX effectiveness, efficiency, and acceptance are medium.

8.1 | Effectiveness of MEX

Effectiveness means the degree to which something is successful in producing a desired result (Dictionary, 2016).The simple definition of effectiveness is doing the right thing. In our study, effectiveness reflects the improvement in decision quality and accuracy when using MEX. Eleven statements in questionnaire are specified for testing the effectiveness of MEX: (1) as an auditing tool for assessing materiality in the planning stage in the audit process, and (2) as a training tool for auditors.

8.1.1 | MEX as an auditing tool

In order to measure the effectiveness of MEX as an auditing tool for assessing materiality in the planning stage of the auditing process. Eight statements are used in order to test the soundness of logic and its potential usefulness. Table 2 indicates that the auditors strongly agree that MEX's logic reflects the professional performance and due care required when assessing materiality in the planning stage (Q. 1, Weighted mean = 4.264, level of significance = .000) and MEX's knowledge and expertise is acceptable (Q. 8, 4.412, .000).

This evaluation reflects that MEX provides relevant information. Most auditors agreed on the usefulness of MEX in assessing planning materiality as it performs in the same manner, as the auditors would do (Q. 3, 4.38, .000). Auditors have evaluated MEX's reliability as good, reliability includes accuracy (Q. 6, 4.44), completeness (Q. 7, 4.47, .000), and relevant to the task of assessing planning materiality (Q. 2, 4.41, .000). Moreover, auditors agreed that MEX contributes to the auditor's commitment to auditing standards (Question 4, 4.35, .000), and provides guidelines for auditors about the required procedures to follow when assessing materiality (Q. 5, 4.38, .000).

Table 2: Auditors' evaluation of MEX

Questions Strongly agree=5……Strongly disagree =1	Mean =34	Std. Dev.	Std. Err.	T	Sig (2-tailed)
1-MEX Logic Reflects Professional Performance and Due Care.	4.2647	.61835	.10605	11.926	.000
2-MEX is Appropriate and Relevant in Assessing Materiality	4.4118	.65679	.11264	12.534	.000
3-MEX can Assess Materiality in The Same Manner as Professionals can do.	4.3824	.60376	.10354	13.350	.000
4-MEX Contributes to The Auditor's Commitment of Auditing Standards	4.3529	.59708	.10240	13.212	.000
5-MEX Provides Guidelines for Auditors According to The Required Procedures	4.3824	.60376	.10354	13.350	.000
6-MEX's accuracy in assessing materiality in the planning stage.	4.4412	.61255	.10505	13.719	.000
7-MEX's completeness as a program for assessing materiality	4.4706	.61473	.10543	13.949	.000
8-MEX's knowledge base contains a complete knowledge and expertise.	4.4118	.60891	.10443	13.519	.000
9-MEX is useful as a training tool for new auditors.	4.2647	.75111	.12881	9.818	.000
10- MEX helps auditor to understand how to assess materiality in the planning stage of audit process.	4.2941	.75996	.13033	9.929	.000
11- MEX helps auditors in explaining in a better way the procedures needed when assessing planning materiality	4.3235	.76755	.13163	10.055	.000
12- MEX helps in reducing time needed for the task	4.2647	.70962	.12170	10.392	.000
13- MEX helps in reducing the cost of audit process (auditor's fees)	4.3235	.76755	.13163	10.055	.000
14- MEX is useful for auditors.	4.1176	.84440	.14481	7.718	.000
15- MEX's logic is sound	4.2353	.78079	.13390	9.225	.000
16- Phrasing of questions in MEX is simple and understandable	4.3235	.72699	.12468	10.616	.000
17- MEX assessment can be trusted	4.2353	.60597	.10392	11.887	.000
18- Benchmark determination sub-model has a clear acceptance from Auditors.	4.2353	.49597	.08506	14.523	.000
19- Control Risk Sub-model has a Clear Acceptance from Auditors	4.2647	.56723	.09728	13.001	.000
20- Threshold Determination Sub-model has a clear acceptance from auditors	4.2647	.56723	.09728	13.001	.000
21- Performance materiality determination sub-model has a clear acceptance	4.2647	.56723	.09728	13.001	.000
22- The overall KBS gain a clear agreement from auditors about its acceptance.	4.3235	.58881	.10098	13.107	.000

Source: Statistical Analysis. Note: P-Values of all variables are less than .05; this means that each variable Mean of auditors' responses (which is more than 4) differs from number 3 (neutral) and all variables are significant at the level of confidence 95 %. Therefore, there is an agreement on MEX efficiency, effectiveness, and acceptance as a tool for assessing materiality

8.1.2 | MEX as a training tool

In order to measure the effectiveness of MEX as a training tool for new auditors, we used three statements to illustrate the role of MEX in transferring the knowledge from professionals to novices. Table 2 shows that MEX is useful as a training tool for new auditors (Q. 9, 4.26, .000). In addition, the auditors agreed that MEX helps auditor understand

how to assess materiality (Q.10, 4.29, .000). Also, MEX explains in a better way the procedures needed when assessing planning materiality (Q. 11, 4.32, .000).

8.2 | Efficiency of MEX

Efficiency is doing the work with fewer resources (hours, dollars, etc.). In addition, it's the ratio of outputs to inputs (Wahdan, 2006; Madanhire & Mbohwa, 2016). In this case, we measured efficiency of MEX by reducing the time required to perform the specific task (assess PM), and reducing the cost of audit process by reducing the numbers of organizational levels involved in these process. Table 2 shows that MEX improves the efficiency of the audit process by reducing the time required for assessing planning materiality (Q. 12, 4.2647, .000). Furthermore, there is a clear agreement between auditors that MEX reduces the cost of audit process (Q. 13, 4.32, .000).

8.3 | Acceptance

Cambridge dictionary defines acceptance from the marketing view, as it is the willingness of people to use a new product or service or to believe a new idea. The acceptance is a function of efficiency and effectiveness (Wahdan, 2006). Table 2 demonstrates how to evaluate MEX's acceptance. In this study, we refer to acceptance, as the professionals believe in the idea of this software as stated in the questionnaire: MEX is useful (Q. 14, 4.12, .000). The logic of MEX is sound and easy to follow (Q. 15, 4.24, .000). Moreover, phrasing of questions in MEX is simple and understandable (Q. 16, 4.32, .000). Finally, their confidence in MEX are (Questions 17, 18, 19, 20, 21, 22) with values equal (4.24, 4.24, 4.26, 4.26, 4.26, 4.32) respectively, with level of significance =.000.

9 | CONCLUSION AND FUTURE RESEARCH

9.1 | Conclusion and contributions

This paper concerned with modeling, implementing and evaluating a KBS called Materiality EXpert (MEX). MEX can assess planning materiality and performance materiality as professionals act. Knowledge used to build MEX is acquired from literature and from experienced auditors using questionnaire as well as unstructured and structured interviews. MEX was developed and consisted of two main conceptual models for assessing planning materiality and performance materiality. Thirty-four auditors from different audit firms in Egypt including international audit firms evaluated MEX. The evaluation results acquired from experienced auditors in Egypt indicated that MEX successfully executes the task of assessing the level of planning materiality and performance materiality.

Moreover, the results of evaluation indicate that MEX is efficient as it can reduce the time required to assess materiality in the audit planning stage. Moreover, it can reduce the cost of audit process by reducing the numbers of organizational levels involved in these processes. Therefore, the use of MEX will improve the auditor's productivity. Furthermore, MEX is effective as an auditing tool for assessing planning materiality and performance materiality. MEX's logic reflects the professional performance and due care required when assessing materiality in the planning stage, MEX's knowledge

and expertise is acceptable. The evaluation reflects that MEX provides relevant information. Most auditors agreed on the usefulness of MEX in assessing planning materiality as it performs in the same manner as the auditors would do. Auditors have evaluated MEX's reliability as good, reliability includes accuracy, completeness, and relevant to the task of assessing planning materiality.

