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Big Data: are accounting educators ready?

Pandula Gamage[a,1]

[a]*College of Business, Victoria University, Melbourne, Australia*

Abstract: This paper explores the latest developments in Big Data and its impact on accounting education. As such, it reviews Big Data developments with specific reference to the accounting profession. It also presents some of the initiatives taken by the professional accounting bodies and universities to address Big Data topics in the accounting curriculum. The findings suggest that Big Data will have an impact on the future role of accounting professionals. Therefore, this study proposes that Big Data topics be embedded in existing courses across accounting curricula to prepare twenty-first-century accounting professionals with skills related to Big Data analytics.

Keywords: Big Data, accounting curriculum, accounting education.

JEL codes: M41

1. Introduction

Big Data is widely regarded as the next frontier for innovation, competition, and productivity (McKinsey Global Institute, 2011). According to a survey conducted by Chartered Global Management Accountants (CGMA) (2013), using 2,000 Chief Financial Officers and finance professionals around the world, 87 per cent agreed that Big Data is going to change the way business is done over the next ten years. Additionally, a survey conducted by McKinsey Global Institute (2012) highlights

[1] *Corresponding author:* College of Business, Victoria University, PO Box 14428, Melbourne, Victoria 8001, Australia; tel. (+61) 41 28 33 049;
email address: padula.gamage@vu.edu.au

that 51 % of corporate leaders have ranked Big Data and analytics as a top ten corporate priority.

As accounting is a field of data, information processing, measurement, analysis, and reporting, accountants have a role to play in Big Data and data analytics (Liu & Vasarhelyi, 2014). Practitioner literature is already discussing the impact of Big Data on the accounting and finance profession. For instance, the latest futures research carried out by the Association of Chartered Certified Accountants (ACCA) and the Institute of Management Accountants (IMA) (2013a: 9) highlights that "*accountants and finance professionals must be open to the changes created by big data, cloud, mobile and social platforms, and face up to the demands of cybercrime, digital service delivery and artificial intelligence."* The CGMA Institute also contends that:

> *"Big Data raises challenging questions about the future role of finance. Accountants could be sidelined as the professionals who specialise in providing financial accounts to report past performance. Alternatively, they could seize the opportunity to become champions of big data as a source of evidence to support decision-making – and help to redefine how business is done." (*CGMA, 2013: 22).

Moreover, in its most recent report, the Institute of Chartered Accountants in England and Wales (ICAEW) (2014), acknowledges that the accounting profession can engage with Big Data and analytics in many different ways such as: using predictive models and other sources of data to improve budgeting and forecasting; using more sophisticated outlier and exception analysis to improve internal control and risk management; and improving the efficiency and quality of audit activities through analysis of whole data sets.

In addition to the leading professional accounting bodies, the reputed international accrediting bodies are also pressuring universities to enhance the technological content (such as Big Data and data analytics) of accounting courses across the curriculum. For example, the Association to Advance Collegiate Schools of Business's (AACSB) Accounting Accreditation Standard A7 states:

> *"The dynamic nature of IT developments related to data creation, data management and processing, data sharing, data analytics, data mining, data reporting, data security, and storage within and across organizations is critical for the development of emerging professional accountants. The underlying learning experiences for accounting graduates demands an interdisciplinary approach that draws input from professionals and academic scholars with expertise in information systems, statistics, computer science and engineering, ethical issues related to IT and big data."* (AACSB International, 2014: 5).

For accounting and finance professionals, the focus should not be on 'accounting information systems' only, but on information storage, management, and analysis. While they are neither software engineers nor data scientists, there is an increasing focus on Big Data for the accounting profession. As noted by Ellis King, the manager of global professional services recruitment consultancy, Morgan McKinley, "in terms of the skills required of candidates entering the market, we have seen a definite shift. Although technical knowledge is still important for any accounting role, Big Data analysis has taken centre stage" (King, 2014).

Further, the ICAEW states that their clients now expect candidates to be creative with data and produce analysis for the commercial benefit of the company, whether this means forecasting potential growth, new markets or competition (www.icaew.com). Therefore, future accounting and finance graduates must be able to stay abreast of developments to ensure continuing career success in the Big Data world. Arguably, accounting and finance educators have an important role to play in helping students to develop skills required for the jobs of the future in a data-driven era of business. However, a discussion about how to prepare students with these new skills is missing from the literature.

