Big Data Analytics Knowledge and Skills: What You Need as a 21st Century Accounting Graduate

Norlaila Md Zin[1], Eley Suzana Kasim[1,2♣], Indra Devi Kandasamy[3], Noor Sufiawati Khairani[4], Noryati Md Noor[1] and Nur Insyirah Mohamed Sufian[5]

[1]Faculty of Accountancy, Universiti Teknologi MARA Cawangan Negeri Sembilan,
Kampus Seremban, Seremban, Negeri Sembilan, Malaysia
[2]Accounting Research Institute, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia
[3]School of Management and Business, Manipal International University,
Nilai, Negeri Sembilan, Malaysia
[4]Faculty of Accountancy, Universiti Teknologi MARA Cawangan Johor,
Kampus Segamat, Segamat, Johor, Malaysia
[5]Faculty of Accountancy, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia

ABSTRACT

This study examined big data analytics (BDA) knowledge and skills required in the accounting profession to better prepare future accounting graduates for the continuously evolving Industrial Revolution 4.0. We used inductive reasoning and the qualitative methodology. Data was collected using semi-structured interviews with accounting educators and practitioners in selected public universities in Malaysia. Findings showed that both BDA knowledge and skills are required to complement traditional accounting knowledge and skills in preparing future accountants to embrace developments in BDA. This study proposed a new typology of skills for 21st century accounting graduates, consisting of visualization, collaboration, analytical and predictive skills. The findings underscore the need for higher learning institutions to emphasise these skills in their accounting curriculum. This study will provide valuable input for higher learning institutions and professional bodies in developing their accounting curriculum for quality education that meets the challenges of the new digital era.

Keywords: Big Data Analytics, Knowledge, Skill, Accounting Education, Higher Learning Institution

♣ Corresponding Author: Eley Suzana Kasim, Faculty of Accountancy Universiti Teknologi MARA Cawangan Negeri Sembilan, 70300 Seremban, Malaysia & Accounting Research Institute, Universiti Teknologi MARA Shah Alam, 40450 Selangor, Malaysia; Email: ekasim@ uitm.edu.my; Tel: +6019-3515211

INTRODUCTION

Big data development in the Industry Revolution 4.0 (IR4.0) era has affected how businesses create their identity, develop careers, cultivate skills, and nurture relationships (Halili et al., 2021; Martinelli, et al., 2021; OECD, 2018). Many changes are anticipated in how data is gathered, analysed and interpreted (Naysary et al., 2022; Ibrahim et al., 2021). Big Data is one of the pillars for IR 4.0. which refers to large and varied data sets. These data set may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions (Khan et al., 2014). The analysis of big data is known as big data analytics (BDA).

The digital economy which permits large-scale data mining have become the main driver of economic growth (Shodiev et al., 2020). As such, digital skills in dealing with BDA are essential in today's business environment. Despite the ability of modern technologies to process big data, the real challenge of BDA comes from the timely informed decisions that management makes (Chen et al., 2012). Accountants have the potential to contribute significantly in the IR4.0 era by incorporating BDA into the existing reporting framework and adding new insights into decision-making and business operations (Wang & Wang, 2016). As the main provider of business information, accountants are encouraged to leverage on BDA to increase operating efficiencies, assess risks and identify advantages and weaknesses through analysis (Tiron-Tudor & Deliu, 2021; PwC, 2015). Accountants need to utilise BDA to position themselves as strategic business partners instead of their more traditional accounting role (Abd Razak et al., 2021; CGMA, 2014). Thus, there is an urgent need to examine how BDA affects the accounting functions in the industry (Tiron-Tudor & Deliu, 2021; Wong et al., 2015; Vasarhelyi et al., 2015).

Unlike traditional businesses transactions and financial statements, BDA involves non-traditional information such as ratings, reviews, one-to-one conversions, and geolocation of customer activities. BDA is commonly used in businesses to provide descriptive analytics, which involves categorising and classifying data as useful information. In a world increasingly driven by data, BDA is expected to facilitate businesses to make more informed decisions with greater speed and lower cost. The ability to assess customer needs and preferences through BDA gives businesses the

power to deliver customized products and services that ensure customers' satisfaction. In other words, BDA enables managers to measure and know radically more about their businesses and directly translate that knowledge into improved decision making and performance (Tiron-Tudor & Deliu, 2021).

Notwithstanding the recent attention given by the accounting practitioners on BDA, the role of accounting education to prepare future accountants in dealing with big data is still unclear. While the accounting profession is embracing new technological challenges, there are still concerns about whether the accounting curriculum in institutions of higher learning is in tandem with these developments (Augustine et al., 2020). Therefore, there is an urgent need to conduct studies to examine the impact of BDA on the accounting profession.

