Received 26 August 2017
Revised 30 March 2018
Accepted 21 July 2018

Relevance of big data to forensic accounting practice and education

Zabihollah Rezaee
Fogelman College of Business and Economics, University of Memphis, Memphis, Tennessee, USA, and

Jim Wang
School of Business, Tung Wah College, Hong Kong, Hong Kong

Abstract

Purpose – This paper aims to examine the relevance of Big Data to forensic accounting practice and education by gathering opinions from a sample of academics and practitioners in China.

Design/methodology/approach – The authors conduct a survey of academics and practitioners regarding the desired demand, importance and content of Big Data educational skills and topics for forensic accounting education to effectively respond to challenges and opportunities in the age of Big Data.

Findings – Results indicate that the demand for and interest in Big Data/data analytics and forensic accounting will continue to increase; Big Data/data analytics and forensic accounting should be integrated into the business curriculum; many of the suggested Big Data topics should be integrated into forensic accounting education; and some attributes and techniques of Big Data are important in improving forensic accounting education and practice.

Research limitations/implications – Readers should interpret the results with caution because of the sample size (95 academics and 103 practitioners) and responses obtained from academics and practitioners in one country (China) that may not be representative of the global population.

Practical implications – The results are useful in integrating Big Data topics into the forensic accounting curriculum and in redesigning the forensic accounting courses/programs.

Social implications – The results have implications for forensic accountants in effectively fulfilling their responsibilities to their profession and society by combating fraud.

Originality/value – This study provides educational, research and practical implications as Big Data and forensic accounting are advancing.

Keywords Big data, Big data analytics, Business curriculum, Forensic accounting education and practice

Paper type Research paper

JEL classification – M40, M41, M42

This manuscript benefits from the invaluable comments and suggestions of participants at the 2016 World Business Ethics Forum in Hong Kong, the 2017 Midyear Forensic Accounting Conference of the American Accounting Association in Orlando in March 2017, and the 2017 American Accounting Association Annual Meeting in San Diego, in August 2017. The authors thank the workshop participants at the University of Memphis, the United International College and the Sino-US College in Zhuhai, China for their valuable comments on the earlier draft of the manuscript with gratitude, this research is funded by a research grant provided by the University Grant Committee (project reference: UGC/FDS17/B02/14). The authors appreciate support given by Tung Wah College in Hong Kong.

Managerial Auditing Journal
Vol. 34 No. 3, 2019
pp. 268-288

0268-6902
DOI 10.1108/MAJ-08-2017-1633

1. Introduction

Forensic accounting has emerged as a major area of accounting practices, which includes fraud examination, anti-corruption and anti-bribery, business valuation, litigation support, expert witnessing and cyber security (Crumbley *et al.*, 2015; Rezaee *et al.*, 2004). The demand for forensic accounting services is growing as businesses, regulators and investors have continued to raise concerns about fraud, financial irregularities, corruption and bribery cases. For example, business organizations lose about 5 per cent of their revenues to fraud each year, which can exceed US$3.5tn worldwide (ACFE, 2016). Information technology advances (e.g. cloud, social media and analytics) enable organizations to have an unprecedented amount of structured, semi-structured and unstructured data. The emergence of "high-volume, high-velocity, and high-variety" information that can be processed electronically to facilitate decision-making is usually described as Big Data (Gartner, 2014)[1]. The evidence of relevance of Big Data skills and knowledge to forensic accounting practice and education is rare (Rezaee *et al.*, 2016). To help update and advance forensic accounting curricula with Big Data content, this research conducts a survey of both academics and practitioners in China to gather insight regarding the integration of forensic accounting and Big Data into the business curricula.

Insight regarding Big Data and its integration to forensic accounting education from academics and practitioners from Hong Kong and mainland China are obtained for three reasons. First, forensic accounting in Hong Kong and China has grown significantly in the past several years (Rezaee *et al.*, 2016). Second, anecdotal evidence suggests that Asian Pacific countries (APAC) are the fastest-growing region for the Big Data market (Markets and Markets, 2017). Third, China has advanced as the world's second largest economy vulnerable to corporate scandals and fraud (Hung *et al.*, 2015)[2]. The primary purposes of this paper are to:

- describe the use of Big Data in forensic accounting practice;
- investigate the relevance and importance of Big Data to the practice and education of forensic accounting;
- examine the demand for and interest in integrating Big Data and forensic accounting into business curricula; and
- present Big Data topics relevant to forensic accounting education and their integration into the business and accounting curricula.

Analysis of the insight gained from a sample of academics and practitioners indicates that:

- the demand for and interest in Big Data/data analytics and forensic accounting will continue to increase;
- Big Data/data analytics and forensic accounting can be integrated into the business curricula at both undergraduate and graduate levels;
- many of the suggested 25 Big Data topics should be integrated into forensic accounting education; and
- some attributes and techniques of Big Data such as the availability of Big Data, data analytics techniques, accuracy, reliability, accessibility, relevancy and predictive, descriptive and prescriptive analytics are important in improving forensic accounting education and practice.

This study makes several contributions to the Big Data and forensic accounting practice and education literature. First, results support recent initiatives taken by the Association to

Advance Collegiate Schools of Business (AACSB) International accounting program to integrate information technology throughout academic curricula. The AACSB Standard A7 (AACSB, 2014, p. 3) underscores the importance of Big Data and data analytics to business education by suggesting "the development of skills and knowledge related to data creation, data sharing, data analytics, data mining, data reporting, and storage within and across organizations." Thus, this study provides evidence of the importance of Big Data and forensic accounting education. Second, the findings of this study can be used to advance forensic accounting education by integrating Big Data (data analytics)-related topics into the forensic accounting curricula as suggested by Cao *et al.* (2015) and Rezaee *et al.* (2018). Finally, this study presents evidence of the use of data analytics in forensic accounting practice and provides some survey results of the relevance of the use Big Data (data analytics) in forensic accounting practice. Future research can use the insights to further investigate and promote the use of Big Data in forensic accounting education and practice[3].

Section 2 describes the use of Big Data in forensic accounting practices. Section 3 reviews the literature and presents the research questions. Section 4 illustrates research method, survey questionnaire and sample selection procedures. Section 5 reports the results and discussion and Section 6 concludes.

2. Use of big data in forensic accounting practices

Forensic accounting services have emerged as an important practice in accounting firms (Crumbley *et al.*, 2015). Forensic accountants can play an important role in discovering and preventing fraud, corruption and bribery cases. Forensic accounting has recently gained considerable attention as evidenced by a large number of universities offering forensic accounting courses and programs, many published textbooks in forensic accounting, and several established certifications in forensic accounting (Crumbley *et al.*, 2015). Big Data has also received common acceptance and practical application in the business community. For example, more than 98 per cent of all stored information is now electronic, compared with about 25 per cent of digital information in 2000 (Cukier and Mayer- Schonberger, 2013; Crumbley *et al.*, 2015). A recent survey conducted by Ernst and Young (EY) shows that "79 per cent of respondents use more than 10 million records, which are typically outside the domain of spreadsheets and require more sophisticated tools for analysis" (EY, 2016, p. 25).