This paper wants to start a conversation about Big Data and accounting and finance education. It discusses Big Data in general, and then focuses on their effect on the accounting and finance profession. Further, the paper highlights what skills and knowledge accounting graduates need if they are to ensure success in a Big Data world. Finally, the paper discusses how to embed Big Data into the accounting curriculum, and discusses some initiatives undertaken by universities and professional bodies across the globe. It serves as a 'call to action' for accounting educators regarding the need to develop appropriate skills to prepare graduates for a digital world full of both structured and unstructured data.

2. What is Big Data?

The Big Data environment reflects 'the evolution of IT-enabled decision support systems: data processing in the 1960s, information applications in the 1970s-1980s, decision-support models in the 1990s, data warehousing and mining in the 2000s, and Big Data today' (Kim *et al.*, 2014: 79). In fact, the current decade (2010–2019) seems destined to be named 'The Decade of Big Data' (Gillis & Stephanny, 2014). Although the term 'Big Data' has become increasingly common, there remains no single, internationally recognized definition of Big Data.

The leading information technology and research company, Gartner, defines Big Data as "*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, 2012).

Gartner's definition includes three dimensions: the volume of information that systems must ingest process and disseminate; the velocity at which information grows or disappears; and the variety in the diversity of data sources and formats. These three dimensions are known as the 'three Vs'. Additionally, a new V 'veracity' which relates to the reliability of the data, was added. These four dimensions are shown in Figure 1:

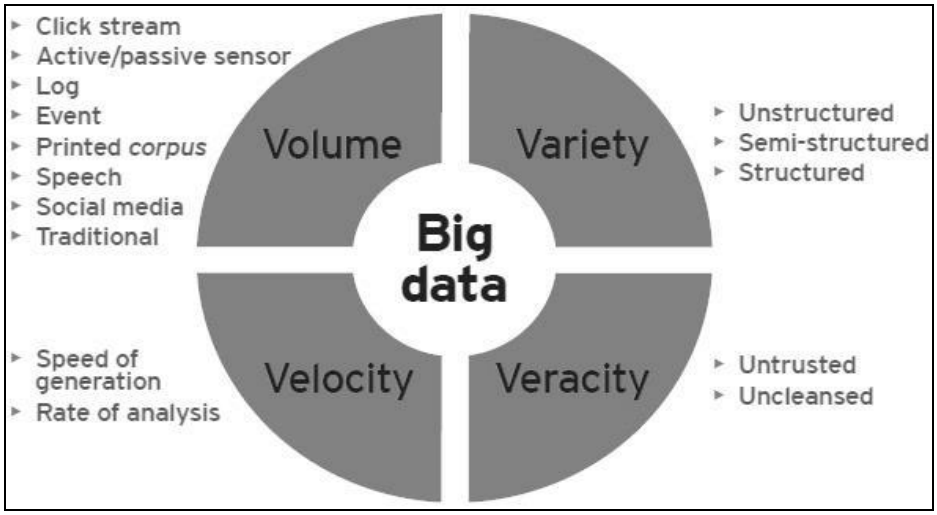

Figure 1. The four V's of Big Data
(*Source:* Ernst & Young, 2014a: 2)

As shown in figure 1, Big Data can exist as both structured and unstructured data. Structured data means the information that is easily stored in relational databases of spreadsheets, with their ordinary columns and rows which constitute 15 % of the today's information. Unstructured data such as email, video, blogs, call centre conversations, and social media, makes up approximately 85% of data generated today (TechAmerica Foundation, 2012). The CGMA report (2013) explains Big Data as the massive increase in the volume of data now being used to garner new insights into business performance, opportunities and risks. According to this report, Big Data is a combination of financial data, enterprise wide data and new types of internal and external data, some of which is unstructured as depicted in figure 2:

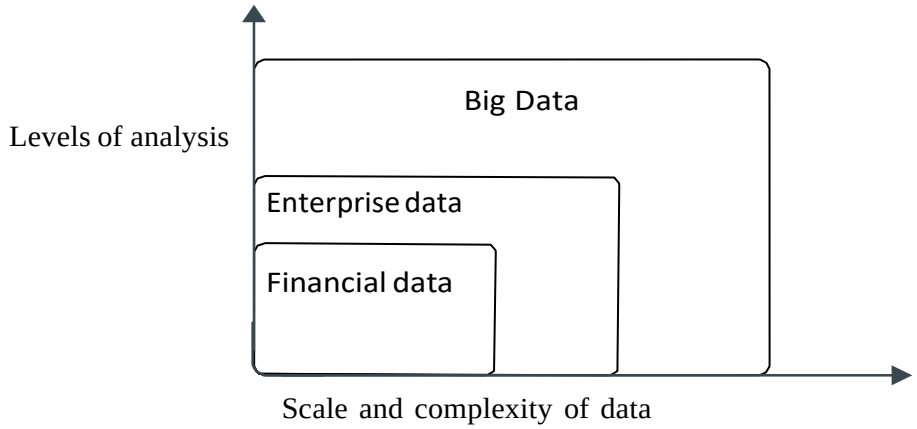

Figure 2. Definition of Big Data
(*Source:* CGMA, 2013: 5)

The financial data shown in Figure 2 include standard financial metrics, whereas the enterprise data include financial data plus broader operational and transactional data that may be used to bolster analysis and forecasting. Big Data include both enterprise data plus new types of internal and external data, much of which is unstructured, but some of which could yield new insights into business.

Big Data is being harnessed by many business sectors. For example, there is a significant use of Big Data in diverse industries and applications such as logistics, health care, government services, retail, manufacturing, financial services and supply chains (Gillis & Stephanny, 2014). The potential benefits of utilizing Big Data in business include, better/more targeted marketing activities, improved business decision making, cost reduction and generation of operational efficiencies, enhanced planning and strategic decision making and increased business agility, risk analysis and fraud detection, waste reduction and customer retention (www.e-skills.com). In fact, research indicates that 77% of companies that are good with data achieve better financial performance (Economic Intelligent Unit, 2013). Moreover, a study by Pearson and Wegener (2013) shows that those who were early adopters of Big Data analytics not only gained a substantial lead in the corporate world but those with advanced analytics capabilities outperformed their competition by a wide margin. Tene and Polonetsky (2012) also show that data-driven decision making leads to 5-6 percent efficiency gains in the different sectors observed.

3. Big Data and accounting and finance professionals

There has been a shift in recent years in accounting, auditing and finance where what were once reporting and number-crunching roles have grown in scope, encompassing data and information analytics across various aspects of both companies and industries at large (www.ambitsearch.com). According to Bhimani and Willcocks (2014: 479):

> *"The analysis of Big Data moves the information professional away not just from historical to real-time processing but also from a focus on samples. Entire data sets become analyzable to determine unknown unknowns ... This presents a new world of possibilities as well as challenges. The real-time analysis of total data sets with broad questioning options lies at the heart of what Big Data offers enterprises."*

Bhimani and Willcocks (2014) conclude that the possibilities for the digitally enabled business create a range of 'information literacy' challenges as well as new possibilities for accounting information providers. Identifying Big Data gives an opportunity for accounting and finance professions to take a more strategic role and help shape the future. Similarly, the report published by ACCA and IMA (2013b: 25) affirms:

> *"trained to gather and analyse structured and unstructured data and to model and benchmark information, accountants and the finance function can provide a new and business-critical service to senior management and boards: making Big Data smaller, distilling information into the insights that improve decision making and transform organisations."*

Furthermore, this report highlights the implications of Big Data for the accounting and finance professions in three areas namely valuation of data assets; use of Big Data in decision-making and use of Big Data in the management of risk. The opportunities and challenges Big Data presents in the said report are shown in Table 1.

Table 1. Opportunities and challenges Big Data presents the accountancy and finance profession

Area	Opportunity	Challenge
1. Valuation of data assets	Helping companies value their data assets through the development of robust valuation methodologies	Big Data can quickly 'decay' in value as new data becomes available
	Increasing the value of data through stewardship and quality control	The value of data varies according to its use
		Uncertainty about future developments in regulation, global governance and privacy rights and what they might mean for data value
2. Use of Big Data in decision making	Using Big Data to offer more specialized decision- making support in real time	Self-service and automation could erode the need for standard internal reporting
	Working in partnership with other departments to calculate the points at which Big Data can most usefully be shared with internal and external stakeholders	Cultural barriers might obstruct data sharing between silos and across organizational boundaries
3. Use of Big Data in the management of risk	Expanding the data resources used in risk forecasting to see the bigger picture	Ensuring that correlation is not confused with causation when using diverse data sources and Big Data analytics to identify risks
	Identifying risks in real-time for fraud detection and forensic accounting	Predictive analytic techniques will mean changes to budgeting and return on investment calculations
	Using predictive analytics to test the risk of longer-term investment opportunities in new markets and	Finding ways to factor failure-based learning from rapid experimentation techniques into processes, budgets and capital