Furthermore, auditors agreed that MEX contributes to the auditor's commitment of auditing standards (ISA 320), and provides guidelines for auditors about the required procedures to follow when assessing materiality in the planning stage of the audit process. MEX is effective as a training tool. It helps to teach the novices how to assess planning materiality in a short time because MEX contains a lot of expertise and knowledge. In addition, auditors agreed that MEX helps in explaining in a better way the procedures needed when assessing planning materiality. Auditors agreed about MEX's acceptance, as it is useful in the planning of the audit. The logic of MEX is sound and easy to follow. Therefore, their confidence in MEX is high.

This research contributes to the existing literature by adding and examining the acquisition and the use of technical knowledge in auditing especially in the planning stage. It provides an opportunity to improve the audit process. MEX will increase the likelihood that auditor's assessment of materiality complies with the international standards of auditing. Auditors need to have a structured materiality guideline using KBS, in order to arrive at more consistent and uniform decision. Therefore, using MEX will reduce the inconsistencies of the personal judgments. MEX is easy to use by auditors and is able to demonstrate quantifiable benefits. MEX helps to transfer the experience from the experts to novices.

9.2 | Limitations and future research

There are some limitations of the study as MEX was built to serve private sector in assessing planning materiality, and didn't contain regulations related to financial institution and public sector. Furthermore, the answer of MEX questions either yes or no, it may affect the user's attitude when using MEX. Furthermore, auditors biased towards using MEX. Moreover, any change in auditing standards after 2017 will affect the knowledge base of MEX. So, MEX knowledge should be continuously updated.

Moreover, we found difficulties in eliciting knowledge from experts, in addition to exploring probabilities on which rules are built. Based on the study limitations, many thoughts for future studies can be as follows: MEX might investigate regulations associated with public sectors and financial institutions. Furthermore, MEX could be tested in training and educating new auditors, formatting excel sheet to MEX; it will be responsible for calculating PM and performance materiality through enabling MEX'S users to enter the value of the selected benchmark.

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Appendix: Questionnaire No. 1

This appendix presents the questionnaire that was provided to respondents The purpose of the questionnaire is to help in knowledge elicitation, required to assess planning materiality and performance materiality, from auditors within audit firm in Egypt. The questionnaire consists of questions using a five-point Likert scale (Always: 100%, Often: >75%- <100%, Sometimes >25% - < 75%, Rarely > 0% - < 25%, Never: 0%). The questionnaire includes six models, as follows:

1- Planning materiality benchmark determination model.
2- Planning materiality threshold determination model.
3- The model of control risk.
4- Proposed threshold of planning materiality model.
5- Model of assessing performance materiality.
6- Proposed percent for performance materiality & key items.

Dear Sir / Mrs

Thank you for your participation in this survey. Please, read each question and click the response that best represent your feeling to the statement. The following abbreviations will be used as:

* FS: financial statements.
* TE: tolerable error (performance materiality).
* EBITA: income before interest, tax, and amortization.
* PM: planning materiality.

Demographical information of participants

First, please provide some background information about you.

(1)Name, (2) Qualification: Bachelor- Diploma- Master- PHD,(3) Position within the firm (owner, partner, manager, auditor), (4) Years of auditing experience: (< 5 years, > 5 years to 10 years, >10 years to 15 years, more than 15 years)

Model 1: Planning materiality benchmark determination

Questions	Always	often	Sometimes	Rarely	Never
1. The client type					
1.1. Listed in the stock market.					
1.2. Not listed in the stock market.					
2. The client concern about liquidity or solvency.					
3. The financial statements user's interests:					
3.1. Can the principle users of the client's FS be assumed to be interested primarily in the results of current operation?					
3.2. Can the principle users of the client's FS be assumed to be interested primarily in the balance sheet measures?					
4. Check income from continuing operation.					
5. Check last three years income from continuing operation.					
6. If the decision is to choose from balance sheet measures, auditor will choose from equity and total assets.					
7. If the decision is to choose from income statement measures, auditor will choose from income before tax, gross margin, total revenue, and EBITA					
Others, (please specify)					

Model 2: Planning materiality threshold determination

Questions	always	often	Sometimes	Rarely	Never
1. Previous experience with the client.					
1.1. The first time to audit the client.					
1.2. The first time the client has ever been audited.					
2. The client relationship with prior auditor.					
2.1. Are there any problems between the client and the previous auditor?					
3. Control risk.					
3.1. Control design& operation evaluation.					
3.2. Control environment evaluation.					
3.3. Risk assessment evaluation.					
3.4. Control activities evaluation.					
3.5. Information& communication evaluation.					
3.6. Monitoring activities evaluation.					
4. Is the management changed this year?					

Questions	always	often	Sometimes	Rarely	Never
5. Management integrity					
5.1. Does one or more control the management?					
5.2. Does the management have a poor reputation in the industry?					
5.3. Does the management have the desire to manipulate profits?					
5.4. Does the management disclose the extraordinary risks?					
5.5. Does the management co-operate with external auditor to get sufficient audit evidence?					
5.6. Does the management constantly change internal auditor & financial accountants?					
5.7. Is there any conflict between the management and shareholder, customer and regulatory bodies?					
5.8. is there a decline in the entity's competitiveness on an ongoing basis?					
5.9. Appropriate internal control, accounting system, and control procedures.					
6. The client's interest of F.S.					
6.1. F.S going to be used for offering client's securities.					
6.2. F.S going to be used for the purpose of the control over the client					
6.3. F.S going to be used to settle some outstanding litigation in which the client is involved.					
6.4. client violate the terms of an agreement or contract which is used to get loan					
7. Related party transaction.					
8. misstatement, include error which cannot be corrected in subsequent periods					
9. Probability of the existence of financial difficulties.					
9.1. Problems regarding liquidity.					
9.2. Significant gain or loss in last years (retained earnings statement)					
9.3. Degree of dependence on debt as a mean of financing.					
10. user adoption on the financial statement					
10.1. size of the client					
10.2. listed in the stock market or not					
10.3. Client using of liabilities in comparison with industry.					
11. auditor's past experience in auditing					
12. Materiality last year.					
Others, (please specify)?					

Model 3: Control risk

Questions	always	often	Sometimes	Rarely	Never
1. Understanding control design and operation.					
1.1. Experience about the entity's internal control.					
1.2. Documentation of control procedure.					
1.3. Documentation of the accounting system.					
1.4. Examination of the documents and records.					
1.5. Inquiries with employee in the auditee.					
1.6. Observation of controls placement.					
2. Control environment evaluation.					
2.1. Management commitment to integrity and ethical value.					
2.2. board of director independence					
2.3. Management establishes organizational structure & determine authorities and responsibilities that pursuit the achievement of objectives.					
2.4. Human resource policy and practices.					
2.5. Management's philosophy and operating style.					
3. Risk assessment evaluation					
3.1. Management defines its objectives clearly.					
3.2. Management analyzes & manages risk related to the organization objectives.					
3.3. Management responds to misstatement.					
4. Control activities evaluation.					
4.1. Select & develop Control activities that contribute to manage & reduce risk to acceptable levels.					
5. Information & communication evaluation.					
5.1. Using relevant information with high quality to support the function of internal control.					
5.2. Delivering information about internal control to whom are responsible for applying control procedure.					
5.3. Communication with external auditor.					
6. Monitoring activities evaluation.					
6.1. Management thoughts about internal control.					
6.2. Management evaluation of internal control.					
6.3. Delivering internal control report to interested person in a timely manner.					
Others (please specify)					

Model 4: Proposed threshold of planning materiality

Questions	always	Often	Sometimes	Rarely	Never
1. If the entity is restricted in the stock market:					
5-8 % of net income before tax.					
1-2% of gross margin					
0.5-1% of total revenue.					
2-3% of EBITA.					
1-2% of owners' equity.					
0.5-1% of total assets.					
2. If the entity is not restricted in the stock market:					
5-10% of net income before tax.					
1-4% of gross margin					
0.5-2% of total revenue.					
2-5% of EBITA.					
1-5% of owners' equity.					
0.5-2% of total assets.					
3. The first time to audit the entity					
5-10% of net income before tax					
2-6% of gross margin					
1-5% of revenue					
3-6% of owners' equity.					
0.5-2% of total assets.					