Big Data and business analytics are also being extensively used in recent years (Markets and Markets, 2017). The Big Data market has grown dramatically from $16.1bn in 2014 (Forbes, 2013a) to over $50bn by the end of 2016 (Kelly *et al.*, 2015) and is expected to continue to grow. The estimated market for Big Data is about $67bn by 2021, with data analytics software holding the highest market share (Markets and Markets, 2017). However, there is an inadequate supply of professionals with Big Data skills. Laney and Kart (2012) predicts a shortage of over 100,000 analytics talents by 2020. McKinsey Global Institute (2011) reports similar shortage of 140,000 to 190,000 professionals with analytical expertise by 2018 in the USA. Forensic accountants are now able to obtain a huge amount of both structured (e.g. general ledger or transaction data) and unstructured data (e.g. email, voice or free-text fields in a database), together with an increasing amount of nontraditional data sources such as third-party watch lists, news media, free-text payment descriptions, email communications and social media. As a result, forensic accountants use advanced technological tools in their investigative practices. For example, forensic accountants use social media and Web monitoring, voice searching and analysis, visualization and reporting tools (EY, 2016).

Two surveys conducted by EY (2014, 2016) report the trends toward the use of IT and Big Data/analytics in forensic accounting practices. First, there is an increasing use of

forensic data analytics in forensic and investigative accounting services. Second, cyber breaches (illicit transferring of funds, disrupting critical operations or stealing intellectual property/confidential personal data) and insider threats (malicious insiders stealing, manipulating or destroying data, fraud and unauthorized trading information technology sabotage) are emerging as the fastest growing fraud risks faced by forensic accountants. Forensic accountants increasingly use Big Data (analytics) in their practices to deal with data sets exceeding the typical constrains of a traditional spreadsheet (EY, 2016). Forensic accountants also use data visualization, predictive analytics, behavior analytics, content analytics, social network analysis, geo-spatial analytics and numerous advanced anti-fraud techniques to overcome the shortcomings of the traditional rules-based relational database techniques, such as matching, sorting, filtering and query design (EY, 2016).

There is a shortage of forensic accountants who possess Big Data/analytical skills and are able to use sophisticated analytical tools to effectively and accurately identify potential risks and proactively search for irregularities and assess and manage their risk profile. The growing demand and inadequate supply of Big Data professionals raises the question whether there is adequate training related to Big Data at the undergraduate/graduate level in the forensic accounting education. The integration of and Big Data into forensic accounting and business curricula supports the market demand for digital forensic accounting services and keeps business curricula aligned with digital forensic accounting practices. Anecdotal evidence from Wang *et al.* (2016) show that only 3 out of 19 universities with the forensic accounting program in China have a standalone course on Big Data. Rezaee *et al.* (2018) examine forensic accounting syllabi of many universities worldwide for their coverage of Big Data topics and conclude Big Data and data analytics topics are not sufficiently covered in forensic accounting courses and programs.

The following examples illustrate the use of Big Data (analytics) in forensic accounting practice. First, when forensic accountants investigate fraud, corruption or bribery cases, they take industry-specific norms or regulations into consideration and use keyword phrases to identify potential fraud. Second, by using historical activities or transaction data, forensic accountants can use predictive modeling and other advanced analytics to detect suspicious and anomalous transactions, high-risk events, or potential fraudulent behavior or activities. Third, by mining across multiple databases (such as customer or third-party databases), forensic accountants can use entity resolution algorithms to identify hidden relationships, addresses and aliases and investigate conflicts of interest, fake identities or sanctioned individuals and entities. Fourth, forensic accountants use social network analytics to detect hidden relationships, bogus vendors or fake bank accounts when they analyze both structured and unstructured data in the format of visuals and links from social media. Fifth, a large amount of unstructured text data is available from the free text field of journal entries, payment description, expense details, e-mails, social media, documents, presentations and hard drives of individual employees or organizations. Forensic accountants use text mining or text analytics with heuristic rules and statistical techniques to discover the sentiments and conceptual meanings of large amounts of text data, which help to identify potential fraud or non-compliance in the organization. Finally, besides traditional simple spreadsheets or static charts and graphs, forensic accountants use data visualization techniques and interactive dashboards to present evidence in an easy to understand manner.

3. Literature review and research questions

Forensic accounting education and practice have gained attention from research scholars. Seda and Peterson-Kramer (2014) examine the availability of forensic accounting education in the USA and other English-speaking countries and find that in the USA, there are 422

universities and colleges offering forensic accounting courses, with 97 of them providing forensic accounting programs; while in Canada and other English-speaking countries, there are 25 universities and colleges offering forensic accounting courses, with 23 forensic accounting programs among 186 Canadian and other English-speaking universities and colleges. Rezaee *et al.* (2004) conducted a survey of both academics and practitioners in the USA and provided evidence of the importance of forensic accounting education and practice and its integration into business curricula. Rezaee *et al.* (2016) examine forensic accounting practice in China and survey both Chinese and international students regarding the importance, demand, relevance, benefits, coverage and delivery of forensic accounting education and suggest that business and accounting universities in China integrate many suggested forensic accounting topics into their curricula.

There is a growing demand for Big Data knowledge and skills, particularly among business and accounting professionals. Russom (2011) made predictions of an increasing use of Big Data, particularly in the areas of predictive analytics, machine learning, artificial intelligence, visualization techniques (dashboards), data warehouses, dedicated database management systems and Big Data technology (e.g. Hadoop, distributed file system). Forbes (2013b) reported that the Securities and Exchange Commission in the USA has used Big Data/analytics, which were labeled as "RobotCop," to identify securities law violations and financial statements irregularities and audit failures. Issa and Kogan (2014) point out that there is an increasing demand for Big Data knowledge and skills for auditors to understand the quality and relevance of the Big Data to make professional judgments. For example, auditors can use predictive analytics to overcome the cognitive limitations associated with ambiguity within from voluminous data and to identify meaningful patterns. Cao *et al.* (2015) argue that because clients use Big Data, auditors should adopt Big Data/analytics in risk assessment, substantive analytical procedures, collection of audit evidence and obtaining audit confirmations. The Charted Global Management Accountant (2014) survey suggests that the use of cloud-based solutions in accounting information systems encourage professional accountants to know more about Big Data skills, such as cyber/information security. The recent survey of Fortune 1,000 firms by New Vantage Partner (2016) find that they increase investment in Big Data to obtain greater insights into business and customers, and a majority of these firms (about 54 per cent) have well-defined roles of Chief Data Officers.

There is an inadequate supply of Big Data professionals. Laney and Kart (2012) forecast a shortage of data specialists that "the need, for data scientists, is growing at about three times that for statisticians and business intelligence analysts, and there is an anticipated 100,000-plus-person analytic talents shortage through 2020." Similarly, McKinsey Global Institute (2011) predicted:

> [. . .] the United States alone faces a shortage of 140,000 to 190,000 people with analytical expertise and 1.5 million managers and analysts with the skills to understand and make decisions based on the analysis of Big Data.