(*Source:* ACCA and IMA Report (2013b: 14))

First, as shown in Table 1, one of the themes identified in the report is valuation of assets. In order to value big data assets, accounting and finance professionals will need to identify what data is of value, select an accepted valuation methodology and determine key assumptions. Second, facilitation of better decision making is identified as one of the greatest benefits of big data.

As technologies allow businesses to very securely capture, store and analyze increasing volumes of data from increasingly diverse sources, accountants who can help extract the right information from data and make it easily available to people in their organization at the right time will create a competitive advantage. Finally, accounting and finance professionals will increasingly use Big Data to manage business risk. They will become more than just preparers of financial data. They will take on a more strategic and proactive role in organizations as they marry both data analytical skills and financial modeling skills to facilitate performance improvement and wealth creation for the business. Because of the opportunities and challenges Big Data presents to the accounting and finance profession, the ACCA and IMA Report (2013b) concludes that the future of the accounting profession lies at the intersection of finance, technology and information. This is shown in figure 3.

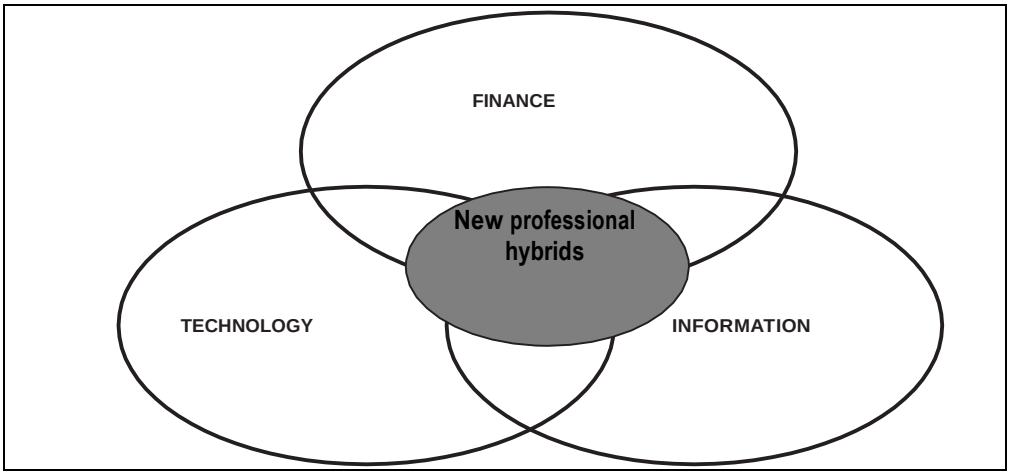

Figure 3. New accounting and finance professional hybrids
(*Source*: ACCA and IMA Report (2013b: 31))

As shown in Figure 3, the CGMA Report (2014) predicts the emergence of 'new professional hybrids' who can work with IT professionals, data scientists and business managers to interpret analytical insights and convey them as commercial insights in terms the business can understand and implement. The accounting and finance professionals who have the business acumen and domain knowledge to apply Big Data insight and transform it into business strategy and action can perform these new professional hybrid roles. Hence**,** today's accountants are required to liaise with people from all areas of the business, from IT to sales and marketing. Similar views are reported by King (2014) who observes that "in the past accountants were perhaps considered the 'number-crunchers,' now they are expected to be the 'middle man' in many organizations."