Model 5: Assessing performance materiality

Questions	always	Often	Sometimes	Rarely	Never
To assess performance materiality, the auditor should obtain sufficient understanding about:					
1. Previous experience with the client.					
1.1. The first time to audit the client.					
1.2. The first time the client has ever been audited.					
2. Materiality of last year.					
2.1. The aggregate of corrected & uncorrected misstatement 25% or less.					
2.2. The entity achieve a lot of misstatement.					
3. Audit risk					
4. Control risk					
5. Inherent risk					
6. Account nature (asset, liability, equity, revenue, or expense)					
Others (please specify).					

Model 6: Proposed percent for performance materiality & key items.

Questions	always	Often	Sometimes	Rarely	Never
1. Auditor choose between 50%-75% of PM to determine performance materiality (maximum amount)					
2. Auditor determine performance materiality for accounts in the financial statement according to the account nature					
3. If the auditor relies on control and higher inherent risk: (50%- 75%) for assets/ income and (15%- 25%) for liability/ expense.					
4. If the auditor relies on control and lower inherent risk: (75%-100%) for assets/ income and (25%-50%) for liability/ expense.					
5. If the auditor cannot rely on control and higher inherent risk: (10%-25%) for assets/ income and (5%-10%) for liability/ expense.					
6. If the auditor cannot rely on control and lower inherent risk: (25%-50%) for assets/ income and for liabilities / expenses (10%-15%)					

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INTERNATIONAL JOURNAL OF COMPUTER AUDITING

Journal Section: Research Paper

Auditors' Perceptions of and Competencies in Big Data and Data Analytics: An Empirical Investigation

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This study presents evidence on practicing auditors' perceptions of and competencies in applying big data and data analytics to audit engagements. An electronic questionnaire distributed to accountants shows that auditors have good information technology skills and are well-acquainted with big data and data analytics. However, they lack relevant technical skills and are unfamiliar with related data analysis tools, excluding Excel. The results reveal 64.71% of accountants have not attended any training on big data and data analytics, while 31.37% plan to enhance related knowledge. Auditors need to obtain training on substantive audit risk assessments using big data and data analytics.

KEYWORDS

big data, data analytics, auditors, perception, competence, Saudi Arabia

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1 | INTRODUCTION

A credible financial reporting system must recognize in real time all events or transactions that affect the value of a company's net assets and thus, common shareowners' wealth (Chartered Financial Analysts Institute, 2007). Financial statement disclosures should provide information that allows stockholders to understand how the reported figures were generated, including details of models used to produce them (Nikolai, Bazley, & Jones, 2009). In addition, disclosures must explain all risk exposures and the possible effects of future events on investors' wealth (Chartered Financial Analysts Institute, 2007).

Accounting can be viewed as a craft because it comprises techniques designed to serve certain practical ends, and the instruments of the craft are generally subject to a system that leads to a gradual evolution (Yamey, 1947). During the course of its development, accounting has always responded to business needs with technological inventions (Al-Adeem, 2017). For instance, double-entry bookkeeping, a written manifestation of merchants' affairs (Pacioli, 1494 as cited in Gleeson-White, 2011), was developed in response to business needs (Yamey, 1947). Accounting strives to offer financial investment information, both internally and externally, from the recording of financial transactions to the presentation of financial reports (KPMG, 2013). The process of information disclosure includes sharing relevant data that aid users in evaluating an enterprise's performance and accordingly, in rationalizing their decision to invest in such entities. Accounting and data have a strong interdependency, which is a consequence of ongoing business transactions (Alles, 2015), and auditing has witnessed progressive opportunities and challenges owing to rapidly changing technology. Auditors may earnestly embrace big data as a method to increase the effectiveness and reliability of their tasks (Alles, 2015).

The development of information technology (IT) has influenced auditing, thus creating a contemporary phenomenon in the field (Vasarhelyi & Halper, 2018). In practice, based on sampling testing accompanied by inferences derived from their professional judgement, auditors determine whether further testing needs to be performed to obtain both process and compliance-based outcomes. In addition to possessing the skills needed to gather and objectively evaluate audit evidence and the diligence to perform tasks with integrity (Kueppers & Sullivan, 2010), auditors apply specialized knowledge and thus, societies perceive them as trustworthy (West, 2003). Current trends in technological advancements that incorporate the use of big data for auditing practices have simultaneously created opportunities and challenges for the profession. Auditors must understand the impacts and risks of big data and strive to acquire the requisite professional skills to remain relevant to their societies in general and their clients in particular.

In today's economy, rapid IT movements have enhanced the ability of businesses to collect, store, retrieve, and utilize data. In fact, an increasing number of companies are becoming better and more efficient at structuring data and thus, are able to incorporate information into more complex models and algorithms (Gordon & Shankaranarayanan, 2015). Belkaoui (2017a), a contemporary accounting professor, strongly urged professional accountants to recognize emerging realities that institutionalize them and their profession. Professional auditors with a good understanding of computer-assisted audit techniques (CAATs) have the means to improve audit programs or review plans during an audit using data analytics (Singleton, 2013b). CAATs can be defined as computerized methods used by accountants to process data (Braun & Davis, 2003). Big data necessitate the creation of representative analytics and delivery platforms to track and display data stored on a large scale (Pedrosa & Costa, 2014); "Big data is going to get bigger and faster" (Singleton, 2013b, p. 1).

Saudi Arabia is one of the world's fastest-growing countries, with per-capita income expected to rise from USD 25,000 in 2012 to USD 33,500 by 2020.[1] Mukthar and Sultan (2017) predicted that the value of implementing data analytics in the Saudi Arabian market will grow from USD 920 million in 2013 to USD 1.85 billion in 2018.[2] As businesses, particularly corporations, attempt to tap into these opportunities, investors become more aware and thus demand greater financial information to avert risks associated with their hard-earned capital. In addition, with the recent adoption of the International Financial Reporting Standards (IFRS) and the shift toward a more robust open economy, Saudi Arabia is witnessing considerable economic growth and technological advancements. It is conceivable that the country's decision on IFRS convergence is aimed at strengthening its goal of rapid economic development and progress (Al-Mousa & Al-Adeem, 2017).

With big data becoming a reality, using related data and analytics for audit tasks has become a necessity for accounting professionals to create more value. In general, real-time corporate activities could cause a shift from auditors "providing assurances about numbers to assurances about real-time systems" (Gepp, Linnenluecke, O'Neill, & Smith, 2018, p. 109). In the same vein, with companies using more complex computerized financial data in their transactions, knowledge about and expertise in big data have become a more genuine need for external auditors in audit assignments. IT plays a fundamental role in the efficiency and integration of operations in modern organizations, thus requiring audit professionals to maintain up-to-date knowledge on IT and data management (Silltow, 2003). This creates both challenges and growth opportunities for preparers and reviewers of financial information. It is pertinent to explain the extent to which auditors can tackle the challenges of this shift—that is, the need for new skills, creating opportunities, and questioning relevance—given its impact on auditing. Thus, a major challenge is using the vast amount of data created and stored by organizations to reduce risks and improve the proportion of IT in audit functions (Dzuranin & Malaescu, 2016). Given the above discussion, auditors' perception toward and competence in applying big data and data analytics to audit assignments is an appropriate research topic to explore. This study, thus, empirically examines auditors' awareness and practical knowledge of big data and data analytics in creating more value in audit activities.

The remainder of this paper is organized as follows. Section 2 reviews the literature on big data and data analytics. Section 3 presents the method used to address this research question as well as the scale developed and employed in the instrument used to collect data. Section 4 discusses the results, while Section 5 concludes with limitations and suggestions for future research.

2 | LITERATURE REVIEW

This section analyzes the literature on big data and data analytics as phenomena in the auditing profession and the reasons for using big data in related practices. In addition, it highlights the opportunities and challenges that big data create in the auditing profession. Finally, the section poses the following question: how do auditors perceive their competence in the application of big data and data analytics?

[1] See Doing Business in Saudi Arabia's guide on "Why Saudi Arabia?" http://www.saudiarabia.doingbusinessguide.co.uk/the-guide/opportunities-in-saudi-arabia [Last Accessed February 13, 2018].