There is a growing demand for, and short of supply of, forensic accountants with knowledge and skills in digital investigation and Big Data analytics as well. Consistent with the anticipation that demand for Big Data professionals will rise, Wixom *et al.* (2014) document that the market demand for students with Business Intelligence (BI) and Business Analytics (BA) skill sets are growing. Global Times (2017) reports an estimated demand of 1.8 million Big Data professionals in the next three to five years in China, which is 1.5 million more than the current supply.

The growing demand, and shortage, of Big Data professionals raises the question whether there is adequate training related to Big Data at the undergraduate or graduate

level in the forensic accounting education. Hong Kong Institute of CPAs and Chinese Institute of CPAs call on universities to upgrade their accounting curricula to better prepare accounting students for the challenges provided by Big Data (HKICPA, 2013). This study is a response to the call for more coverage of digital forensic accounting education and thus differs from prior research (Rezaee *et al.*, 2004; Seda and Peterson-Kramer, 2014; Rezaee *et al.*, 2016) and contributes to forensic accounting education literature. Rezaee and Burton (1997) examine coverage of forensic accounting and the role of forensic accounting education as perceived by academics and practicing certified fraud examiners and conclude that the integration of forensic accounting education into business curricula either through a separate course or through modules in business, accounting and auditing courses is vital. Rezaee *et al.* (2004) survey both academics and practitioners and collect their opinions on the importance, relevance and delivery of forensic accounting education. Seda and Peterson-Kramer (2014) update the status of forensic accounting education in the USA and other English-speaking countries and document an increasing provision of forensic accounting education in the USA and other English-speaking countries. Wang *et al.* (2016) analyze the environmental factors and find the increasing availability of forensic accounting education in Hong Kong and Mainland China. These prior studies did not examine the IT issue or relevance of Big Data to forensic accounting education. This study further investigates the relevance of Big Data to forensic accounting education to prepare students for the demand of Big Data skills in their future employment.

China has an institutional setting different from many Western countries in terms of economic, legal, social, cultural and political environment (Wang *et al.*, 2016). However, prior research of forensic accounting practice and education in a Chinese setting is rare (Rezaee *et al.*, 2016). Wang *et al.* (2016) examine the environmental factors in China and concludes an increasing demand for forensic accounting services and forensic accounting education. Another research conducted by Rezaee *et al.* (2016) examines the forensic accounting education in China and surveys Chinese students and international students in China on the coverage of forensic accounting topics in business curricula. This research differs from Rezaee *et al.* (2016), which survey students on forensic accounting topics, and conducts a survey of both practitioners and academics on the issues of Big Data in the forensic accounting practice and education. As the input of both academics and practitioners are important in the curriculum design, this study helps to advance forensic accounting education by incorporating Big Data topics into curricula. Thus, the research questions addresses in this study are:

RQ1. What is the status of forensic accounting practice and education in China one of the fastest emerging economies and markets?

RQ2. What is the status of Big Data and Data analytics in China?

RQ3. How can both Big Data and forensic accounting can be integrated into business curricula?

RQ4. What are the topical contents of Big Data and forensic accounting business curricula integration?

RQ5. What are the attributes, skills and techniques of Big Data that can be integrated into forensic accounting courses and programs?

4. Research method and procedures

The review of the literature performed in Section 3 enables us to identify Big Data topics relevant to forensic accounting education. Then, we conduct a survey of academics and

practitioners regarding the desired demand, importance and content of Big Data educational skills and topics for forensic accounting education[4].

4.1 Questionnaire

We prepared, pretested and revised the draft of the four-page, six-section questionnaire. We conducted a pilot and pretesting of the questionnaire by sending it to several academics and practitioners known to authors and experts in the areas of forensic accounting and Big Data. They were asked to review, correct and suggest for improvements and refinements of the original draft of the questionnaire for its relevance, content and wordings. A revised, refined and pre-tested four-page, six-section questionnaire was then sent to the participants. The six main sections of the survey asked respondents for their perceptions of the future demand for, and interest in Big Data and forensic accounting, ways that forensic accounting and Big Data education can be integrated into business curricula and educational content of Big Data and forensic accounting education. The last sections address the relevance and important of the practice and education in forensic accounting with a focus on Big Data and sought comments on forensic accounting and Big Data. To improve the response rate, we included with each questionnaire a cover letter stating the survey objectives, defining forensic accounting and Big Data, assuring the confidentiality of the responses, agreeing to share the summary of findings and giving respondents, the appropriate amount of time needed to complete the questionnaire. The original draft of the questionnaire was pre-tested by asking several academics and practitioners to review it for content, format, completeness and accuracy. Corrections were made in the final draft submitted to participants through online survey. The survey link was generated by an automated survey system in the email of selected participants, which assured their responses would be completely anonymous[5]. A copy of the questionnaire is provided in the Appendix.

4.2 Sample

A survey was introduced to participants at three places. First, participants at the 6th World Business Ethics Forum in December 2016 were approached and invited to participate in the survey and respond to the related on-line questionnaire[6]. Second, authors made a presentation to forensic accounting practitioners through the forensic accounting interest group of Hong Kong Institute of Certified Public Accountants (HKICPA) in December 2016 and invited them to participate in the survey[7]. Third, one of the authors conducted workshops on forensic accounting and Big Data at two universities in mainland China and encouraged colleagues to participate in the survey.

The survey to both academics and practitioners was conducted using an on-line questionnaire. We sent the cover letters to 500 academics and 500 forensic accounting practitioners. Participation was voluntary with no compensation, and all participants were ensured that no identifying information was collected and only summary results reported. To improve the response rate, we distribute the cover letter to participants and reminded them to complete the on-line survey at the conference venue of the 6th World Business

Table I. Sample and responses

	Chinese academics	Chinese practitioners	Total
Conducted	500	500	1,000
No responses	405	397	802
Usable responses	95	103	198
Response rate (%)	19	20.6	19.8

Ethics Forum and at the training workshops of Hong Kong Institute of Certified Public Accountants forensic accounting interest group and two universities in China. We received responses from 95 academics and 103 practitioners, with a response rate of 19 and 20.6 per cent, respectively. The overall response rate is comparable to a prior study (Rezaee *et al.*, 2004, 15.4 per cent for academics and 10.7 per cent for practitioners). The response rate is common in the survey study of certain types of individuals (Hodge, 2003).

We used the chi-square test of independence to test the differences in responses of categorical variables for different groups of respondents. We used Kruskal–Wallis non-parametric analysis of variance to examine the difference in the responses of ranked data. We also applied the *t*-test to test the differences between the two groups of Chinese academics and practitioners with regard to their responses. The results are qualitatively similar between chi-square tests and *t*-tests, which indicate the independence between these two groups. To evaluate and determine the strength of response from each group in a five-point Likert Scale, we follow Rezaee *et al.* (2004) and Campbell and Mutchler (1988) and calculate the absolute value of the difference between the mean response of the group and the neutral response of 3.0 mean responses falling within 0.5 points of the mean response 3.0 are considered neutral ratings.

5. Results and discussions

Results are presented in the following four categories:

(1) the horizon for Big Data and forensic accounting practice;

(2) method of integrating Big Data and forensic accounting into business curricula;

(3) outcome and coverage of Big Data curricula content; and

(4) use and relevance and importance of Big Data in forensic accounting practice and education.