In Malaysia, the Ministry of Higher Education has also shown positive support in preparing the younger generation for the challenges of IR4.0 (Halili et al., 2021). A report by the World Economic Forum in 2020 highlighted that accounting and bookkeeping jobs are expected to decrease in demand by 2025, whereas jobs as data analysts, artificial intelligence and machine learning experts and big data specialists will be in higher demand. Jobs that are reducing in demand, including accountants and auditors, are likely to be displaced by new technologies, rendering them obsolete in the future. As a result, universities urgently need to prepare their accounting graduates with relevant skills, especially digital skills such as BDA. There has been minimal discussion of the cognitive skills that accountants need for efficient BDA; this lack of debate is primarily due to a lack of research in this area (Dalwai et al., 2021). Hence, this study examined the BDA knowledge and skills required by accounting graduates in dealing with a data-driven business environment to better prepare them in the continuously evolving IR4.0.

LITERATURE REVIEW

BDA Knowledge and Skills of Accountants

BDA may help accountants in providing greater value to businesses due to the data-driven nature of accounting (ICAEW, 2019). Accountants in businesses have numerous opportunities to leverage data from various sources, including the internet, social media, mobile technology, open data, and the Internet of things (ICAEW, 2019). The professional accounting bodies acknowledge the need to prepare future accountants to meet the new demands for their services in the IR 4.0 era (Brands & Holtzblatt, 2015; PwC, 2015). There is an increasing concern that data scientists who are skillful in BDA could eventually reduce the advisory capacity of accountants. Thus, accountants need to be equipped with BDA knowledge and skills to maintain a competitive advantage over other professionals (Janvrin & Watson, 2017). According to a survey conducted by the Chartered Global Management Accountants (CGMA) (2014), using 2,000 Chief Financial Officers and finance professionals worldwide, 87 percent agreed that big data would change the way business is conducted over the next ten years. The report added that: "Big data raises challenging questions about the future role of finance. Accountants could be side-lined as the professionals who specialize 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).

The Malaysia Institute of Accountants (MIA) has acknowledged the influence of BDA on the accounting profession. At the MIA's Big Data Analytics Conference in 2015, it was noted that BDA was used by organisations in consumer analytics (48 percent), operational analytics (21 percent), and fraud and compliance (21 percent). Accountants could also play strategic roles in their respective organisations as their ability to interpret and provide valuable insights into data could reveal numerous business opportunities (Wahyuni, 2020).

From the education perspective, the Ministry of Higher Education Malaysia has recently taken progressive steps in responding to the challenges of IR4.0 particularly as set out in the Malaysia Education Blueprint 2015-

2025 (Higher Education) and the Education 4.0 framework. In line with this development, Ma'dan et al. (2020) emphasised the need for higher learning institutions to strategize and implement balanced quality of education in developing future talent. selection of content and teaching methods of higher vocational accounting courses.

Various accounting professional bodies concur on the essential BDA knowledge and skills needed by professional accountants during tertiary level education. As shown in Table 1, technological knowledge and skills dominate the current requirement of professional accountants.

Table 1: Professional Skills of Accountants

Professional bodies	Required skills
Institute of Chartered Accountants in England and Wales (ICAEW)	• Statistical skills • Data and technology skills • Domain knowledge
Chartered Institute of Management Accountants (CIMA)	• Basic digital literacy • Technology know-how • Mindset and behaviours
International Federation of Accountants (IFAC)	• Technology skills • Collaborative skills • Data-driven culture
Institute of Management Accountants (IMA)	• Data analytics skills • Strategic management • Thinking skills • Innovative skill

For instance, according to the ICAEW, statistical skills, data and technology skills, and domain knowledge are critical in performing the accounting function. Similarly, the CIMA places high value on basic digital literacy and technology know-how with appropriate mindset and behaviour. Additionally, both the IFAC and IMA also include data analytic knowledge and skills as part of the requirement of the profession.

BDA and Accounting Education

Current accounting education needs to thoroughly equip future professional accountants with the essential knowledge and skills related to the technological revolution in order for them to be able to adapt and prosper (Sun, 2020; Polimeni & Burke, 2021). According to Selamat et al. (2017), suitable enabling ecosystems consisting of institutional

preparedness, integration of institutional vertical and horizontal value chains, and innovations are critical enablers for the education system to meet the challenges of IR 4.0. Nonetheless, the focus on accounting education in training future data-driven accountants remains uncertain (Asonitou, 2021). Courses that focus on traditional curricula must be supplemented with contemporary skills of new technologies (Asonitou, 2021; Al-Htaybat et al., 2018).