[2] See MicroMarketMonitor's report. See Computer Weekly's article (2016) on "Saudi Arabia turns to Big Data to boost business innovation": https://www.computerweekly.com/news/450402173/Saudi-Arabia-turns-to-big-data-to-boost-business-innovation; (Last Accessed February 13, 2018)

2.1 | *Overview of IT in Auditing*

The auditing profession is currently in a critical phase, particularly with the world concurrently witnessing greater advancements in technology and real-time methods of business transactions, resulting in a call for change in the auditing profession (American Institute of Certified Public Accountants [AICPA], 2012). Traditional audit tools were effective in dealing with limited data. These practices proved feasible for auditors for a reasonable period; however, with increasing data volume, the use of CAATs has become essential for dealing with expanding data and the accelerated speed of data transformation and recall. Conventional audit approaches have evolved into utilization of technology such as electronic spreadsheets, electronic working papers, generalized audit software, embedded audit modules, SQL database search and retrieval, parallel simulation software, and test data (Rosli, Yeow, & Eu-Gene, 2013). In addition, "automated decision-making has played a vital role for quite some time" in the financial sector (Frey & Osborne, 2017, p. 260). The integrated and real-time nature of digital businesses requires collaboration among historically independent organizational units, where data analytics programs are at the core of enhancing decision-making processes (Gartner, 2017). In its report on audit data analytics, the Centre for Financial Reporting Reform (CFRR, 2017) asserts that rapid growth in technology combined with stakeholder demands drives "the need for auditors to innovate and transform their approaches in order to keep pace with demand" (p.1).

The application of CAATs to audit procedures has been tested, including the potential for improvements in audit engagement productivity (Curtis & Payne, 2008). In fact, the audit profession has the opportunity to collect audit evidence from the entire data population rather than simply relying on sampling techniques. Persistent growth in technology and software applications has allowed auditors to anticipate steps in their auditing processes (CFRR, 2017). Undoubtedly, "present and future users of accounting and auditing services have an increasing need for relevant, reliable, and timely information and IT provides the means to meet them" (Elliott, 2002, p. 139, as quoted in Curtis & Payne, 2008, p. 3). Compared to traditional manual auditing, CAATs have played a more vital role in the application of innovative processes (AICPA, 2012). Further, with the growing global expectations of capital owners and relevant parties, the adoption of modern technology in audit programs is rapidly evolving (International Federation of Accountants-IFAC, 2017).

The fundamental purpose of accounting has been to process and communicate financial information to both internal and external decision makers (Janvrin & Watson, 2017). The accounting profession, through the prudent use of financial data, has long contributed to organizations' key objectives and decision-making processes (Richins, Stapleton, Stratopoulos, & Wong, 2017). Auditors must analyze financial statement data and significant data related to financial statements to enhance decision-makers' confidence. A rapidly increasing number of corporate strategies are accounting for the use of IT to provide adequate relevant information and maintain reasonable compliance with related regulations and laws (Rikhardsson & Dull, 2016). Janvrin and Watson (2017) contend that accountants have a tendency to expand their expertise to new data. For example, in the 1990s, many practicing accountants extended their traditional auditing services to assurance services, symbolizing modern methods of improving sources of data for financial accounting (Janvrin & Watson, 2017). Data-based decision making has been considered a tool for achieving enhanced productivity and profitability, but this perception has not been developed without experience (Alles, 2015; Waller & Faucett, 2013).

2.2 | *Big Data and Data Analytics as Phenomena*

Understanding the nature of big data can broaden knowledge about the techniques, impacts, and conditions necessitating its adoption. "Big Data is a relatively recent phenomenon," where records of every significant aspect can be captured, measured, and eventually converted into meaningful data (Cao, Chychyla, & Stewart, 2015, p. 1). Gartner (2016) defines big data as high-volume, high-velocity, and/or high-variety information assets that demand cost-effective, innovative forms of information processing, enabling enhanced insight, decision-making, and process automation. "Big data is no mere buzzword—big data is here to stay" (Hammer, Kostroch, & Quiros, 2017, p. 6). From a technical perspective, Gepp, Linnenluecke, O'Neill, & Smith (2018) describe big data as certain techniques and technologies used to deduce results from a pool of events characterized by both structured and unstructured datasets representing the four Vs: volume, variety, velocity, and veracity. In sum, big data are "large volume unstructured data which cannot be handled by standard database management systems like DBMS, RDBMS or ORDBMS" (Mukthar & Sultan, 2017, p. 258).

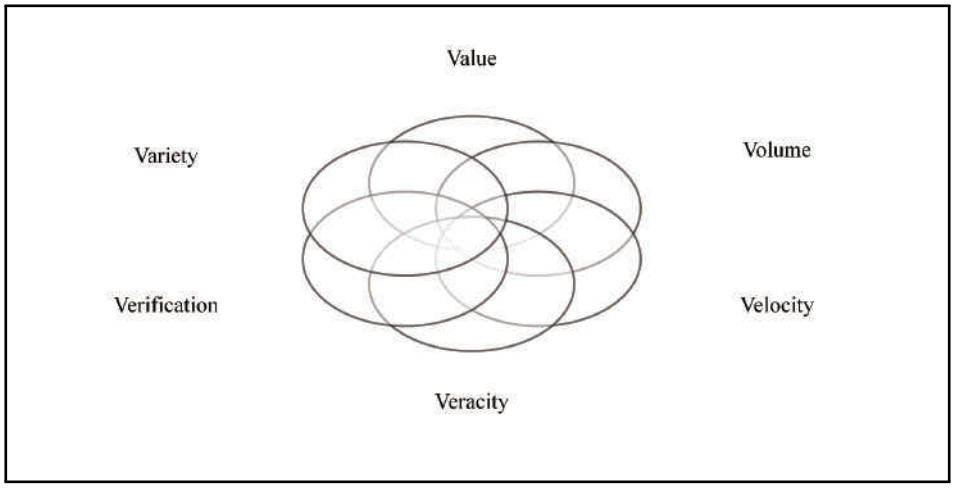


FIGURE 1 6Vs of Big Data

In practice, auditors are more concerned with the efficient use of big data to obtain substantial and reliable audit evidence (Appelbaum, Kogan, & Vasarhelyi, 2017; Brown-Liburd & Vasarhelyi, 2015). As for organizations, data alone may not meet business needs; that is, data may be of limited value unless further efforts are made to analyze them for rational decision making, thus highlighting the need for analytics. Data analytics techniques and methods allow audit teams to both analyze client data and identify areas that need further investigation early on in the audit process. This way, audit teams can tailor audit approaches to deliver substantial results by adapting their audit plans (IFAC, 2017). Data analytics address the communication of complex data to arrive at cogent decisions. Data analytics as a field identifies whether data deviate based on comparative industry data and the current situation (Yeo & Carter, 2017). This communication entails descriptive, diagnostic, predictive and prescriptive procedures and techniques. Such techniques determine causal factors that help predict likely outcomes and prescribe appropriate actions and strategies accordingly. That is, they offer insights into important business events using visualization and data diagnosis. Further, to reflect value, data remain more meaningful when analytics and technology are used for complex data needs (KPMG, 2018).