5.1 Horizon for big data and forensic accounting

Table II summarizes the responses to a question regarding the demand for and interest in Big Data and forensic accounting. A majority of both academic and practitioner respondents reported the increased demand for and interest in Big Data and forensic accounting. The differences in responses between practitioners and academics are statistically significant as a higher percentage of academics, 94 per cent compared to 83 per cent of practitioners, reported that demand for and interest in Big Data will continue to increase. The differences in responses regarding the demand for and interest in forensic accounting are not

(%)

	Big data		*Forensic Accounting*	
	Chinese academics	*Chinese practitioners*	*Chinese academics*	*Chinese practitioners*
Increase?	94	83	66	66
Remain the same?	2	8	20	21
Decrease?	0	4	3	9
Unsure?	4	5	11	4
Total	*100%*	*100%*	*100%*	*100%*

Note: Demand and interest in Big Data and Forensic Accounting percentage for both groups. Do you expect future demand and interest in the following two areas?

Table II.
Big data and forensic accounting

statistically significant between the two groups. Overall, there is more demand for, and interest in, Big Data than forensic accounting by both groups of respondents as 83 per cent of practitioners believe that the demand for Big Data will increase, while only 66 per cent of them think that the demand for forensic accounting will increase. Similar results are revealed for academics as a high percentage of academics (94 per cent) felt that the demand for Big Data will increase, but only 66 per cent of them expect that the demand for forensic accounting will increase. These results suggest that both groups of respondents are expecting that demand for, and interest, in Big Data will increase more than demand for forensic accounting. One explanation is that Big Data has emerged substantially in recent years, whereas forensic accounting has been in practice in many years and has reached its maturity acceptance by both academics and practitioners. However, academics are more optimistic than practitioners regarding the demand for, and interest, in Big Data.

Table III shows that a majority of both academics and practitioners believe that Big Data and forensic accounting courses should be offered at both graduate and undergraduate levels. Panel A of Table III shows that the majority of academics (71 per cent) and practitioners (65 per cent) reported that a Big Data course should be offered at both undergraduate and graduate levels with some support also for graduate coverage (over 22 per cent) and not much in favor of an undergraduate course in Big Data. Panel B of Table III indicates that the majority of academics (65 per cent) and about 47 per cent of practitioners felt that a forensic accounting course should be offered at both undergraduate and graduate levels. Again, there is some support for offering a graduate forensic accounting course (over 27 per cent), whereas there is less preference for an undergraduate coverage of forensic accounting (less than 20 per cent) for both groups. Differences in responses between two groups are not statistically significant. These results suggest that both groups of respondents believe that forensic accounting and Big Data subjects are more advanced topics that require prerequisite accounting and business knowledge for students in lower undergraduate accounting and business courses[8].

5.2 Perception toward integration of big data and forensic accounting education

Respondents were asked to express their opinion on the integration of Big Data into forensic accounting education. We asked both academics and practitioners to respond to nine related questions by ranking their responses on a five-point Likert scale, with "5" indicating

Level	Chinese academics (%)	Chinese practitioners (%)
Panel A: At what level do you think a Big Data course should be offered?		
Graduate	22	20
Undergraduate	6	13
Both graduate and undergraduate	71	65
None	1	2
Total	100	100
Panel B: At what level do you think a Forensic accounting course should be offered?		
Graduate	27	29
Undergraduate	7	19
Both graduate and undergraduate	65	47
None	1	5
Total	100	100

Table III.

"strongly agree" and "1" representing "strongly disagree." Results presented in Table IV indicate that both groups agree that Big Data will help forensic accounting students to:

- perform data-mining and modeling in forensic accounting investigations (4.22 mean response for academics and 3.87 for practitioners);
- have advanced analytical and other data management skills (mean responses of 4.21 and 3.94 for academics and practitioners, respectively);
- extract, transform and leverage syndicated data for use in forensic accounting practices (4.09 and 3.95, respectively);
- have a clear and coherent database digital strategy (3.92 and 3.74, respectively);

Chinese academics				Significantly different		Chinese practitioners		
Rank	Mean response	Standard deviation	Curriculum content	5%	1%	Rank	Mean response	Standard deviation
1	4.37	0.36	Forensic data analytics	No	No	1	4.05	0.55
2	4.33	0.27	Data base management	Yes	Yes	13	3.70	0.78
3	4.31	0.30	Ethical issue in business intelligence	Yes	Yes	24	3.49	0.95
4	4.29	0.31	Forensic analytical tools (EnCase)	No	No	7	3.83	0.70
5	4.28	0.32	Data structure/data warehouse	Yes	Yes	17	3.63	0.69
6	4.26	0.34	Data mining/predictive modeling analysis	Yes	No	10	3.78	0.74
7	4.21	0.40	Digital investigation	Yes	Yes	4	3.88	0.67
8	4.20	0.41	Data visualization	No	No	2	3.93	0.57
9	4.19	0.60	Information assurance and authentication	No	No	5	3.86	0.85
10	4.18	0.48	Big Data technologies (Hadoop, Map Reduce)	Yes	No	14	3.68	0.84
11	4.18	0.47	Data integration	Yes	No	18	3.61	0.84
12	4.11	0.51	Expert system/artificial intelligence	Yes	Yes	23	3.51	0.79
13	4.08	0.62	Business intelligence user tools (OLAP)	Yes	Yes	16	3.64	0.69
14	4.07	0.68	Data governance	Yes	Yes	12	3.72	0.76
15	4.06	0.56	Computer forensics	No	No	3	3.91	0.68
16	4.05	0.58	Mobile digital forensics	No	No	8	3.82	0.76
17	4.03	0.55	Networks, internet and E-commerce	Yes	No	22	3.55	0.81
18	3.99	0.59	Data movement (in-memory data)	Yes	No	20	3.59	0.78
19	3.98	0.53	Text analytics	No	No	19	3.61	0.78
20	3.96	0.78	Dimensional modeling	Yes	Yes	21	3.57	0.72
21	3.94	0.79	Cybercrime, computers and auditors	No	No	6	3.83	0.74
22	3.93	0.75	Data streaming management	Yes	Yes	25	3.48	0.87
23	3.87	0.70	Recovery of digital data	No	No	11	3.73	0.72
24	3.87	0.71	Digital evidence seizure	No	No	9	3.81	0.71
25	3.79	0.90	Data encryption	Yes	Yes	15	3.68	0.59

Table IV.
Opinion on big data in forensicaccounting practice

- use and interpret data sets that may not have standard data formats (3.87 and 3.73, respectively);
- effectively present findings to diverse audiences using strong verbal, written, and visual communication skills (3.81 and 3.83, respectively); and
- connect the dots in mining data for patterns that lead to evidence (3.78 and 3.68, respectively). The last two questions regarding "sharing Big Data with others" and "align people, processes, and culture" receive relatively low agreement from either group of respondents.