Similarly, both internal and external auditors can also take advantage of Big Data. According to the recent PwC Report (2015:6) *"data analytics are altering the way the audit process is done at both the transaction and general-ledger levels. Auditors have new tools to extract and visualize data, allowing them to dig into larger, non-traditional data sets and perform more intricate analysis."* In addition, Capriotti (2014) reports that internal and external auditors have come to see Big Data as a potential game-changer in terms of the efficiencies that can be achieved and the value that can be provided to clients. Further, he summarises that auditors face a complex, fast-paced business environment, and data analytics can be used to refine the focus on risks and provide more meaningful insights into an organization. According to Vasarhelyi *et al.* (2010), Data analytics, if properly implemented, can provide continuous auditing and can aid in mitigating risks such as operational issues or the impact of cost cutting in a more efficient and effective matter. Hoogduin *et al.* (2014) also hold the opinion that applications from the world of data science can be applied by auditors to perform more effective audits and to provide new forms of audit evidence not previously available to practitioners. Kingston (2014) reports:

> *"For the first time in history, we have an easy way to gather data from across all our audits and employ that data in useful analytics, subject to the client's agreement in the engagement letters. When you combine this with data available from our other practices and externally available data, we have a fairly sizable database of information. This will not only change our audits but allow us to give our clients perspectives on where they sit relative to their competitors, industry and larger markets as a whole. None of this impairs our independence and actually provides value to our clients, which is something they've been begging us to bring to our audits for years."* (www. goingconcern.com).

As Moffitt and Vasarhelyi (2013: 16) note, *"Big Data will place at the hands of the accountant/auditor, enormous amounts of external (endogenous or exogenous) data that can serve in model building or in the creation of competitive baselines. Additionally, they highlight that new forms of audit evidence are progressively emerging to complement and replace old approaches and are covering a more recent set of risk."* In their recent paper Cao *et al.* (2015: 424) list the following audit activities that are likely to benefit from Big Data analytics:

- Identifying and assessing the risks associated with accepting or continuing an audit engagement, for example, the risks of bankruptcy or high-level management fraud.

- Identifying and assessing the risks of material misstatement of the financial statements due to fraud, and testing for fraud with regard to the assessed risks (ISA 240, IAASB 2014a).
- Identifying and assessing the risks of material misstatement through understanding the entity and its environment (ISA 315, IAASB 2014b). This includes performing preliminary analytical procedures, as well as evaluating the design and implementation of internal controls and testing their operating effectiveness.
- Performing substantive analytical procedures in response to the auditor's assessment of the risks of material misstatement (ISA 520, IAASB 2014c).
- Performing analytical procedures near the end of the audit to assist the auditor in forming an overall conclusion about whether the financial statements are consistent with the auditor's understanding of the entity (ISA 520, IAASB 2014c).

Another area that will have an impact from Big Data is forensic accounting services. These services generally involve the application of specialized knowledge and investigative skills possessed by forensic accountants to collect, analyze and evaluate evidential matter and to interpret and communicate findings in the courtroom, boardroom or other legal/administrative venue. Mining Big Data using forensic data analytics tools can improve compliance and investigation outcomes and can help management provide useful summary information to the board (Ernst & Young, 2014b). According to the findings of the survey conducted by the Forensic and Valuation Services Section of American Institute for Certified Public Accountants (2014), Big Data is the most pressing issue facing forensic and valuation professionals over the next two to five years.

Management accountants' roles also will change in the Big Data era. The CGMA Report (2013: 22) succinctly summarises this change when it states:

> *"Management accountants need to know what the critical pieces of data are and what insights can be derived from them. They do not necessarily need to know the in-depth database structures or actually do the analytics. Finance people need to understand what the outcomes of analytics are and how they can drive value for the business."*

CGMA report further notes that management accountants already know how to work with data, they understand the inner workings of the business and they are well placed to help turn new data insights into commercial advantage. Hence, management accountants can best add value by working with the data scientists to make commercial sense of new data.

The role of tax accountants is also expected change in the Big Data environment. This is highlighted in the recent Deloitte report (2016) which states that big data is fundamentally changing the tax accountant's role by providing the ability to explore data in new ways. Historically, tax accountants have tended to sit in a silo, apart from the organization as a whole. As the trend toward Big Data leads organizations to emphasize the value to be found in deep analyses of available information, this tendency can no longer continue. The Deloitte report (2016: 4) further summarises the change of mindset that must take place in tax function as follows:

> *"Traditionally, tax data- gathering has focused on hindsight, dealing with data from transactions that have already occurred for business planning and compliance purposes. While hindsight remains important, tax organizations are looking to use data more for gaining insight and even foresight into what lies ahead. Analytics can help more towards insight and foresight…"*