In Malaysia, all graduates are still being prepared to adopt IR4.0 by the Ministry of Higher Education (Brahim & Dahlan, 2019). According to researchers, IR 4.0 will require significant changes in pedagogy, curricular material, and other foundational elements of education (Lase, 2019). Universities have a special obligation to educate their students who will influence the digital transformation in the future as well as the highly trained graduates who will work in a society that has undergone a digital transformation (Jørgensen, 2019). For instance, BDA could be added to the current curriculum of forensic accounting because it will help forensic accounting instruction and practice (Rezaee & Wang, 2019). In the field of auditing, BDA expertise and knowledge would allow auditors to conduct "continuous auditing" to find ways to raise the cost-benefit ratio of internal auditing activities (Capriotti, 2014). Because of this, universities must provide accounting graduates with BDA competencies, i.e., BDA knowledge and skills, to shift the traditional accounting function toward more technologically adept accountants (Gamage, 2016; CGMA, 2013).

However, since BDA in the accounting is in its infancy, its incorporation in accounting programmes at higher learning institutions is still limited. Therefore, this study was conducted to provide insights on the specific BDA knowledge and skills required in the accounting profession in dealing with a data-driven business environment. Furthermore, the way in which accounting education could be tailored to better prepare future accountants in the industry is also discussed.

METHODOLOGY

The present study used inductive reasoning and the qualitative methodology to investigate the research focus. Qualitative research enables the researchers

to gain an in-depth understanding of future accountants' BDA knowledge and data-driven skill sets from both the educators and the industry perspective. The purposive sampling technique was used for the selection of interviewees. The main sources of evidence consisted of semi-structured interviews with educators who were involved with the curriculum delivery in accounting and computer science as well as with accounting practitioners in public and private sectors. The semi-structured interviews consisted of open-ended questions based on the interview protocols prepared. The list of interviewees is provided in Table 2.

Table 2: List of interviewees

Interviewees	Job Position	Interview hours
A	Manager of a public listed company	1.5 hours
B	Partner of audit and accounting firm	1.5 hours
C	Manager of a public listed company	1.5 hours
D	Accountant at statutory body	30 minutes
E	Public sector accountant	1 hour
F	Accounting lecturer	30 minutes
G	Accounting lecturer	1.5 hours
H	Accounting lecturer	1.5 hours
I	Accounting lecturer	1.5 hours
J	Computer Science lecturer	40 minutes
K	Information Technology lecturer	1.5 hours

Following each interview, the recorded data was transcribed and coded to establish themes or patterns. Several rounds of coding were conducted throughout the data analysis process, resulting in the final refined coding scheme. The code refinement enabled the researcher to formulate findings statements subsequently. Additionally, a review of websites, newspaper clippings, and archival records was also performed as shown in Table 3.

Table 3. List of documents reviewed

Types of documents reviewed	Title of document
Websites	• Ministry of Higher Education Malaysia • Public and private universities websites
Open access government documents	• Malaysia Education Blueprint 2015-2025
Newspaper clippings	• Berita Harian • The Star Online • New Straits Times
Professional magazine	• Financial Management

Using Yin's (2009) pattern matching logic, the data was analysed together with a more specific analysis suggested by Bloomberg and Volpe (2008) and Miles and Huberman (1994). Following the write up of key findings, a procedure called "member checks" was conducted to ensure the trustworthiness of the qualitative data already collected. The interviewees were contacted through emails and provided with the draft findings to validate. Upon receiving the responses from the interviewees, several vital conclusions were drawn. The findings are linked to insights and the literature during this stage, as suggested by Bloomberg and Volpe (2008). Despite the weaknesses in terms of statistical generalisations, this qualitative study offered opportunities for in-depth observation and an analysis of the BDA knowledge and skills for future data-driven accountants at higher learning institutions.

FINDINGS

The evidence from the study suggested that accountants need two critical elements to enable them to embrace big data developments in their workplace, consisting of BDA knowledge and skills. Both BDA knowledge and skills are critically required to complement traditional accounting knowledge and skills in preparing future accountants to embrace big data developments.