Although the two groups rank the importance of various opinions regarding Big Data very similarly, there are some differences in raking among them. For example, practitioners are more in agreement with statements that Big Data should help forensic accountants to extract, transform and leverage syndicated data for use in forensic accounting practices (Rank 1st); which academics believe less important (Rank 3rd). All responses to statements presented in Table IV between the two groups are statistically insignificant at the 0.05 and 0.01 levels[9], which suggest that academics and practitioners unanimously agree on the outcomes of Big Data knowledge and skills in the forensic accounting education.

5.3 Curriculum content of big data in forensic accounting education

Given that the demand for and interest in use of Big Data in forensic accounting will increase, what should be the curriculum content of Big Data in forensic accounting education? We asked both groups of respondents to indicate the importance of 25 suggested Big Data topics by using a Likert scale of one to five, with five being the "most important" and one being the "least important." These 25 topics come from a review of existing literature (Business Intelligence Congress, 2012; Wixom *et al.*, 2014; Gupta *et al.*, 2015; EY, 2014; EY, 2016; Rezaee *et al.*, 2018)[10]. The results in Table V reveal that academics rank the importance of 25 topics for integration into forensic accounting or auditing curricula much higher than practitioners, and the differences are statistically significant for most responses. Results show that both academics and practitioners ranked the topics "forensic data analytics," "forensic analytical tools (Encase)," "data mining/predictive modeling analysis," "digital investigation," "data visualization" and "information assurance and authentication" on the top of the list.

The main disparity between the two groups involved the topics of "database management" (Rank Number 2 and 13 for academics and practitioners, respectively), "ethical issue in business intelligence" (3 and 24, respectively), "data structure/data warehouse" (5 and 17, respectively), "expert system/artificial intelligence"(12 and 23, respectively), "computer forensics" (15 and 3, respectively), "mobile digital forensics" (16 and 8, respectively),"cybercrime, computers and auditors" (21 and 6, respectively) and "digital evidence seizure" (24 and 9, respectively). Compared with practitioners, academics perceive that these four topics: "database management" "ethical issue in business intelligence" "data structure/data warehouse" and "expert system/artificial intelligence" are more important. However, practitioners rank "digital investigation" higher than academics (Rank Number 4 and 7 by practitioners and academics, respectively).

The differences between academics and practitioners, regarding 10 Big Data topics, are statistically insignificant, including "forensic data analytics," "forensic analytical tools (Encase)," "data visualization" and "information assurance and authentication". Overall, all the suggested 25 topics are considered by both groups of academics and practitioners as important (with mean responses of greater than 3.68) to be integrated into forensic accounting and business education.

Chinese academics				Significantly different		Chinese practitioners		
Rank	Mean response	Standard deviation	Curriculum content	5%	1%	Rank	Mean response	Standard deviation
1	4.37	0.36	Forensic data analytics	No	No	1	4.05	0.55
2	4.33	0.27	Data base management	Yes	Yes	13	3.70	0.78
3	4.31	0.30	Ethical issue in business intelligence	Yes	Yes	24	3.49	0.95
4	4.29	0.31	Forensic analytical tools (EnCase)	No	No	7	3.83	0.70
5	4.28	0.32	Data structure/data warehouse	Yes	Yes	17	3.63	0.69
6	4.26	0.34	Data mining/predictive modeling analysis	Yes	No	10	3.78	0.74
7	4.21	0.40	Digital investigation	Yes	Yes	4	3.88	0.67
8	4.20	0.41	Data visualization	No	No	2	3.93	0.57
9	4.19	0.60	Information assurance and authentication	No	No	5	3.86	0.85
10	4.18	0.48	Big Data technologies (Hadoop, Map Reduce)	Yes	No	14	3.68	0.84
11	4.18	0.47	Data integration	Yes	No	18	3.61	0.84
12	4.11	0.51	Expert system/artificial intelligence	Yes	Yes	23	3.51	0.79
13	4.08	0.62	Business intelligence user tools (OLAP)	Yes	Yes	16	3.64	0.69
14	4.07	0.68	Data governance	Yes	Yes	12	3.72	0.76
15	4.06	0.56	Computer forensics	No	No	3	3.91	0.68
16	4.05	0.58	Mobile digital forensics	No	No	8	3.82	0.76
17	4.03	0.55	Networks, internet and E-commerce	Yes	No	22	3.55	0.81
18	3.99	0.59	Data movement (in-memory data)	Yes	No	20	3.59	0.78
19	3.98	0.53	Text analytics	No	No	19	3.61	0.78
20	3.96	0.78	Dimensional modeling	Yes	Yes	21	3.57	0.72
21	3.94	0.79	Cybercrime, computers and auditors	No	No	6	3.83	0.74
22	3.93	0.75	Data streaming management	Yes	Yes	25	3.48	0.87
23	3.87	0.70	Recovery of digital data	No	No	11	3.73	0.72
24	3.87	0.71	Digital evidence seizure	No	No	9	3.81	0.71
25	3.79	0.90	Data encryption	Yes	Yes	15	3.68	0.59

Table V.
Big data curriculum content

5.4 Relevance of big data in forensic accounting practice

We ask two groups of respondents regarding the three attributes of Big Data that may influence forensic accounting practice and education:

(1) the effect of Big Data on the effectiveness of forensic accounting;

(2) the use of Big Data in practicing forensic accounting; and

(3) importance of several other attributes Big Data in forensic accounting.

Panel A of Table VI show that academics rank "availability of Big Data" as the most important factor whereas practitioners feel that the "availability of analytical talent" is the most important factor. However, both academics and practitioners agree that "analytical techniques and tools to support forensic accounting" is the second most important factor that can influence the effectiveness of forensic accounting. The results of Panel A show that the differences between academics and practitioners are significant at the 0.05 level, except for "availability of analytical talent" (insignificant at 0.05 level), which suggests that academics are more interested in "Big Data" itself, whereas practitioners are more concerned with the analytical talent and techniques in using Big Data.

Panel B of Table VI indicates that both academics and practitioners agree that "descriptive analytics," "capturing data" and "aggregating/integrating data" are very useful in forensic accounting practices suggesting that both academics and practitioners believe these Big Data techniques are important in advancing forensic accounting education and practice. However, academics and practitioners rank "predictive analytics," "prescriptive analytics" and "disseminating data" differently. Academics feel that forensic accountants use "predictive analytics" the most, whereas practitioners believe that "disseminating data" and "capturing data" are the most important use of Big Data. However, in most cases, responses from academics are not significantly different from neutral response of 3.0 and so the strength of the response is weak. In comparison, the responses from practitioners are strong and significant from neutral response of 3.0. The differences between academics and practitioners on the use of three Big Data techniques ("capturing data," "aggregating/integrating data" "and disseminating data") are not statistically significant at the 0.05 and 0.01 level[11].

Panel C of Table VI reveals that both academics and practitioners agree that accuracy, reliability and completeness attributes of Big Data are important in forensic accounting practices with the mean responses of greater than 3.84. Attributes of Big Data such as completeness, accessibility, relevance and consistency (while considered important by both groups) received different rankings. For instance, academics rank completeness as the number one attribute, whereas practitioners believe the reliability is the most important attribute. This suggests that academics focus on the volume and size of Big Data, but practitioners are more interested in the information quality when they use of Big Data in forensic accounting practices. Overall, academics feel that accessibility is significantly more useful than practitioners and the two groups are insignificantly different with regard their opinion of three attributes, namely "accuracy," "reliability" and "detailed."

