Journal of Information Systems Engineering and Management
2025, 10(62s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Big Data Analytics Integration in Accounting Education: A Critical Review into Current Progress, Challenges and Frameworks

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ARTICLE INFO

Received: 30 Dec 2024

Revised: 19 Feb 2025

Accepted: 27 Feb 2025

ABSTRACT

The increasing adoption of big data analytics (BDA) in the finance industry has transformed the role of accountants, requiring them to develop data-driven decision-making skills. This study examines the integration of big data analytics into undergraduate accounting education to assess its alignment with industry expectations and identify areas for improvement. A critical analysis of existing literature highlights key competencies expected from graduates and academic constraints hinder effective integration. This study also reviews existing frameworks suggested as part of phased approaches in incorporating big data analytics within accounting education. Through this analysis, the study identifies the future direction of the research by examining the current gap that exists in academia and industry expectations.

Keywords: Big Data Analytics, Accounting Curriculum, Data Analytics Skills, Process Innovation, Inclusive Education

INTRODUCTION

The rapid emergence and advancement of new technologies in the finance landscape has resulted in a need for accountants to become more tech-savvy. At the frontier of this landscape lies big data analytics which has enabled organizations to improve their operations through making data-driven decisions, (ICAEW, 2019). With the finance profession now shifting away from the traditional scope of record-to-report towards enabling accountants to utilize big data analytics to create real-time data driven decisions, (Herath & Woods, 2021), the underlying question remains whether future accountants are adequately equipped to enter a data-driven workforce.

Recent literature underscores an increasing acknowledgment of the significance of Big Data in accounting methods. McBride and Philippou assert that accounting education is transforming due to technological advancements, with Big Data analytics impacting multiple accounting fields, including auditing and forensic accounting (McBride & Philippou, 2021). Younis advocates for the integration of Big Data analysis into accounting curricula to improve students' comprehension of data processing and its professional ramifications (Younis, 2020). Rezaee and Wang support the incorporation of Big Data subjects into forensic accounting education to enhance the curriculum in alignment with modern requirements (Rezaee & Wang, 2019).

Furthermore, the utilization of Big Data analytics has demonstrated an enhancement in the quality and pertinence of accounting information, which is essential for augmenting transparency and facilitating stakeholder decision-making (Warren et al., 2015). The use of Big Data into financial reporting and auditing processes not only enables more objective evaluations but also improves the overall quality of audit reports (Biglari et al., 2023). This signifies

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a substantial change in educational emphasis towards preparing students with the essential abilities to manage the intricacies of Big Data in accounting.

Notwithstanding the advancements, numerous obstacles hinder the smooth incorporation of Big Data analytics into accounting education. Aziz delineates five principal challenges: variety, value, velocity, volume, and veracity, that firms must confront to successfully integrate Big Data analytics into their accounting systems (Aziz, 2023). These problems require a reassessment of current educational frameworks to ensure they sufficiently equip students for the practical realities of Big Data.

The conventional accounting education approach is criticized for its failure to adapt to digital globalization and the swift advancement of technology (Angelus & Witjaksono, 2022). This disparity underscores the pressing necessity for educational institutions to revamp their pedagogical approaches and curriculum development. Li and Wu advocate for the optimization of teaching strategies through the integration of intelligent pedagogical methods and the enhancement of practical training to more effectively meet the requirements of the digital economy (Li & Wu, 2024). Therefore, further research is essential to evaluate the current frameworks, challenges, and progress in the integration of big data analytics into accounting education. This will ultimately guide the development of innovative, evidence-based practices that have the potential to revolutionize the field.

OBJECTIVES

The primary objective of this study is to explore the current level of big data analytics integration into undergraduate accounting education to identify areas for improvement that will allow for an improved integration of big data analytics into the undergraduate curriculum. To achieve this objective, this study adopts a critical analysis of past research covering topics of industry expectations, the current level of big data analytics integration in the context of accounting education, current challenges faced by Higher Education Institutions in incorporating big data analytics and current frameworks suggested in past studies to understand existing gaps that still exist within the landscape to suggest improved steps that will allow for improved integration.