Similarly, Maxwell *et al.*, (2013) note that the mindset of the tax function must be transformed to one that focuses on data and the corresponding algorithms to make decisions and generate knowledge to the benefit of the organization

4. Big Data and accounting education

International Data Corporation forecast that, at the end of 2013, the big data technology and services market would grow at a 27% compound annual growth rate to $32.4 billion through 2017. This would be approximately six times the growth rate of the overall information and communication technology market (AICPA Survey, 2014). In the meantime, McKinsey Global Institute (2011) predicts that there will be a shortage of talent necessary for organizations to take advantage of Big Data. By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts with the expertise to use the analysis of Big Data to make effective decisions. Similar views are expressed about other countries such as UK, Australia, and India as well. Hence, it is clear that Big Data skills shortage is global, and every region will face similar challenges. The lack of skilled Big Data practitioners of all types is limiting the ability of business to derive value from Big Data (Kelly, 2013). Recent research (e.g. Olavsrud, 2013; Rowe, 2013; Yerak, 2013) finds that there is a talent shortfall in data strategy and in a wide variety of technical data management positions, largely due to the shortfall in university, professional, and executive education programs designed to produce the talent needed to fill the growing demand for every type of Big Data professional.

In the meantime, research highlights the fact that Big Data is not tied to any single discipline. According to Miller (2014: 26), the big data and analytics talent discussion has largely focused on a single role; the data scientist. However, the need is much broader than data scientists. Data has become a strategic business asset. Every professional occupation must adapt to this new mindset. CFO Research Services (2011) (reported in Lawson *et al.*, 2014: 296) studied senior accounting and finance executives and identified competency gaps in areas including business strategy, business intelligence, analytics, and operational experience. This research suggests that accounting and finance professionals need skills for providing enhanced reporting of risk exposures, for reporting information to inform decisions on deploying capital to grow the business profitably, for supporting the long-term value creation for their enterprise, and for communicating the ways in which accounting can promote the success of enterprise leaders. Additionally, Siegel *et al.* (2010) report that, despite the fact that over 80% of accounting graduates ultimately choose careers outside of public accounting, the majority of core undergraduate accounting courses focus on topics that academics assume students need to work in public accounting. However, the focus of accounting education should include organizational settings beyond a focus on public accounting.

Therefore, universities must move quickly in partnership with industry to ensure that the graduates they produce have the required skills for the age of Big Data. Highlighting the importance of Big Data in accounting education, Griffin and Wright (2015: 379) affirm that *"academics, as educators, certainly must revamp their accounting and auditing curricula to provide the necessary skills for Big Data in the accounting and auditing profession."* The CGMA report (2013) has listed following skills that are required for future finance leaders who run a data-centric finance function.

1. The ability to identify which data points are useful in understanding what drives the business
2. A clear sense of what customers care about most, and ideas about how to track this
3. The ability to embrace new forms of data, and creative ways to incorporate this into business decision-making
4. Comfortable with uncertainty, including the reality that big data may not provide definitive answers
5. The ability to explore new ways to interpret data to better inform management

In order to develop the above skills, existing accounting curricula should be reviewed and adapted to ensure relevance and new curricula and degree programs are needed.

Several professional accounting bodies and universities have already taken initiatives in this regard. For example, the CGMA has added new material on 'Big Data', in their new syllabus for 2015 (see: www.cimaglobal.com). In the meantime, some universities in the US have already taken action to incorporate Big Data and data analytics into their courses. For example, the School of Accounting at the Rawls College of Business, Texas Tech University, reports:

> *"The School of Accounting has positioned itself to adjust for the age of 'Big Data' in the accounting profession, specifically by focusing on improving traditional audit techniques ... Students acquire the knowledge and skills necessary to manage and interpret large amounts of financial and economic data, including searching for and detecting fraudulent activity*." (accounting.ba.ttu.edu).

Additionally, St. Mary's University's Greehey School of Business formed a new Bachelor of Business Administration degree program in Accounting and Data analytics that is designed to prepare more students for careers as data analysts. The university website acknowledges:

> *"Big Data is everywhere, and it's only getting bigger. St. Mary's University, wants its students to be ready, so we are offering a Bachelor of Business Administration in Accounting and Data Analytics. In this new major, students complete the basic 120-hour accounting major, plus an additional 30 hours in data analytics and information systems courses and electives"* (www.stmarytx.edu/academics/business).