We ask two groups of respondents several questions regarding the role of Big Data and forensic accounting in organizations. The results of Table VII show that majority of both academics and practitioners agree that Big Data/Analytics improve forensic accounting practices (81 and 80 per cent for academics and practitioners, respectively); data security threats limit the use of Big Data in forensic accounting (80 and 73 per cent, respectively) and Big Data/Analytics and forensic accounting overlap (67 and 62 per cent, respectively). Compared with academics, practitioners are significantly more optimistic than organizations' Big Data/Analytics roles and forensic accounting roles are well defined (significant at 0.05 and 0.01 level). This suggests that the organizations have used the Big Data/Analytics and forensic accounting functions to meet the challenges of the digital age.

6. Conclusions

This paper examines the relevance of Big Data to forensic accounting practice and education. We conduct a survey of both practitioners and academics in China. The

Chinese academics				Significantly different		Chinese practitioners		
Rank	Mean response	Standard deviation	Curriculum content	5%	1%	Rank	Mean response	Standard deviation
Panel A: To what extent do the following affect the effectiveness in forensic accounting?								
1	3.97	0.59	Availability of Big Data	Yes	No	3	3.56	0.72
2	3.85	0.58	Analytical techniques and tools to support forensic accounting	Yes	No	2	3.70	0.66
3	3.96	0.58	Availability of analytical talent	No	No	1	3.73	0.72
Panel B: To what extent do you use the following in practicing forensic accounting?								
1	3.69	1.32	Predictive analytics	Yes	No	5	3.43	0.82
2	3.31	1.28	Descriptive analytics	Yes	No	3	3.55	0.81
3	3.24	1.34	Capturing data	No	No	2	3.56	0.86
4	3.21	1.18	Prescriptive analytics	Yes	No	6	3.38	0.82
5	3.19	1.40	Aggregating/integrating data	No	No	4	3.53	0.91
6	3.03	1.24	Disseminating data	No	No	1	3.61	0.77
Panel C: To what extent do the following attributes of Big Data is useful in forensic accounting practices?								
5%	*1%*							
1	4.07	0.77	Completeness	Yes	Yes	4	3.83	0.50
2	4.05	0.84	Accuracy	No	No	2	3.86	0.57
3	4.03	0.94	Reliability	No	No	1	3.92	0.67
4	4.02	0.81	Accessibility	Yes	Yes	6	3.83	0.50
5	3.94	0.86	Relevancy	Yes	No	3	3.84	0.67
6	3.93	0.81	Consistency	Yes	No	5	3.83	0.56
7	3.82	0.73	Detailed	No	No	7	3.82	0.44

Table VI.

Table VII.
Big data and forensic accounting roles in organizations

Chinese academics				Significantly different		Chinese practitioners		
ank	Yes (%)	No (%)		5%	1%	Rank	Yes (%)	No (%)
1	81	19	Have Big Data/Analytics improved forensic accounting practices?	No	No	1	80	20
2	80	20	Do data security threats limit the use of Big Data in forensic accounting?	No	No	2	73	27
3	67	33	Does your organization's Big Data/ Analytics overlap with forensic accounting?	No	No	3	62	38
4	36	64	Are your organization's forensic accounting roles well defined?	Yes	Yes	4	61	39
5	35	65	Are your organization's Big Data/ Analytics roles well defined?	Yes	Yes	5	53	47

results show that the integration of Big Data into forensic accounting education enables students to achieve outcomes, including performing data-mining and modeling in forensic accounting investigation, acquiring advanced analytical data management skills and extracting, transforming and leveraging data for usage in the forensic accounting practices. Results also indicate that the demand for and interest in both forensic accounting and Big Data is expected to increase; forensic accounting and Big Data should be offered at both the undergraduate and graduate levels; and many of the suggested 25 Big Data topics are considered important to be integrated into Big Data/ forensic accounting courses. Both academics and practitioners viewed a majority of these topics, 25 Big Data and data analytics topics (Table V) as important for integration into forensic accounting education. The convergence of these Big Data related forensic accounting topics requires the classification of interrelated topics into smaller subsets or tiers. For example, the top ranked topics of 1-10 can be labeled as "fundamentals of Big Data for forensic accounting" and be taught in a separate module. The ranked of topics 11-20 can be covered in a module as "data analytics and techniques," whereas topics 21-25 can be considered as "Big Data application in forensic accounting." Coverage of these Big Data topics in the forensic accounting curricula should enable students to successfully prepare for their future professional career.

The survey reports that both groups of respondents believe the use of Big Data/analytics improve the forensic accounting practices, but data security threats limit the use of Big Data/analytics. This is consistent with EY (2016) that the use of Big Data/analytics increased dramatically, but cyber-security remains an important issue in the use of Big Data/analytics. With regards to forensic accounting practices, the survey finds that Big Data techniques including descriptive and prescriptive analytics, capturing data and Big Data attributes such as accuracy, reliability, accessibility and consistency are important to forensic accounting practices.

This research has a few limitations. First, this paper does not address the relevance of Big Data topics at undergraduate or graduate (MS and MBA) levels. Gupta *et al.* (2015) argue that Big Data Analytics courses are different at undergraduate, MS and MBA levels where undergraduate courses emphasize an understanding of business information (BI) tools, while graduate courses emphasize BI applications. Second, the 25 Big Data topics reported in Table V come from the extensive review of related literature (Gupta *et al.*, 2015; Rezaee *et al.*, 2018). It is possible that

these topics do not represent all of the topics that should be covered regarding Big Data. The list of the suggested 25 topics is by no means all-inclusive and overlap can exist among them. Finally, readers should interpret the results with caution because of the sample size (95 academics and 103 practitioners) and responses obtained from academics and practitioners in one country (China) that may not be representative of the global population. The surveyed practitioners could have self-interest bias toward forensic accounting and naturally report higher demand for forensic accounting. Thus, future research could extend our survey to several countries. Specifically, a comparison of survey results from academics and practitioners in the developed countries (e.g. the USA) with those in emerging markets (e.g. China) should be interesting to both academics and practitioners. The nature, and speed of the process by which the business community, the accounting profession and business schools adopt Big Data curricula design, including Big Data courses, concentrations and programs, is another area for future research.

Notes

1. IBM (2015) defines Big Data with five attributes as volume, velocity, variety, veracity and value.
2. Authors are affiliated with universities and professional organizations in Asia.
3. Indeed, we are not aware of any prior research providing insight into the integration of Big Data topics into the forensic accounting curriculum.
4. Insight from both academics and practitioners was sought to ensure coverage of forensic accounting education and practice, respectively.
5. One condition that the participants agree to join the survey is that they remain anonymous. We distribute the survey to them through the group e-mail list. So, we will not be able to provide the profiles of the participants.
6. The World Business Ethics Forum was set up by the Business Schools of Hong Kong Baptist University and Macau University in 2006. The Forum attracted many academics from business schools in Hong Kong, Macau and Mainland China.
7. The HKICPA has developed a Forensic Accounting Interest Group in 2011 with a membership of more than 500 professionals in 2016.
8. Although curriculum design and development for Big Data/forensic accounting courses in general and the level of course offerings in particular are faculty decisions, inputs from practitioners can be relevant and valuable.
9. Variances within each group are quite big, which result in statistically insignificant differences between mean responses of two groups.
10. We acknowledge the limitation of the 25 Big Data topics in the conclusion.
11. Variances within each group are quite big, which result in statistically insignificant differences between mean responses of two groups.