BDA Knowledge

Although accountants are typically assumed to be end users of BDA tools in performing their job function, they must have basic knowledge of BDA. In this study, BDA knowledge refers to the knowledge of elements, processes and technology used to analyse Big Data. BDA knowledge is important for accountants in understanding programming language and the necessary coding to retrieve the right data. For accountants to embrace big data development, they must have a solid foundation of expertise in data input and sophisticated data analytic and data interpretation techniques. The findings further showed that one of the ways in which universities and other higher learning institutions can disseminate analytical knowledge to young accounting graduates is by integrating BDA knowledge within the existing accounting curriculum. Universities can assist students in preparing for the

digital world with up-to-date technology, updated information and mould them to be globally recognised future accountants. This is because acquiring BDA knowledge would provide the necessary exposure for Malaysian accounting graduates on something 'big' in the industry to become globally recognised. Hence, BDA is viewed as a powerful and useful tool for the graduates as learning about and mastering BDA will give a competitive advantage to accounting graduates.

BDA certification is not a requirement for aspiring accountants to execute their jobs well. Instead, accounting graduates are required to have a fundamental understanding of the topic. This is consistent with the view of an interviewee who commented:

> *Maybe they do not need in depth BDA knowledge but at least they know how they can make use of that data, know what is the point of having the data and what are the things that they can do with the data.*

Professional accounting bodies such as ACCA have duly incorporated big data development in the accounting curriculum, keeping abreast with the recent digital developments in the accounting profession. Our findings noted that BDA was not generally included in the current university accounting curriculum of the selected participants. As such, there is a concern that the accounting curriculum in Malaysian universities' is still lagging in incorporating big data developments in their teaching and learning activities. This study highlights that the Ministry of Higher Education needs to work with the universities to equip their graduates with relevant technical knowledge in big data development to face the digital era.

Along similar lines, universities have also recognised the need for accounting and finance graduates to have more non-technical skills which would add value to their profession. One of the interviewees from a local university mentioned that:

> *Nowadays companies are not just looking for accounting graduates with excellent academic qualification. Rather, employers look for graduates who have good extra-curricular activities... basically, they want resilient people (to join the profession).*

However, despite the government's initiative to promote IR4.0, there was no formal directive nor clear guidance from the Ministry of Higher Education on how to incorporate BDA in the university accounting curriculum. In the absence of a mandatory requirement, the participating universities in this study had an option to integrate or not integrate BDA into their accounting curriculum. The findings in this study noted that with such flexibility, universities had opted not to integrate BDA in their current accounting curriculum. Hence, accounting graduates are deemed to be inadequately trained to face the digital challenges of the accounting profession.

BDA Skills

BDA skills are defined as the ability to use BDA knowledge to perform analysis of Big Data. Based on the findings, this study proposed three levels of BDA skills that accountants are required to possess to effectively embrace big data development, viz (1) low; (2) medium; and (3) high skill level. These levels are further categorised into several typologies of skills in ascending order consisting of reporting and visualisation, collaborative skills, analytical, predictive and interpretative skills. Figure 1 presents a model that shows a typology of skills needed by tech-adroit accountants based on the three skills levels. This model suggests that the medium skill level can further be classified as medium-high and medium-low depending on the complexity of the skills needed.
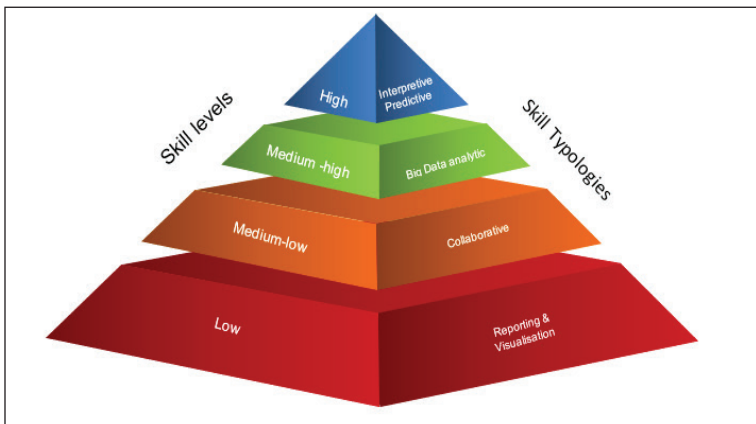

Figure 1: A model of skill typologies for 21st century Accounting Graduates
(Source: Authors)

Low skill level

The traditional role of accountants in reporting business results is still required even though the nature of data has changed significantly due to big data. This study suggests that the reporting skill in big data era does not pose a great challenge to accountants in terms of skill level, hence the low skill level. An interviewee (A) noted that:

They (accountants) still need to do the same as before but now because the sources of data are many and varied, they need to discover, visualise and display patterns.