LITERATURE REVIEW

2.1 Introduction

To identify areas for improvement in accounting education, it is important to first understand what the expectations of the accounting and finance industry are in relation to big data. Presently, the use of big data analytics is more widely embraced by businesses due to the vast benefits that big data analytics brings to their businesses. Some notable positive impacts are how big data analytics assists accountants to facilitate intelligent data driven business decisions at faster transmission times and lower costs, this enables business to enhance and maintain customer satisfaction, penetrate new market opportunities and improve risk control by enabling real-time monitoring of accounts for timely detection of frauds, (Huttunen et al., 2019, Md Zin et al., 2022, Hasan et al., 2023, Yu & Zhu, 2023). Hence, equipping accountants to complete their work in a more effective and efficient manner.

While big data analytics is revered for the benefits it brings to the profession, it is critical to acknowledge that there are still challenges that impact the integration of big data into accounting such as the lack of human capital to bridge the gap between decision-making and analytics. This is substantiated by a report published by (ACCA, 2020) which highlights the gap that accountants would need to bridge between the IT department (who historically manages data and tools) and business (who require the insights to develop new products and improve processes). The lack of right human capital poses as a weakness to ensure that the data collected is transformed properly to ensure real-time analysis of the data, (Yu & Zhu, 2023, Hasan et al., 2023). These studies highlight the need for accountants to be well-equipped when handling BDA in a corporate set-up which draws the need higher education institutions to work on integration of big data analytics into the curriculum.

2.2 Industry Expectations

The increased popularity of big data analytics in the industry has resulted in a need to evaluate whether accounting and finance graduates have the necessary skills to successfully utilize big data analytics (Tin et al., 2024). This has resulted in past research focusing on identifying core employability skills that are needed by industry. Some notable

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e-ISSN: 2468-4376
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employability skills include critical thinking, ICT literacy, technological skills, data cleaning and analytical skills, and visualization skills amongst the top skills needed, (Bose, Dey & Bhattacharjee, 2022, Mainga, 2022, Hansen & Daniel., 2023, Jackson et al., 2023, Zainnudin et al., 2023). However, the most critical skills include technical, analytical and visualization skills.

Technical Skills

Digitalization of accounting processes have now become inevitable; due to these technological advancements, the scope of work performed by accountants have expanded as well. Therefore, there is a need for accountants to increase their technical knowledge on subject matters such as big data, cloud computing, artificial intelligence, etc. to understand the usefulness of these digitalization tools and strategically utilise these tools in their work. The need to enhance their digital skills is no longer an option but a necessity. Hence, it is crucial that graduates hone their technical knowledge and build competence in digital and information literacy to successfully pave their career paths , (Awang et al., 2022 & Younis, 2020). Professional bodies such as ACCA are also recognising the rising need for digital skills development and are encouraging accountants to recapture lost ground caused by digital transformation through upskilling themselves. In order to successfully enhance technical skills, it is crucial for accountants to continuously develop themselves and undergo on-the-job training to successfully apply big data analytics into their work and refine their business skills to provide greater value towards their organisations, (ACCA, 2020). These studies have shown that one key competent skill that is expected from accounting and finance graduates is to have a strong competency in data analytics tools.

Analytic Skills

Analytical skills expected from accountants may differ from one accounting role to another. Given that big data analytics involves us assessing through large multitudes of data that can vary for different accountants; it is important that accountants are able to source relevant data and distinguish between forms of analytics to successfully use them in their line of work, (Chu & Yong, 2021). The research done by past researchers have categorized some core analytical skills to include descriptive analytics (using past information to provide insights), prescriptive analytics (identifying the best possible result), predictive analytics (understanding patterns and trends from historical data that allows for accurate forecasts to be developed), and diagnostic analytics (identifying the causes and reasons behind past data results). Similar, to the importance for accountants to gain technical knowledge, it is critical that accountants understand the different types of analytics and are able to collaborate with other departments to successfully utilise the analytic capabilities to and when to gain insights and make informed decisions on future outcomes that adds value to the business, (Md Zin et al., 2022 & Bose, Dey & Bhattacharjee, 2022).