2.3 | *Reasons for Using Big Data in Auditing Practice*

Auditing is about attesting to the integrity of financial statements prepared by managers. Oversight in this simple assertion may raise doubt about the accounting profession's capabilities and thus, could diminish the level of public confidence in the profession (Edelman & Nicholson, 2011; see also Al-Adeem, 2015; Bayou & Reinstein, 2001; Belkaoui, 2017b; Berton, 1985; Previts, 1992). Using big data, new information can be extracted online, sieved, and generated, creating new knowledge (Kim, 2000). With business operations expanding globally, the role of the audit profession has become more prominent, and the greater amount of captured data has resulted in massive transaction volumes. The real-time capture of transaction data, including location, time, amount, and medium, can ease the process of gathering substantive evidence for development of an audit opinion. Littley (2012) posits that part of big data's achievable benefits is providing auditors with internal and external tools to better forecast estimates, concerns, fraud, and other audit matters (Alles, 2015). Marr (2015) suggests that certain large-scale companies have witnessed more growth in recent times by using big data to improve their business processes. A prominent example is Amazon's use of big data analytics to strengthen their retail experience (Marr, 2015). Walmart also applies big data analytics to identify current trends in social media to monitor buying habits among consumers of substitute products (Cao, Chychyla, & Stewart, 2015; Marr, 2015), thereby tracking their competitors' advances in real time (Marr, 2015)

2.4 | *Opportunities and Challenges of Big Data in Professional Auditing*

Corporations, for-profit or non-profit organizations, and medium-scale businesses that integrate, secure, and create value with big data are likely to outperform their counterparts (Deloitte, 2018; Ghobakhloo, Morteza, Sabouri, Hong, & Zulkifli, 2011). Big data is revolutionizing numerous fields at an increasing rate and it is only a matter of time before the auditing profession adopts similar analytical methods (Cao, Chychyla, & Stewart, 2015). Big data analytics can augment accountants' data skills and knowledge through their prior familiarity with structured datasets (Richins, Stapleton, Stratopoulos, & Wong, 2017). Thus, it is necessary for financial accountants, particularly auditors, to take a dominant position in the course of strategic decision making. Big data enables auditors to analyze processes that generate data, including full population testing, which adds value to the auditing and accounting profession and consequently, to their clients (Gepp, Linnenluecke, O'Neill, & Smith, 2018). Consequently, to effectively exploit the inexhaustible opportunities and value of big data, professionals must develop an understanding of business strategy fundamentals and be able to draw inferences from pools of available data.

In 2012, the AICPA made a statement regarding changes from the historical paradigm toward a proactive approach, emphasizing the need for auditors to keep pace with such changes more quickly than other professionals. However, evidence from the literature reveals that data remain underutilized in modern audit engagements (Alles, 2015; Brown-Liburd, Issa, & Lombardi, 2015; Cao, Chychyla, & Stewart, 2015). For example, Gepp, Linnenluecke, O'Neill, & Smith (2018) claim that "academic literature has lamented the slow integration of Big Data into auditing" (p. 110).

2.5 | *Auditors' Perceived Big Data Competencies*

The accounting and audit professions have not been isolated from growth through modern-day technological advancements. In the current era, auditing might even have to upskill and break new ground. Future professional auditors will

have to be competent in three sensitive areas: analytical skills, development of new metrics, and generation of a visual language for data (Yeo & Carter, 2017). At a panel discussion held on November 27, 2017, Roger O'Donnell, a partner at KPMG, stressed the need for auditors to remain relevant in the recent big data phenomenon:[3]

> We need a combination of different skills in audit teams. We need data specialists—people who extract data, understand the systems, who can bring all the data available to us. We also need analysts—people who have critical thinking skills; those people who are not only able to look at a single transaction, but also are able to analyze the entire population, the entire system. That is a transformative exercise for the audit profession.

Accountants who nurture themselves and stay updated on modern technological events are likely to succeed and remain relevant in the big data era. More recently, both academic and professional bodies have emphasized the relevance of and insights from using big data. In particular, the Association to Advance Collegiate Schools of Business (AACSB) has considered more dynamic approaches to advancing tools and prerequisites to create a program for data analytics.[4] According to Helen Brand, Chief Executive of the Association of Chartered Certified Accountants (ACCA), [5]

> To succeed as a professional accountant…a vastly different set of skills is required than was necessary just 10 short years ago. And in the next decade, things are likely to change even faster and more dramatically as the global economy continues to evolve at an ever-quickening pace.

Yeo and Carter's (2017) recent study in Malaysia revealed that the current generation of auditors possesses the required IT skills (e.g., systems applications and products [SAP] and enterprise resource planning [ERP]) as well as big data infrastructure and management skills (e.g., data analytics). Since auditors are more interested in applying big data to perform substantive risk assessments using control testing procedures, a reasonable level of data analysis seems pertinent.

Several scholars have emphasized the need for descriptive, diagnostic, and predictive analytical skills combined with in-depth knowledge of mathematics, statistics, business skills, and creativity to effectively use big data analytics (Davenport & Dyche, 2013; Gartner, 2016; Strengell, 2017; Yeo & Carter, 2017). In addition, descriptive, diagnostic, predictive, and prescriptive analytics help present-day business executives more effectively run their organizations (Marr, 2014). An obvious need is accounting for the current technological phenomena and auditors may have no choice but to enhance their knowledge and skills in big data techniques and analytics as an essential component of their professional dealings. Auditors perceive the need to keep pace with technological trends "not because they necessarily value the analytical power of Big Data, but because their clients do" (Alles, 2015, p. 4). Gepp, Linnenluecke, O'Neill, & Smith (2018, p.110) refute such a claim by highlighting that the early use of random sampling techniques has already set auditors ahead of their clients "regardless of whether client firms utilize Big Data or not."

Despite the countless opportunities evident from the use of big data in audit practices, little or no research has been conducted on the topic, particularly in the context of Saudi Arabia. This study examines external auditors' perception of big data and analytics application to audit tasks and the requisite professional and technical competencies.

[3] See Xing Gao's "Data, Data! Key to Auditors" on Accounting Blog. Retrieved from https://www.bna.com/data-data-key-b73014472450/.

[4] AACSB (2018). Curriculum development series, *Data Analytics Summit* held on March 19–20, 2018. Tempe, Arizona, US.

[5] See Sharron Arnold's "6 skills accountants need to survive the robot uprising" on Blackline Magazine. Retrieved from https://www.blackline.com/blog/exceptional-accountants/6-skills-exceptional-accountant/

3 | RESEARCH METHOD

3.1 | *Research Instrument for Data Collection*

This study investigates auditors' perceptions toward and competencies in the application of big data and analytics given their impact on the accounting profession. Auditors in the 21st century, including those in Saudi Arabia, should be aware of the trending boom in data, which has resulted from both internal and external business activities. In addition, it is increasingly necessary for auditors to manage data effectively and efficiently while conducting audits, that is, the readiness to adopt and adapt to technological changes since "technology will continue to change at light speed" (Arnold, 2018, p. 9).

As suggested in Morgado, Meireles, Neves, Amaral, & Ferreira (2018), a literature review is one way of developing survey items. Thus, the items included in this study's survey were developed from related literature on the essential skills (e.g., IT skills) and competencies needed by auditors to utilize big data and analytics to gather material audit evidence (Abu-Musa, 2008; Deloitte, 2017; E-Skills UK, 2013; Hammer, Kostroch, & Quiros, 2017; Rouhani, Rotbei, & Hamidi, 2017; UN Economic Commission for Europe [UNECE], 2015; Yeo & Carter, 2017).[6]

The following subsections briefly explain the research instruments and design approach for each item. The analysis considers both internal and external practicing auditors in Saudi Arabia because of the country's recent economic reforms, one of which includes granting foreign investors the opportunity to invest in the country's stock market. The survey was conducted in English as most professional auditors in Saudi Arabia are familiar with the language.

3.2 | *Scale Development*

Auditors should possess a certain level of technological skill and awareness about related improvements, particularly big data and analytics. The following skills are considered relevant to this study's objectives.

3.2.1 | ERP Skills

The most basic skills needed to benefit from big data and analytics are ERP skills. This study goes beyond end-user computing skills to include the efficient use of accounting and ERP software (integrated accounting information systems software) (Yeo & Carter, 2017), particularly when dealing with complex transactions. Such skills include knowledge of vendor-based software (e.g., Oracle, SAP, QuickBooks, and Sage).

[6] The researchers admit that while developing items solely by relying on the literature, even quality studies on the subject, may not be an ideal approach to developing scales; nevertheless, it is a suitable method for this study given its objectives and nature. The results are intended to be preliminary.

3.2.2 | Data Design and Management Skills

Data design and management skills require auditors to understand the definitions and guidelines of database concepts. In addition, auditors must know how to efficiently store, organize, use, maintain, and analyze various types of data to aid in risk assessments, analytical procedures, and insightful audit processes. Proficiency encompasses technical areas (e.g., data aggregation, mining, interpretation, and modeling), processes, and knowledge about databases. This category comprises big data analytics software such as Hadoop, Relational, and online analytical processing (OLAP) (Deloitte, 2018; E-Skills UK, 2013).