However, accountants need to complement their reporting skill with additional skills to provide effective display of business results. This can be done through the visualisation skill especially by using modern technology such as dashboards. A dashboard conveniently tracks, analyses and displays data which often provides at-a-glance views of key performance indicators (KPIs) and relevant business metrics to a particular objective or business process. Such visualisation technique would enable deeper insight into the overall "health" status of the business. Hence, there is a need for accountants nowadays to be familiar with various techniques and software available in providing good visuals. A manager of a public listed company (Interviewee C) noted that:

Visualisation skill means you visualize and use your imagination to vision your target. This skill is important to me as it will move us forward to achieve our goal. By visualizing the success, we will put an effort to make sure things are on the right track.

With the rising need for accountants to be technologically prepared for advanced visualisation skill, universities and other higher learning institutions have to offer supplementary courses and training in using business dashboards such as Microsoft Power BI and Oracles Business Intelligence. The reporting skill will be enhanced when complemented with adequate visualisation skills.

Medium skill level

Findings from this study noted that the analytical role of accountants has evolved from a traditional analyst role to a more contemporary big data analyst position. The model presented in Figure 1 suggests that the analytical skill is viewed as a medium skill level. This is due to the higher complexity surrounding analytical tasks as compared to the reporting and visualising skills. In general, analytical skill is essential as massive raw data generated by a business will not be of value without meaningful analytical output. This view was echoed by an accounting practitioner (E):

> *Since analytical skill involves searching, organizing and explain the data, one should organize and filtering the data that he/she gathered. It will not be helping if there are too much irrelevant information. Therefore, analytical skill is important to ensure quality and relevant data has been gathered.*

However, since accountants need to possess BDA knowledge as an essential requirement before they can analyse big data, they must possess certain collaborative skills. In the proposed model (Figure 1), collaborative skill refers to the ability of accountants to collaborate with work teams from other disciplines particularly in data science in sharing information to produce a more detailed and better analysis. More importantly, accountants play an important role in providing inputs to system developers for BDA on what and how the data needs to be analysed and what type of output is required. They are tasked with giving relevant advice to the developers about the rules of the business, how the data needs to be stored and presented. Although systems developers are mostly staff with computer science backgrounds and trained to conduct business analytics, advice on how the output needs to be presented must be provided by the accounting and finance professionals. Since the professionals are involved in more strategic levels, they are the most appropriate individuals to determine what data they want to use to support the various management functions such as planning, decision-making, and control. From the accounting education perspective, such collaborative skill may be obtained through hands-on training, on the job training and through intense courses and learning modules.

High skill level

In businesses, managers need to understand and make decisions based on data. With the availability of BDA, the primary role of accountants to provide relevant information to managers will become more difficult. The voluminous amount of data generated at high speed pose a significant challenge to accountants whereby they need to possess high-level skills which consist of interpretive and predictive skills. Interpretive skill involves scrutinising ideas, assumptions and reasons to discover precise meaning of the data in a certain context from detailed information such as charts, graphs and diagrams. Interpretive skill is significant as the overwhelmingly "big" data need to be adequately interpreted into valuable business insights. Interpretive skills are needed to transform raw data into new knowledge. Moreover, data analytics without sufficient understanding of the implication of the results through reflexive and critical interpretation will be meaningless. Another high-level skill needed by tech-adroit accountants is the predictive skill. Predictive skills involve the use of data from a variety of sources that helps accountants to develop accurate forecasts. This can be done through identification and extrapolation of existing trends captured by the "big" data to predict future trends. Such information is crucial for businesses to respond to environmental changes especially in uncertain and volatile environment. From the perspective of the accounting curriculum, university graduates need to be trained so that they will be more insightful when interpreting and predicting future outcomes. Formal accounting education on both skills can be achieved through learning and hands-on training.

DISCUSSION OF FINDINGS

This study suggests that accountants need to possess a basic knowledge of BDA in order to know the different types of data, what data might be useful, and where and how it can be obtained. This is consistent with McKinney et al., (2017) who noted that future accountants need to have knowledge such as on the challenges of statistics and integrating data sets. BDA knowledge is viewed as a pre-requisite for the accountants to successfully perform their tasks in the 21st century environment. Accountants also need five critical skills ranging from low to high skill level in managing big data. These skills consist of reporting and visualisation, collaborative, analytical, interpretive and predictive skills. Effective communication of

business results that capture the element of big data is crucial. Accountants need relevant visualisation skills such as digital dashboards in reporting business results. Dashboards can significantly benefit business since it allows monitoring of multiple business metrics simultaneously as well as improve performance visibility. This finding is consistent with Kokina et al. (2017) who suggested that accounting graduates should be familiar with tools including Excel and Tableau to effectively communicate to the users of accounting information.