References

Association of Certified Fraud Examiners (ACFE) (2016), "Report to the nations on occupational fraud and abuse", available at: www.acfe.com/rttn2016.aspx (accessed 19 August 2016).

Business Intelligence Congress (2012), "BIC 3 survey", available at: www2.commerce.virginia.edu/bic3/content/2012%20State%20of%20BI%20FINAL.pdf (accessed 1 August 2017).

Campbell, J.E. and Mutchler, J.F. (1988), "The 'expectation gap' and going-concern uncertainties", *Accounting Horizons*, Vol. 2 No. 1, pp. 42-49 (March).

Cao, M., Chychyla, R. and Stewart, T. (2015), "Big data analytics in financial statement audits", *Accounting Horizon*, Vol. 29 No. 2, pp. 423-429.

Charted Global Management Accountant (2014), "Readying business for the big data revolution", available at: www.cgma.org/Resources/Reports/DownloadableDocuments/CGMA-briefing-big-data.pdf

Crumbley, L., Heitger, L. and Smith, S. (2015), *Forensic and Investigative Accounting*, 7th ed., Commerce Clearing House, Chicago.

Cukier, N. and Mayer- Schonberger, V. (2013), "The rise of big data", Foreign Affairs (May/June), pp. 28-40.

Ernst and Young (EY) (2014), "Global forensic data analytics survey 2014", available at: www.ey.com/gl/en/services/assurance/fraud-investigation–dispute-services/ey-global-forensic-data-analytics-survey-2014 (accessed 12 July 2017).

Ernst and Young (EY) (2016), "Global forensic data analytics survey 2016", available at: www.ey.com/gl/en/services/assurance/fraud-investigation–dispute-services/ey-shifting-into-high-gear-mitigating-risks-and-demonstrating-returns (accessed 12 July 2017).

Forbes (2013a), "$16.1 billion big data market: 2014 prediction from IDC and IIA", available at: www.forbes.com/sites/gilpress/2013/12/12/16-1-billion-big-data-market-2014-predictions-from-idc-and-iia/#3f285f304482 (accessed 1 August 2017).

Forbes (2013b), "How SEC's new RoboCop profiles companies for accounting fraud", available at: www.forbes.com/sites/janetnovack/2013/08/09/how-secs-new-robocop-profiles-companies-for-accounting-fraud/#2342b7f43226 (accessed 4 January 2017).

Gartner (2014), "IT dictionary", available at: www.gartner.com/it-glossary/?s=big±data (accessed 31 July 2017).

Global Times (2017), "Alibaba to help build china's first big data college to offer postgraduate courses", available at: www.globaltimes.cn/content/1048287.shtml (accessed 31 July 2017).

Gupta, B., Goul, M. and Dinter, B. (2015), "Business intelligence and big data in higher education: status of a Multi-Year model curriculum development effort for business school undergraduates, MS graduates and MBAs", *Communications of the Association for Information Systems*, Vol. 36 No. 23, pp. 449-476.

Hodge, F.D. (2003), "Investors' perceptions of earnings quality, auditor independence, and the usefulness of audited financial information", *Accounting Horizons*, Vol. 17 No. Supplement, pp. 37-48.

Hong Kong Institute of Certified Public Accountants (HKICPA) (2013), "Sixth long rang plan", available at: www.hkicpa.org.hk/file/media/section1_about_us/organization/pdf-file/6-plan.pdf (accessed 22 March 2016).

Hung, M., Wong, T.J. and Zhang, F. (2015), "The value of political ties versus market credibility: evidence from corporate scandals in China", *Contemporary Accounting Research*, Vol. 32 No. 4, (winter) pp. 1641-1675.

IBM (2015), "Why only one of the 5Vs of big data really matters", available at: www.ibmbigdatahub.com/blog/why-only-one-5-vs-big-data-really-matters (accessed 19 August 2016).

Issa, H. and Kogan, A. (2014), "A predictive ordered logistic regression model as a tool for quality review of control risk assessments", *Journal of Information Systems*, Vol. 28 No. 2, pp. 209-229.

Kelly, J. Vellante, D. and Floyer, D. (2015), "Big data market size and vendor revenues", available at: http://wikibon.org/wiki/v/Big_Data_Market_Size_and_Vendor_Revenues (accessed 22 March 2016).

Laney, D. and Kart, L. (2012), "Defining and differentiating the role of data scientist", Gartner, Inc, available at: http://blogs.gartner.com/doug-laney/defining-and-differentiating-the-role-of-the-data-scientist/ (accessed 25 March 2012).

Markets and Markets (2017), "Big data market worth 66.79 billion USD by 2021", available at: www.marketsandmarkets.com/PressReleases/big-data.asp (accessed 5 July 2017).

McKinsey Global Institute (2011), "Big data: the next frontier for innovation, competition, and productivity", available at: www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation (accessed 5 July 2017).

New Vantage Partner (2016), "Big data executive survey 2016", available at: http://newvantage.com/wp-content/uploads/2016/01/Big-Data-Executive-Survey-2016-Findings-FINAL.pdf (accessed 1 August 2017).

Rezaee, Z. and Burton, J. (1997), "Forensic accounting education: insights from academicians and certified fraud examiner practitioners", *Managerial Auditing Journal*, Vol. 12 No. 9, pp. 479-489.

Rezaee, Z., Larry Crumbley, D. and Elmore, R.C. (2004), "Forensic accounting education: a survey of academicians and practitioners", *Advances in Accounting Education*, Vol. 6, pp. 193-231.

Rezaee, Z., Lo, D., Ha, M. and Suen, A. (2016), "Forensic accounting education and practice: insights from China", *Journal of Investigative and Forensic Accounting*, Vol. 8 No. 1, pp. 106-119.

Rezaee, Z., Wang, J. and Lam, B. (2018), "Toward the integration of big data into forensic accounting education", *Journal of Forensic and Investigative Accounting*, Vol. 10 No. 1, (January-June 2018).

Russom, P. (2011), Big Data analytics. The Data Warehousing Institute (TDW1) Best Practices Report (Fourth Quarter) available at: https://tdwi.org/research/2011/09/~/media/TDWI/TDWI/Research/BPR/2011/TDWI_BPReport_Q411_Big_Data_Analytics_Web/TDWI_BPReport_Q411_Big%20Data_ExecSummary.ashx (accessed 5 July, 2017).

Seda, M. and Peterson-Kramer, B.K. (2014), "An examination of the availability and composition of forensic accounting education in the United States and other countries", *Journal of Forensic and Investigative Accounting*, Vol. 6 No. 1, pp. 1-46.