3.2.3 | Analytical and Business Intelligence Skills

Analytical skills include a good working knowledge of statistical packages employed to analyze large-scale datasets, for example, SPSS, SAS, and Excel, as well as other modern tools. In addition, they entail the ability to use analytical techniques to map business intelligence and formulate strategies, as well as creative problem-solving skills based on real data to articulate and address future events (Chen, Chiang, & Storey, 2012).

3.2.4 | Programming Skills

Programming skills are specific to computer programming and scripting area languages such as JavaScript, NoSQL, Python, and PHP (Hammer, Kostroch, & Quiros, 2017; UNECE, 2015).

3.3 | *Protocol for Data Collection*

The survey respondents include both internal and external practicing auditors in independent financial services and other sectors. To ensure the face validity of the research instrument, two accounting professors reviewed the survey questions before it was administered to the participants. A pilot study was then conducted where five accounting graduate students responded to the survey and reported to the researchers any issues they may have faced while taking it. They were also encouraged to share comments or suggestions that could enhance the clarity and thus, the readability of the questions. While no technical issues were raised, all related and material comments were addressed and referenced to modify the instrument, thereby enhancing the quality of the survey prior to it being dispatched to the target respondents.

The questionnaire was sent to all auditors whose contact details were available on the Saudi Organization for Certified Public Accountants (SOCPA) website.[7] In addition, social media platforms,[8] such as Twitter, LinkedIn, and WhatsApp, were used to share the questionnaire with as many subjects as possible. The confidentiality of the respondents was

[7] For more details, visit http://socpa.org.sa/SOCPA/files/f6/f6a885b7-1db9-4fb6-b8d1-1263bbb826d3.html.

[8] Data collection from social media platforms was introduced as the result of a low response rate from personal emails. The researchers could not introduce a variable for respondent location because the survey was initially sent out via email before being distributed using social media. After social media platforms were utilized, subjects who had received the survey via email were still able to take the survey. The data collection was done from variety of sources simultaneously.

considered, and identities were kept anonymous. A total of 52 questionnaires were returned, of which 51 (98.08%) were usable; we excluded one owing to missing data.

The survey consisted of three parts: (i) academic and professional qualifications and active years of experience; (ii) use and perception of big data, data analytics capabilities in respondents' companies, and whether respondents plan to enroll in training courses for data analytics; and (iii) technical questions on big data and analytics competencies.

4 | RESULTS

4.1 | *Descriptive Statistics*

Table 1 and Figure 2 present averages of responses to questions on respondents' perception as well as the rate of big data analytics capabilities in an accountant's workplace. Table 2 shows the percentage of responses on auditor perceptions on big data and analytics on a five-point Likert-type scale, where 5 = "strongly agree," 4 = "agree," 3 = "don't know," 2 = "disagree," and 1 = "strongly disagree." The study classified respondents by academic discipline. A majority of the respondents studied accounting (82.35%), followed by business management (9.80%), finance (3.92%), financial risk management (1.96%), and taxes and zakat[9] (1.96%). In addition, 49% of the respondents have bachelor's degrees, 49% have master's degrees, while 2% have ACCA qualifications without a degree.

The majority of the subjects (64.71%) had no recognized professional certification/qualification, 15.69% were SOCPA certified, and 19.6% had various certifications in the field of accounting, including Certified Public Accountant (CPA; 5.88%), Certified Management Accountant (CMA; 3.92%), Certified Information Systems Auditor (CISA; 1.96%), Certified Internal Auditor (CIA; 3.92%), Certified Risk Professional (CRP; 1.96%), and Association of Chartered Certified Accountants (ACCA; 1.96%). Data further reveal that 19% of the auditors have more than 10 years of practice experience, 16% between 5–10 years and 16% less than 5 years. Figure 2 illustrates the current use of big data analytics in the respondents' companies.

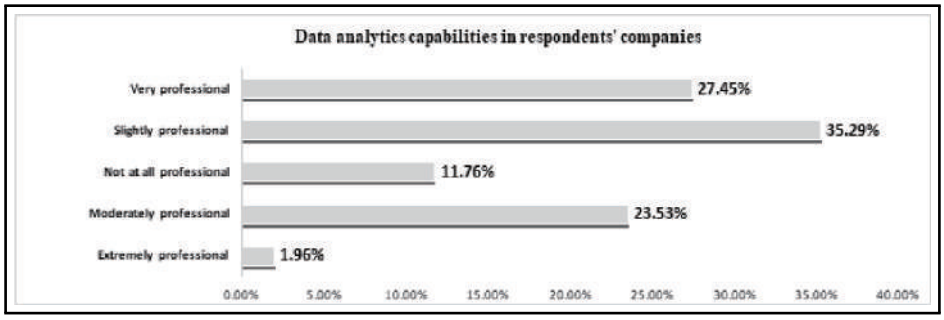


FIGURE 2 Ratio of Data Analytics Capabilities in Auditors' Companies

[9] Zakat is a form of alms-giving treated in Islam as a religious obligation or tax. It is the third pillar of Islam and a mandatory charitable contribution, the right of the poor to find relief from the rich. It is customarily 2.5% (or 1/40) of a Muslim's total savings and wealth above a minimum amount. Retrieved from https://en.wikipedia.org/wiki/Zakat

Table 1 shows that the means for each response to questions 1–6 range between 3.37 (S.D. = 0.96) and 3.90 (S.D. = 0.76). The grand mean of 3.64 is an above-average grand mean. This indicates the moderate positive perception of Saudi Arabian auditors of the benefits derived from big data and data analytics.

Table 1. Averages of Responses to Questions on Respondents' Perception

Questions	Mean	SD	Max	Min
1. Big data analytics is taking over the auditing profession.	3.37	0.96	5	1
2. The auditing profession should move toward the use of data analytics specialists in audit engagement.	3.90	0.76	5	1
3. Should CPE requirements for the profession be reformulated to reflect new big data learning?	3.80	0.83	5	1
4. I am able to effectively research and gather reliable data using IT resources in a relatively short time period.	3.53	0.88	5	1
5. I have the ability to find and detect patterns across volumes of data.	3.45	0.88	5	2
6. I have effective communication skills.	3.76	0.89	5	1
Grand Mean	3.64			

4.2 | *Responses on Auditor Perceptions*

In Table 2, about 47.06% and 5.88% of the surveyed auditors agree and strongly agree that big data analytics is taking over auditing practices. In addition, 84.32% agree to the need for data analytics specialists in audit engagements. A high rate of 68.63% and 11.76% agreed and strongly agreed that courses related to big data should be included in accountants' continuous professional educational programs. About 68.63% agreed to testing auditors' abilities to research and gather useful data using relevant IT tools, indicating their capabilities to perform such tasks. Similarly, 62.74% reported having the professional ability to find and detect patterns across volumes of data gathered from a series of client and company transactions. Finally, 80.39% auditors claimed their communication before and after audit engagements to be effective.

Table 2. Percentage of Responses on Auditor Perceptions

No.	Question	Strongly agree	Agree	Don't know	Strongly disagree	Disagree
1	Big data analytics is taking over the auditing profession	5.88%	47.06%	31.37%	5.88%	9.80%
2	The audit profession should move toward the use of data analytics specialists in audit engagements	13.73%	70.59%	9.80%	1.96%	3.92%
3	Should CPE requirements for the profession be reformulated to reflect new big data learning?	11.76%	68.63%	9.80%	1.96%	7.84%
4	I am able to effectively research and gather reliable data using IT resources in a short time period	3.92%	64.71%	13.73%	1.96%	15.69%
5	I have the ability to find and detect patterns across volumes of data.	3.92%	58.82%	15.69%	0	21.57%
6	I have effective communication skills	9.80%	70.59%	11.67%	5.88%	1.96%

In addition, Table 2 details that 27.78% of responses were either "don't know," "strongly disagree," or "disagree," while 72.22% were "agree." This demonstrates auditors' positive perception of knowledge about and the need for big data analytics in audit practices. The results also demonstrate their elevated level of awareness about the big data phenomenon and its application to the accounting profession.