Another important skill for the accountants is having the collaborative skill. Accountants must have relevant skills to exploit BDA to add value to the business. A collaborative working relationship with systems developers and data scientists may help them identify how BDA can add value to the business. As suggested by Rios et al. (2020), collaborative skills of employees with colleagues and customers will allow them to work with colleagues from cross functional departments. Such collaborative skill can facilitate negotiation and management of conflicts. Consistent with Brink and Stoel (2019), the findings indicated that accounting professionals need to be able to interpret results from BDA they act as intermediaries who need to translate data analytics into deeper business insights. In interpreting analytics results, these accountants need to exercise their judgement in filtering relevant information to avoid information overload. With an enormous amount of data, information overload can easily occur, leading to poor interpretation of business results. Higher skill levels are needed to ensure the qualitative characteristics of information are achieved. This skill is consistent with the predictive analytical skills of BDA. The focus is now more on "decision usefulness" rather than "faithful representation" of business transactions. Relevant interpretations of BDA are essential to building meaningful insights into the business (predictive). Having predictive skills enables accountants to create value to organisations by leveraging on BDA, as suggested by Nielsen (2018).

The findings also highlighted the need for accounting graduates to exhibit strong, soft skills besides acquiring BDA technical skills. Findings from this study also indicated that there had been significant changes to the role of accounting professionals over recent years. With the emergence of BDA, their role has shifted from mere input providers to systems developers to a deeper involvement in assisting business decision-making. More

specifically, with the current development, there are higher expectations on what these professionals can do in harnessing voluminous data and converting them into useful information. However, this does not mean that their traditional role in financial reporting has changed. Instead, their role needs to be expanded considering the multiple sources of data they need to handle. This finding is consistent with accounting professional bodies' suggestions that, amongst others, accounting professionals need to be able to identify which data point, that is the factors that are useful in driving the business forward. They also need to have a clear sense and embrace new forms of data and creative ways while staying comfortable with uncertainty, including big data. Similarly, Green et al. (2018) noted that accountants play an important role in decision making and viewed as being indispensable advisors to the top management, hence their knowledge and skills in BDA will provide them with valuable resources. With the voluminous nature of big data, accounting professionals face the bigger challenge to filter the information since data can also be unstructured. Findings also suggested that in a big data environment, the flow from data to information may also be accompanied by the reverse flow of information back to data. Apart from that, accountants are expected to be involved in predictive analytics more extensively. This means that from the data mining process and subsequent analytics, accounting and finance professionals need to go beyond mere interpretation of results to provide useful business prediction models.

CONCLUSION

This study aimed at examining the knowledge and skills required by accounting graduates to better prepare them with the big data development in the digital era. Accounting professionals need to be adaptive to the environment. In other words, when they use their skills and detailed understanding of the business and the environment in which it operates, these professionals must ask challenging questions in providing valuable advice. Furthermore, accountants are increasingly needed in many industries, and they need to be an "all-rounder" rather than strictly have accounting qualifications. In response to the development of BDA in the 21st century, accounting professional bodies and higher learning institutions need to provide accounting graduates with basic BDA knowledge and skills to effectively perform their tasks that could add value to the business.

This study contributes to practice by recommending that BDA skills and knowledge be embedded in existing accounting courses at universities and other institutions of higher learning to prepare future accountants. This study offers valuable input for higher learning institutions and professional bodies in developing their accounting curriculum for quality education that meets the challenges of the new digital era in the 21st century. Despite these recommendations, our study was limited due to the small sample size used and thus lacks generalizability. Hence, future studies may explore the importance of BDA knowledge and skills using a quantitative method of inquiry.

REFERENCES

Abd Razak, S. N. A., Wan Mohamad Noor, W.N. B., & Mat Jusoh, Y. H. (2021). Embracing digital economy: Drivers, barriers and factors affecting digital transformation of accounting professionals. *International Journal of Advanced Research in Economics And Finance*, 3(3), 63-71.

Al-Htaybat, K., von Alberti-Alhtaybat, L., & Alhatabat, Z. (2018). Educating digital natives for the future: accounting educators' evaluation of the accounting curriculum. *Accounting Education*, *27*(4), 333-357.

Asonitou, S. (2021). Technologies to communicate accounting information in the digital era: Is accounting education following the evolutions? In Kavoura, A. et al. (Eds.), *Strategic Innovative Marketing and Tourism*, Springer Proceedings in Business and Economics, Springer Nature Switzerland, 187-194, https://doi.org/10.1007/978-3-030-36126-6_21.