Visualization Skills

Additionally, past researchers have also highlighted the need for accountants and graduates likewise to develop their visualization skills through utilising different data visualization tools such as Microsoft Excel, PowerBI, Tableau, Qilk, etc. The research done by (Dalwai et al., 2021), discusses the usage visualization tools as part of accounting curriculum to enhance graduates' data analytics capabilities. This is further supported by the research done by (Md Zin et al., 2022) where the researcher interviewed a manager from a public accounting firm that discussed the need for accountants to be able to complement their reporting skills with visualisations that so that business results can be effectively seen. As such it is significant that accountants are to be able to use their data analytics skills combined with visualization skills to successfully display information into dashboards that enhance business decision-making capabilities.

2.3 Current Level of Big Data Integration

Considering the rising popularity of big data analytics in the industry, there is a rising recognition for big data analytics to be included into accounting curriculum. This rising popularity and call for inclusion can be substantiated by the fact that many professional bodies such as American Association of Certified Public Accountants (AICPA), American Accounting Association of Accountants (AAA) and The Institute of Chartered Accountants in England and Wales (ICAEW) are discussing the need to incorporate more technologies and big data into the accounting curriculum, (Dalwai et al., 2021). Additionally, the Association to Advance Collegiate Schools of Business (AACSB)

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e-ISSN: 2468-4376
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have also made amendments to standard A5 which relates to the integration of information technology into accounting curriculum, hence calling for a need for higher education institutions to consider integrating information technology, big data, cloud computing into the syllabus, (Dalwai, et al., 2021, Sarkar, et al., 2020, Bandeira, et al., 2023).

As a result, there has been an increase in research being done to evaluate the steps being taken to include BDA into accounting curricula. Majority of the research done on this topic shares common consensus that big data analytics is an important and upcoming skill that future accountants need and that more initiatives should be taken to include BDA into accounting curricula (Dewu & Barghathi 2019, Qassim et al., 2020, Hoodlebrink et al., 2021, Wan Kamalluarifin et al., 2022, Razali et al., 2022, Md Zin et al., 2022).

Past literature done have extensively covered several aspects of the big data integration scenario from the viewpoint of feedback from relevant professionals, challenges and limitations in the integration at tertiary education level. However, it is critical to consider these three pillars in order to understand the gap that exists between the current state and the potential to improve the integration progress.

Feedback Received from Accounting Practitioners and Professors

Most of the past research done has focused on analytical aspects of reviewing past literature to understand the issues and challenges concerning the implementation of BDA into accounting curriculum. However, in some recent papers, researchers have begun collecting data in the form of interviews with industry practitioners and accounting professors or lecturers to understand their perspectives on big data and accounting. A common consensus identified is that both accounting practitioners and professors agree that there is a need to incorporate more BDA into accounting education with findings that show that accounting professors agree and acknowledge that the evolving needs of data analytic capabilities have resulted in more need to incorporate data analytics into accounting syllabus; however, significant challenges limit the integration of data analytics into the curriculum. Additionally, past researchers in this topic have also considered the viewpoint of professionals who utilize BDA in their work and the results of the interviews done with practitioners describes the need for BDA in their work, the benefits that big data has done in simplifying their work and tools that they utilize in the corporate set up, (Dewu & Barghathi, 2019, Md Zin et al., 2022, Sufian et al., 2023).

Despite the rising recognition on the need to incorporate big data into the accounting curriculum, it is critical to note that the introduction of big data analytics in the accounting curriculum amongst most universities is still in its infancy stage. The research done in (Dewu & Barghathi, 2019) supports this statement as the outcome of their interviews with accounting professors shown that there is still no incorporation of big data analytics into the accounting curriculum. While most scholars have noted the importance of including technology into accounting curriculum, the existence of technology-related skill gaps results in the need to better understand the role of educators around this new technology, (Jackson et al., 2023). Currently, the method used by faculties to incorporate big data analytics is done by increasing big data analytics concepts into Accounting Information Systems (AIS) modules and the introduction of new programs such as a master's degree in accounting analytics, (Hoodlebrink, et al., 2021). While these initiatives mark a pioneering step towards big data analytics, the underlying question remains on whether it is effective as there is still limited exposure at an undergraduate level. In (Razali et al., 2021), the researchers describe the impact of IR 4.0 in reshaping the accounting profession through a qualitative approach from previous research studies. A common trend noticeable in the research was that majority of students are not well-versed in the skills needed to be qualified graduates which leads to a mismatch in expectations from industrial employers, especially in terms of technology and data analytics. The expectation is that overtime progression of BDA should be included in accounting curriculum and some introductory steps should be taken to overcome challenges that hinder the progress.