4.3 | *Competencies Related to Big Data*

In line with its objectives, this study investigates individual auditors' perceived competence in big data analytics. The required skill areas are classified into four categories, including essential skills related to big data analytics expected from a 21st-century auditor to meet the profession's technological demands.

Question 3 in the survey is based on IT skills and focuses on the ability to efficiently use accounting ERP software, particularly when dealing with complex business transactions. Questions 4 and 5 address the understanding of technical areas related to data design and management, including processes and knowledge of databases. Questions 6 and 7 focus on data analytics and business intelligence defined by auditors' use of modern statistical software and their aptitude for innovation. Question 8 addresses specific computer programming training that the respondents received prior to the study.

4.3.1 | IT Skills

Figure 3 reveals that 80.39% of auditors use various accounting ERP software (Oracle, 19.61%; QuickBooks, 3.92%; Sage, 5.88%; SAP, 23.53%; and Others, 27.45%) while 19.61% have no such skill.

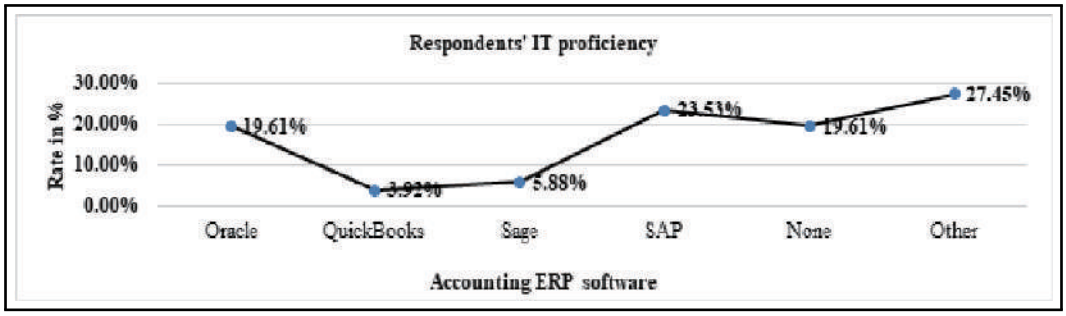


FIGURE 3 Auditors' IT Skills

4.3.2 | Data Design and Management Skills

Figures 4 and 5 reveal a majority of the surveyed accountants have received training in various areas of data design and management, with training on data modeling ranking the highest (21.57%). However, a majority (76.47%) have no practical knowledge of certain big data management tools.

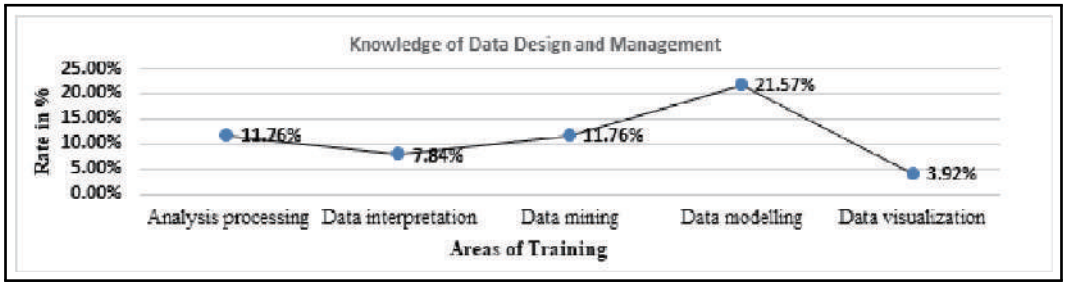


FIGURE 4 Areas of Training

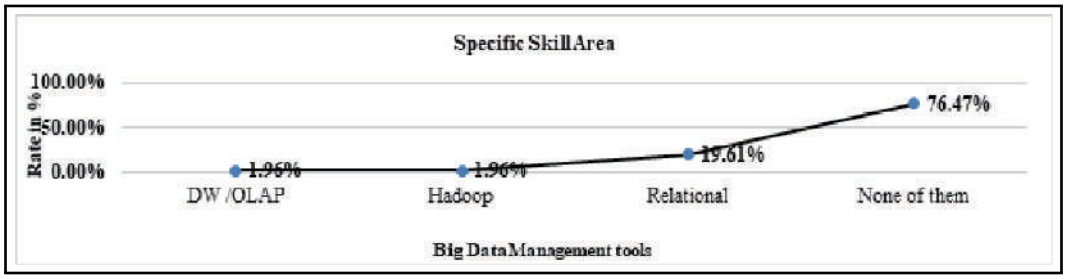


FIGURE 5 Big Data Management Tools

4.3.3 | Analytical and Business Intelligence Skills

According to Figure 6, compared to Excel (84.31%), few auditors are able to use statistical analysis software such as SAS (3.92%) and SPSS (9.80%). Meanwhile, only 1.96% of respondents use SAS, Excel, and ASL.

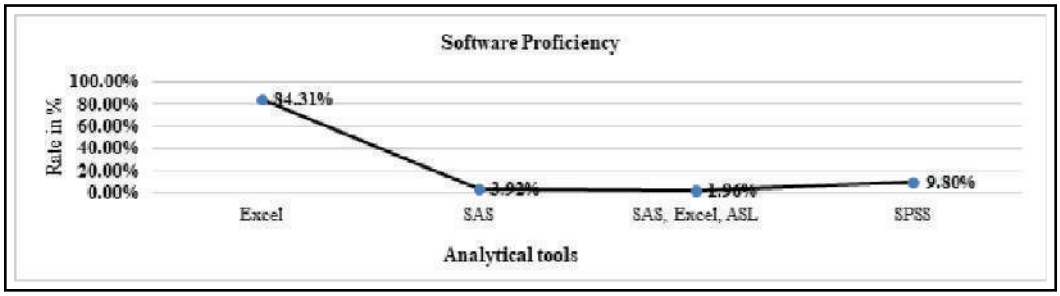


FIGURE 6 Data Analysis Proficiency

Figure (7) illustrates respondents' aptitude for innovation. When asked about how often they are able to create something new or unique, a majority of the respondents stated that they feel this drive "sometimes" (45.10%), followed by "very often" (27.45%), "always" (11.76%), "rarely" (13.73%), and "never" (1.96%). This demonstrates the low level of innovation in applying big data technologies to audit processes.

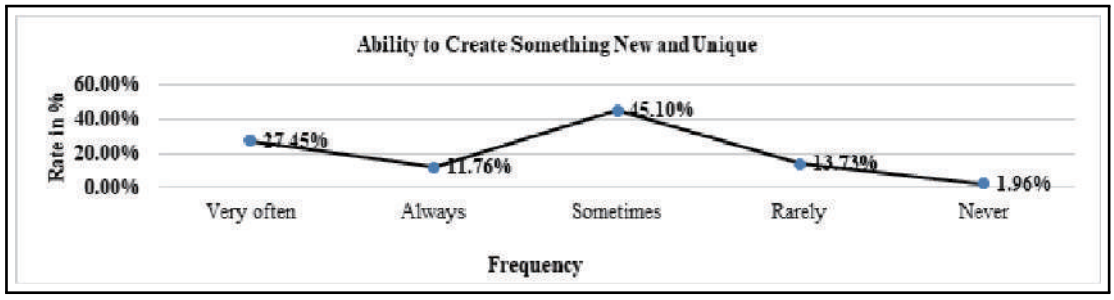


FIGURE 7 Auditors' Aptitude for Innovation

4.3.4 | Programming Skills

Figure 8 shows that most of the surveyed subjects (78.43%) have no in-depth knowledge about programming scripts or languages.