Augustine, F. K. Jr., Woodside, J., Mendoza, M., & Chambers, V. (2020). Analytics, accounting and big data: Enhancing accounting education. *Journal of Management & Engineering Integration*, 13 (1), 1-8.

Bloomberg, L. D. & Volpe, M. (2008). *Completing your qualitative dissertation: A road map from beginning to end*. Thousand Oaks, CA: Sage.

Brahim, A., & Dahlan, A. R. A. (2019). University of the Future: Reshaping Malaysian Universities' relevance through humanising education and 4IR. *International Journal of Management and Commerce Innovations*, *6*(2), 1106-1113.

Brands, K. & Holtzblatt, M. (2015). Business analytics: Transforming the role of management accountants. *Management Accounting Quarterly*, 16 (3), 1-12.

Brands, K. (2014). Big data and business intelligence for management accountants. *Strategic Finance*, 64-65.

Brink, W. D., & Stoel, M. D. (2019). Analytics knowledge, skills, and abilities for accounting graduates. In *Advances in accounting education: Teaching and curriculum innovations*. Emerald Publishing Limited.

Capriotti, R. J. (2014). Big data: Bringing big changes to accounting. *CPA Journal*, 85 (2), 36.

Chartered Global Management Accountant (CGMA) (2013). *From insight to impact: Unlocking opportunities in big data*. https://www.cgma.org/content/dam/cgma/resources/reports/downloadabledocuments/from-insight-to-impact-unlocking-the-opportunities-in-big-data.pdf.

Chartered Global Management Accountant (CGMA) (2014). *CGMA Briefing: Readying business for the big data revolution*. 1-12. https://www.cgma.org/Resources/Reports/DownloadableDocuments/CGMA-briefing-big-data.pdf

Chen, H., Chiang, R.H.L. & Storey, V.C. (2012). Business intelligence and analytics: From Big Data to big impact. *MIS Quarterly*, 36 (4), 1165-1188.

Dalwai T., Mohammadi S.S., Chugh G. & Somerville A. (2021). Big data analytics and accounting education: A systematic literature review. In: Al Mawali N.R., Al Lawati A.M., S A. (eds) *Fourth Industrial Revolution and Business Dynamics*. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-16-3250-1_8.

Gamage, P. (2016). Big Data: are accounting educators ready? *Journal of Accounting and Management Information Systems*, 588-604.

Green, S., McKinney Jr, E., Heppard, K., & Garcia, L. (2018). Big Data, digital demand and decision-making. *International Journal of Accounting & Information Management*.

Halili, S.H., Sulaiman, S., & Sulaiman, H. & Razak, R. (2021). Embracing industrial revolution 4.0 in universities. Annual Conference on Computer Science and Engineering Technology (AC2SET) 2020. *IOP Conf. Series: Materials Science and Engineering* 1088 (2021) 012111, IOP Publishing doi:10.1088/1757-899X/1088/1/012111.

Ibrahim, A. E. A., Elamer, A. A., & Ezat, A. N. (2021). The convergence of big data and accounting: innovative research opportunities. *Technological Forecasting and Social Change*, *173*, 121171.

ICAEW. (2019). Big data and analytics: The impact on the accountancy profession. https://www.icaew.com/-/media/corporate/files/technical/technology/thought-leadership/big-data-and-analytics.ashx.

Janvrin, D. J., & Watson, M. W. (2017). "Big Data": A new twist to accounting. *Journal of Accounting Education*, 38, 3-8. http://dx.doi.org/10.1016/j.jaccedu.2016.12.009

Jørgensen, T. (2019). Digital skills Where universities matter. *Learning and Teaching Paper, The European University Association*, *7*.

Khan, N., Yaqoob, I., Hashem, I.A.T., Inayat, Z., Ali, W. K., Alam, M., Shiraz,M & Gani, A. (2014). Big Data: Survey, Technologies, Opportunities, and Challenges. *The Scientific World Journal*. http://dx.doi.org/10.1155/2014/712826

Kokina, J., Pachamanova, D., & Corbett, A. (2017). The role of data visualization and analytics in performance management: Guiding entrepreneurial growth decisions. *Journal of Accounting Education*, 38, 50-62.

Lase, D. (2019). Education and industrial revolution 4.0. *Jurnal Handayani Pgsd Fip Unimed*, *10*(1), 48-62.