Some of the emerging economies also have responded to the accounting curriculum changes to face the business challenges in the Big Data world. For example, the 2015 curriculum of Chartered Accountants Program of the Institute of Chartered Institute Accountants of Sri Lanka has embedded new topics in Big Data in its final module (Corporate Level). This final module has the focus on using information technology and systems skills in strategic planning and management process, and becoming conversant in contemporary topics such as social media, cloud computing and Big Data (www.casrilanka.com/casl). Malaysia has also taken steps to address the changes in the Big Data world. According to Ismail (2009), in 2006 the Malaysian Institute of Accountants, the Ministry of Higher Education and other local institutions of higher learning established a committee to ensure that accounting programmes offered by local universities are in line with the global developments within the profession. The committee recommended a minimum of three AIS courses in the structure of an accounting program. These courses include an introduction to IT, AIS, and system analysis and design.

However, accounting degree programs cannot simply add additional data analytics courses to the current curriculum without sacrificing existing elements. Hence, to properly address the 'Big Data' into accounting curriculum, an integrated approach is recommended to embed data analytics topics into already available courses in the Accounting program such as Business Statistics, Accounting Information Systems, Financial Accounting, Management Accounting, Auditing and Taxation. Accounting educators should also promote accounting and finance students to enrol in elective units such as Introduction to Database Design and Management, Database Systems, Fundamentals of Business Analytics, Business Intelligence, Applied Statistics, Enterprise Modelling in the accounting degree program. This view is also supported in the recent report by one of the 'Big Four' Accounting firms, PwC (2015: 1), which states '*we believe data analytics should be integrated into accounting coursework.*" Additionally, Lawson *et al.*, (2014) state that the knowledge, skills, and abilities of an accounting education should emerge and be developed within the curriculum as integrated competencies, as this is how those competencies will be deployed within the organization. Some of the Big Data topics that can be integrated into the existing courses are given in Table 2.

Table 2. Big Data topics that can be included within existing courses

Course	Topics
Business Statistics	Data gathering techniques, Data exploration, Data summarisation, Data analysis, Data visualization, Communication of analytical findings
Business Information Systems	Advanced Databases, Information Retrieval, Advanced Data Mining Applications, Predictive Analytics for Decision Making, Big Data information management
Management Accounting	Application of Big Data to competitor analysis, Big Data as a strategic resource
Accounting Information Systems	Business intelligence, Enterprise analytics Information search and retrieval, Data mining, familiarity with languages such as XBRL, specialized software/reporting systems with decision support, ERP systems, Cybercrime, Data management issues
Business Finance	Financial analytics, modelling and computation of financial risks, Information Risk Management
Auditing and Assurance	Data Analytics in auditing , Mine new sources of data, Data integrity , Privacy, Safeguards, Cybersecurity, Design and evaluate IS controls, Manage IS risks and compliance, Overseeing fraud risk assessment
Forensic Accounting	Big Data, Benford's Law, Financial Analytics, Data Analytics for Fraud, Anomaly Detection in Forensics and Security
Taxation	Indirect tax and Big Data, tax value and non- tax value form data that is collected in the tax function, Visualize accounting data

4. Conclusion

In this digital age, data analytics are transforming the workplace. This is impacting and will further impact the role of management accountants, forensic accountants, tax accountants and auditors. Because of this, there is a call for accounting educators to develop skill sets related to data analytics. The importance of this is also mandated by the accounting professional bodies, Big-Four accounting firms and leading accreditation bodies such as AACSB. Therefore, there is a need to review the existing accounting curricula to ensure relevance and to introduce new curricula and degree programs to have a strong background in data analytics. This paper proposes an integrated approach to incorporate data analytics and related topics in the accounting curriculum. By doing so, *"the accounting and finance professionals in the future will form a bridge between data science and data art, combining analytical skills and sophisticated models developed by mathematicians and statisticians with the skills of data art and data 'storytelling"* (ACCA and IMA Report, 2013b: 7). This will require accounting educators to change their mindset and there is a lot of work ahead to prepare students for success in this data-driven and analytics-enabled future.

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