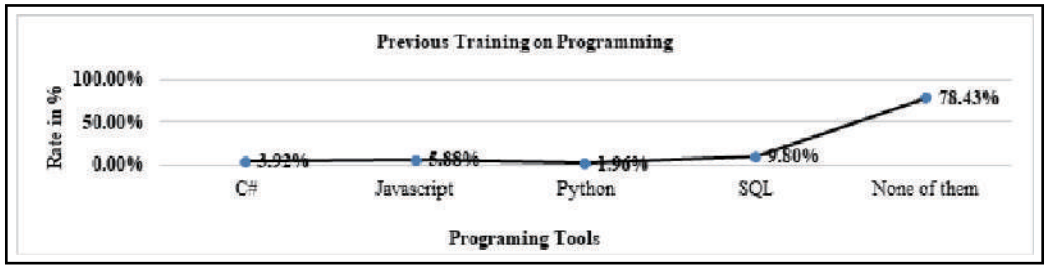


FIGURE 8 Auditors' Computer Programming Skills

In sum, figures 3–8 reveal that auditors have sufficient IT skills and reasonable knowledge about database management systems. However, apart from Excel, they are largely unfamiliar with modern data analysis tools. In addition, a large number of respondents lack big data analytics software and programming language skills.

4.3.5 | Received Training and Willingness to Receive Training on Big Data

Table 3 indicates that 35.29% of accountants have already attended different levels of training on big data and 31.37% plan to enroll in one or more courses. However, 64.71% of auditors declare that they have never attended such training, 50.98% might enroll in a course in the future, and 17.65% have no intention of doing so . Thus, a high percentage of the sampled auditors are either not trained or are open to receiving proper training.

Table 3. Received Training and Willingness to Receive Training on Big Data

Responded Auditors				
Training received on big data and analytics		Plans to receive training in the near future		
Attended	Not attended	Have plans	No plans	Maybe
35.29%	64.71%	31.37%	17.65%	50.98%

5 | CONCLUSIONS, LIMITATIONS, AND FURTHER RESEARCH

This study provides empirical evidence on auditors' perceptions toward and competencies in the application of big data and analytics to audit engagements. Using an electronically administered survey developed from the literature, the findings confirm that the surveyed auditors are well aware of the influence on and necessity of big data analytics in audit processes. In addition, they have a high level of appreciation for IT systems related to accounting (e.g., ERPs) and big data as well as their application to the auditing profession. Auditors' unfamiliarity with relevant data analysis tools, big data analytics software, and programming language skills can be attributed to their low inclination toward big data training and innovation. This may be due to the fact that the current CPA exam and most accounting programs in universities are conventionally oriented with no emphasis on such skills. The lack of requisite skills in data analytics software and programming language as well as unfamiliarity with relevant data analysis tools have important implications, particularly in the context of their counterparts in more developed nations. Auditors may have to make greater efforts to perform substantive audit risk assessments using big data analytics when faced with the complex business transaction data of their clients or companies. Thus, this study highlights the need for auditors, including those in Saudi Arabia, to receive training courses on big data analytics and techniques that can prove beneficial to their auditing practices.

The results of this study are consistent with a recent study in Malaysia (Yeo and Carter, 2017), who report that auditors need further training in the techniques and application of data analytics to enhance their investigative capabilities. However, research has shown that auditors in more advanced countries are now at least reasonably familiar with using big data analytics during audit investigations (Brown-Liburd & Vasarhelyi, 2015). Consequently, it was emphasized that overall technological advances (including auditor's professional competencies in this respect) in applying data analytics in audit engagements will be motivated by the advances in the US and international auditing standards (see Alles, 2015). These results have implications for practicing auditors in Saudi Arabia.

This study is not free of limitations. The main limitation is that it does not account for all specialty and skill areas in big data that a typical big data scientist might consider. In addition, the sample size is small compared to the number of practicing accountants in the case country, Saudi Arabia. Another constraint that may limit the generalizability of the research findings of the study is the use of social media in the data collection phase without including a question in the research instrument asking respondents to specify their geographic location to control for country. As indicated, utilizing social media to distribute the survey was the result of a low response rate to emailed surveys. Future research should add a variable to control for country.

Future research could also investigate the possibilities and potential effects of International Auditing Standards (IAS) pronouncements on adjusting audit engagements to foster the use of data analytics. Such an investigation could also explore key components for possible guidelines on data protection and ethical requirements in IT audits.

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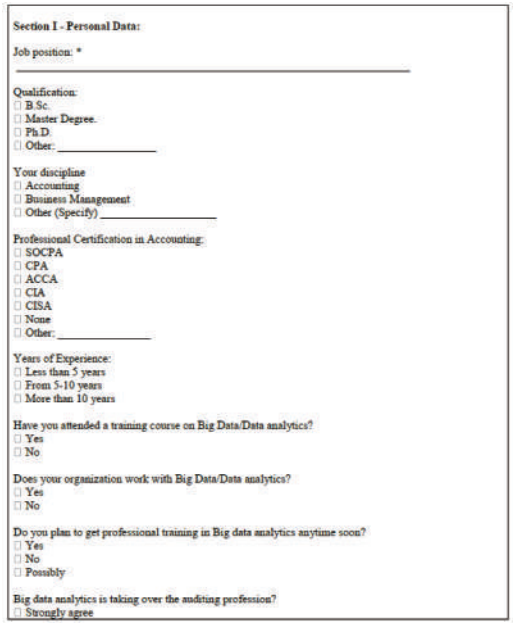
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APPENDIX



Section I - Personal Data:

Job position: *

_____

Qualification:
- ☐ B.Sc.
- ☐ Master Degree.
- ☐ Ph.D.
- ☐ Other: _____

Your discipline
- ☐ Accounting
- ☐ Business Management
- ☐ Other (Specify) _____

Professional Certification in Accounting:
- ☐ SOCPA
- ☐ CPA
- ☐ ACCA
- ☐ CIA
- ☐ CISA
- ☐ None
- ☐ Other: _____

Years of Experience:
- ☐ Less than 5 years
- ☐ From 5-10 years
- ☐ More than 10 years

Have you attended a training course on Big Data/Data analytics?
- ☐ Yes
- ☐ No

Does your organization work with Big Data/Data analytics?
- ☐ Yes
- ☐ No

Do you plan to get professional training in Big data analytics anytime soon?
- ☐ Yes
- ☐ No
- ☐ Possibly

Big data analytics is taking over the auditing profession?
- ☐ Strongly agree

☐ Agree
☐ Do not know
☐ Disagree
☐ Strongly disagree

The audit profession should move more toward the use of Data analytics specialists in the audit engagement?
☐ Strongly agree
☐ Agree
☐ I do not know
☐ Disagree
☐ Strongly disagree

Should the Continuing Professional Education (CPE) requirements of the profession be reformulated to reflect new Big data learning skills/requirements?
☐ Strongly agree
☐ Agree
☐ I do not know
☐ Disagree
☐ Strongly disagree

How would you rate the Data analytics capabilities in your company today?
☐ Extremely professional
☐ Very professional
☐ Somewhat Professional
☐ Not so professional)
☐ Not at all professional

Section II

1. I am able to effectively research and gather reliable data using IT resources in a relatively short time?
☐ Strongly agree
☐ Agree
☐ I do not know
☐ Disagree
☐ Strongly disagree

2. I have the ability to find and detect patterns in a volume of Data?
☐ Strongly agree
☐ Agree
☐ I do not know
☐ Disagree
☐ Strongly disagree

3. Which of these Accounting ERP software do you use proficiently?
☐ SAP
☐ Oracle
☐ Sage
☐ QuickBooks
☐ Other
☐ None

4. In which of these you previously been trained on?
☐ Data aggregation
☐ Data interpretation
☐ Analysis processing
☐ Data visualization
☐ Data mining
☐ Data modelling
☐ None of them

5. Which of the following you are skilled:
☐ DW /OLAP
☐ Relational
☐ Hadoop
☐ None of them

6. Which of these software do you use proficiently?
☐ Excel
☐ SAS
☐ SPSS
☐ Other(Specify) _____

7. Which of these you previously been trained on?
☐ JavaScript
☐ SQL
☐ Python
☐ PHP
☐ C#
☐ None of them

8. I am an effective communicator?
☐ Strongly agree
☐ Agree
☐ I do not know
☐ Disagree
☐ Strongly disagree

9. How often do you think outside the box and create something entirely new and unique?
☐ Always
☐ Usually
☐ Sometimes
☐ Rarely
☐ Never

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