Ma'dan, M., Imail, M. T., & Daud, S. (2020). Strategies to enhance graduate employability: Insight from Malaysian public university policy-makers. Malaysian Journal of Learning and Instruction, 17 (2), 137-165. https://doi.org/10.32890/mjli2020.17.2.5

Martinelli, A., Mina, A., & Moggi, M. (2021). The enabling technologies of industry 4.0: Examining the seeds of the fourth industrial revolution. *Industrial and Corporate Change*, 30 (1), 161–188. https://doi.org/10.1093/icc/dtaa060.

McKinney Jr, E., Yoos II, C. J., & Snead, K. (2017). The need for 'skeptical'accountants in the era of Big Data. *Journal of Accounting Education*, *38*, 63-80.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Ministry of Education Malaysia. (2015). *Malaysia Education Blueprint 2015-2025* (Higher Education). https://www.mohe.gov.my

Naysary, B., Dhoraisingam, S., Siew, E. G., & Asiaei, K. (2022). *Application of Big Data Analytics in Accounting: A Bibliometric and Visual Study.* Preprints. Available at SSRN 4214190.

Nielsen, S. (2018). Reflections on the applicability of business analytics for management accounting–and future perspectives for the accountant. *Journal of Accounting & Organizational Change*. 14 (2), 167-187. https://doi.org/10.1108/JAOC-11-2014-0056

OECD. (2018). *The future of education and skills: Education 2030*. https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf.

Polimeni, R.S., & Burke, J.A. (2021). Integrating emerging accounting digital technologies and analytics into an undergraduate accounting

curriculum—A case study. *Journal of Emerging Technologies in Accounting*, 18 (1), 159–173. https://doi.org/10.2308/JETA-2020-042.

PwC. (2015). Data driven: What students need to succeed in a rapidly changing business world. https://cpb-us-w2.wpmucdn.com/sites.gsu.edu/dist/1/1670/files/2015/08/pwc-data-driven-paper-1wdb00u.pdf

Rezaee, Z., & Wang, J. (2018). Relevance of big data to forensic accounting practice and education. *Managerial Auditing Journal*.

Rios, J. A., Ling, G., Pugh, R., Becker, D., & Bacall, A. (2020). Identifying critical 21st-century skills for workplace success: A content analysis of job advertisements. Educational Researcher, 49(2), 80-89.

Selamat, A., Alias, R. A., Hikmi, S. N., Puteh, M., & Tapsi, S. M. (2017). Higher education 4.0: Current status and readiness in meeting the fourth industrial revolution challenges. *Redesigning higher education towards industry*, *4*, 23-24.

Shodiev, T., Turayev, B., & Shodiyev, K. (2020). ICT and economic growth nexus: Case of Central Asian countries. *Procedia of Social Sciences and Humanities,* Proceeding of the International Conference on Intellectuals' Global Responsibility 2020 (ICIGR): Science for Handling the Effects of Covid-19, Facing the New Normal, and Improving Public Welfare, 155-167, Indonesia.

Sun, J. (2022). Research on the Practice of "Helping Learning" in Higher Vocational Accounting Course under the Background of Digital Economy: Takes the Big Data and Accounting Major of Wenzhou Polytechnic as An Example. *International Journal of Education and Humanities*, *4*(1), 15–22. https://doi.org/10.54097/ijeh.v4i1.1153

Tiron-Tudor, A., & Deliu, D. (2021). Big data's disruptive effect on job profiles: Management accountants' case study. *Journal of Risk and Financial Management*, 14(8), 376. MDPI AG. http://dx.doi.org/10.3390/jrfm14080376.

Vasarhelyi,M.A., Kogan, A. & Tuttle, B.M. (2015). Big data in accounting: An overview. *Accounting Horizons*, 29 (2), 381–396.

Wahyuni, T. (2020). The role of information technology in supporting accountant profession in the era of Industrial Revolution 4.0. *Advances in Social Science, Education and Humanities Research*, 426, 256-264.

Wang, Y. & Wang, Z. (2016). Integrating data mining into managerial accounting system: Challenges and opportunities. *Chinese Business Review*, 15 (1), 33-41. doi: 10.17265/1537-1506/2016.01.004

Wong, K. L., Chuah M. H. & Ong, S. F. (2015). Are Malaysian companies ready for the big data economy? A business intelligence model approach [Paper presentation]. *International Conference on Accounting Studies* (ICAS) 2015, 17-20 August 2015, Johor Bahru, Johor, Malaysia.

World Economic Forum (2016). The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution. 1-167.

Yin, R. K. (2009). Case study research: Design and methods (4th Ed.). Thousand Oaks, CA: Sage.