The Association to Advance Collegiate Schools of Business (AACSB) International (2014), "Accounting accreditation standard A7: information technology skills and knowledge for accounting graduates: An interpretation", available at: www.aacsb.edu/~/media/AACSB/Publications/white-papers/accounting-accreditation-standard-7.ashx (accessed 19 August 2016).

Wang, J., Lee, G. and Crumbley, L. (2016), "Current availability of forensic accounting education and state of forensic accounting services in Hong Kong and mainland China", *Journal of Forensic and Investigative Accounting*, Vol. 8 No. 3, pp. 515-534.

Wixom, B., Ariyachandra, T., Douglas, D.E., Goul, M., Gupta, B., Iyer, L., Kulkarni, U.R., Mooney, J.G., Phillips-Wren, G.E. and Taretken, O. (2014), "The current state of business intelligence in academia: the arrival of big data", *Communications of the Association for Information Systems*, Vol. 34, pp. 1-34.

Corresponding author
Zabihollah Rezaee can be contacted at: zrezaee@memphis.edu

Appendix

FORENSIC ACCOUNTING AND BIG DATA QUESTIONNAIRE

This questionnaire is designed to determine the use of Big Data/analytics in forensic accounting. Forensic accounting is defined as the practice of rigorous data collection and analysis in the areas of litigation support consulting, expert witnessing, fraud examination, and cyber security. Big Data is characterized by the high volume, velocity, and variety of data that can be transformed into information for decision making. The phrase analytics and Big Data are used interchangeably in this study. Thank you for your cooperation.

1. Do you expect future demand for and interest in the following to:

	Big Data	Forensic Accounting
Increase?	☐	☐
Remain the same?	☐	☐
Decrease?	☐	☐
Unsure?	☐	☐

2. How could Big Data be integrated into the business curriculum?

_____ Graduate _____ Undergraduate _____ Both graduate and undergraduate _____ None

3. How could forensic accounting be integrated into the business curriculum?

_____ Graduate _____ Undergraduate _____ Both graduate and undergraduate _____ None

4. Please indicate the extent to which you would agree with the following statements by circling the appropriate responses where 1=strongly disagree and 5=strongly agree. If you have no opinion, please indicate by choosing 0 under N/A.

Big Data skills and knowledge help forensic accounting students to be able to…	**Strongly Disagree**		**Neutral**		**Strongly Agree**	**N/A**
a. Perform data-mining and modeling in forensic accounting investigation	1	2	3	4	5	0
b. Extract, transform, and leverage syndicated data for use in forensic accounting practices	1	2	3	4	5	0
c. Use and interpret datasets that may not have standard data formats	1	2	3	4	5	0
d. Have advanced analytical other data management skills	1	2	3	4	5	0
e. Connect the dots in mining data for patterns that lead to evidence?	1	2	3	4	5	0
f. Effectively present findings to diverse audiences using strong verbal, written, and visual communication skills?	1	2	3	4	5	0
g. Share Big Data with others	1	2	3	4	5	0
h. Have a clear and coherent database digital strategy	1	2	3	4	5	0
i. Align people, processes and culture	1	2	3	4	5	0

(*continued*)

5. Please indicate the importance of covering the following Big Data topics in a forensic accounting course or modules integrated into an auditing course by circling the appropriate number where 1=least important and 5=most important. If you have no opinion, please indicate by choosing 0 under N/A.

		Least Important		Neutral		Most Important	N/A
a.	Data structure/data warehouse	1	2	3	4	5	0
b.	Forensic data analytics	1	2	3	4	5	0
c.	Data governance	1	2	3	4	5	0
d.	Data base management	1	2	3	4	5	0
e.	Networks, Internet and E-commerce	1	2	3	4	5	0
f.	Text analytics	1	2	3	4	5	0
g.	Data visualization	1	2	3	4	5	0
h.	Dimensional Modeling	1	2	3	4	5	0
i.	Data encryption	1	2	3	4	5	0
j.	Data movement (in-memory data analysis)	1	2	3	4	5	0
k.	Cybercrime, computers and auditors	1	2	3	4	5	0
l.	Big Data technologies (Hadoop, Map Reduce)	1	2	3	4	5	0
m.	Data integration	1	2	3	4	5	0
n.	Business Intelligence user tools (OLAP)	1	2	3	4	5	0
o.	Digital evidence seizure	1	2	3	4	5	0
p.	Data streaming management	1	2	3	4	5	0
q.	Recovery of digital data	1	2	3	4	5	0
r.	Data mining/predictive modeling analysis	1	2	3	4	5	0
s.	Forensic analytical tools (EnCase)	1	2	3	4	5	0
t.	Ethical issue in business intelligence	1	2	3	4	5	0
u.	Expert system/artificial intelligence	1	2	3	4	5	0
v.	Digital investigation	1	2	3	4	5	0
x.	Computer forensics	1	2	3	4	5	0
y.	Mobile digital forensics	1	2	3	4	5	0
z.	Information assurance and authentication	1	2	3	4	5	0

6. Please indicate to what extent the following statements are relevant and important to the practice, research, and teaching of forensic accounting with focus on Big Data where 1=not at all and 5=all the time. If you have no opinion, please indicate by choosing N/A

6a. To what extent do the following affect the effectiveness in forensic accounting?

	Not at all.	Small extent.	Some extent.	Great extent.	All the time	N/A
1. Availability of Big Data	1	2	3	4	5	0
2. Availability of Analytical Talent	1	2	3	4	5	0
3. Analytical techniques & tools to support forensic accounting	1	2	3	4	5	0

(*continued*)

6b. To what extent do you use the following in practicing forensic accounting?

	Not at all.	Small extent.	Some extent.	Great extent.	All the time	N/A
1. Capturing Data	1	2	3	4	5	0
2. Disseminating Data	1	2	3	4	5	0
3. Prescriptive Analytics	1	2	3	4	5	0
4. Descriptive Analytics	1	2	3	4	5	0
5. Predictive Analytics	1	2	3	4	5	0
6. Aggregating / Integrating Data	1	2	3	4	5	0

6c. To what extent do the following attributes or Big Data is useful in forensic accounting practices?

	Not at all.	Small extent.	Some extent.	Great extent.	All the time	N/A
1. Accessibility	1	2	3	4	5	0
2. Accuracy	1	2	3	4	5	0
3. Completeness	1	2	3	4	5	0
4. Consistency	1	2	3	4	5	0
5. Detailed	1	2	3	4	5	0
6. Relevancy	1	2	3	4	5	0
7. Reliability	1	2	3	4	5	0

7. **Please answer the following questions by circling (Yes) or (No.)**

a. **Does your organization's Big Data / Analytics overlap with forensic accounting?**	Yes	No
b. **Do data security threats limit the use of Big Data in forensic accounting?**	Yes	No
c. **Are your organization's Big Data / Analytics roles well defined?**	Yes	No
d. **Are your organization's forensic accounting roles well defined?**	Yes	No
e. **Have Big Data / Analytics improved forensic accounting practices?**	Yes	No

Comments: Please feel free to comment on Big Data (analytics) in forensic accounting education research and practice. Thank you for your cooperation and assistance.