Therefore, it is critical to consider the challenges that limit the incorporation of big data analytics into the curriculum. Research that has been previously done highlights the difficulties faced in incorporating BDA into accounting education. Some common factors commonly drawn as challenges are inadequate textbooks and outdated curriculum, difficultly to integrate into a full curriculum, lack of skills and knowledge from faculty academicians, accreditation, time constraints and some resistance met from the faculty (Richardson & Shan, 2019, Dewu & Barghathi 2019, Qasim et al., 2020, Hoodlebrink et al. 2021, Han, 2022, Md Zin et al., 2022, Al Ghatrif, 2023, Birt et al., 2023, & McConville,

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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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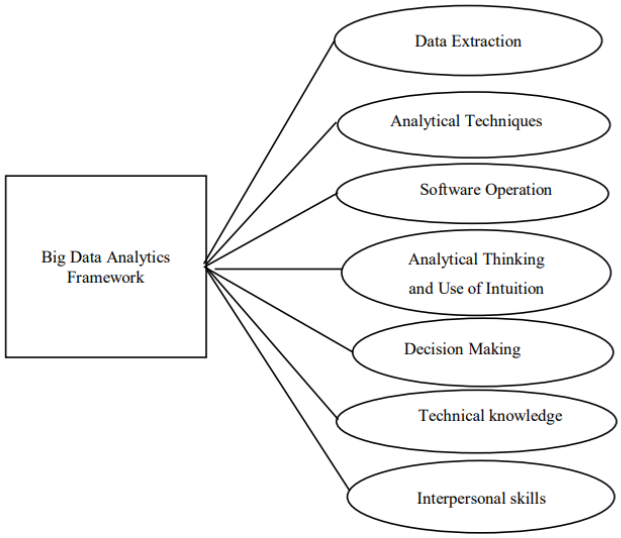
2023). These challenges pose as gap into the incorporation of BDA into accounting curriculum, especially with regards to the curriculum and faculty elements as outdated curriculum and resistance or inexperience faculty are not able to provide accounting students with the necessary skills needed to remain relevant and employable in industry which further puts them at risk of replacement with other professionals such as IT professionals. Furthermore, another limitation results from ability to get accreditation to include BDA in accounting curriculum. In (Han, 2022), the research discusses that only in the Association to Advance Collegiate Schools of Business (AASCB) standards had accredited data analytics and it was not mentioned in any other standards. The lack of accreditation also results in the limitation towards the slow progress in incorporating big data in accounting education. Considering a practical context, the research conducted in (Md Zin, et al., 2022), narrowed their focus on Malaysian universities that shows in their discussion that due to a lack of formal, mandatory requirement to accredit data analytics into the course, the incorporation of big data analytics it is left as an option at the discretion of the universities to choose whether they want to integrate into the curriculum. This poses as a gap as although there is a recognition on the importance of BDA, the lack of requirement and difficulty to meet accreditation requirement leads to some universities introducing BDA in Master courses, (Dow et al., 2019).

2.4 Existing Frameworks

The current extent and limitations towards the incorporation show a gap that exists in the current landscape which needs to be addressed to ensure that students' skills developments are done to meet the expectations of industry. To overcome this gap, past researchers on this topic have also looked into the creation of frameworks to overcome the gap.

In (Dewu & Barghathi, 2019), the authors developed the framework in **Figure 1** based on the literature reviews conducted and interviews held with academicians and industry professionals. Their research suggests that accounting students should be able to understand and extract potential useful data that may exist in various forms and utilize relevant techniques and software to analyze these data. While highlighting the need for BDA capabilities, the researchers also highlight the need for the students to develop competencies in skills such as analytical skills, decision-making, technical knowledge, etc. to make useful decisions from BDA. This shows that to successfully integrate BDA, students must not only acquire the knowledge on how BDA works, but also the relevant soft skills to successfully use BDA.

Figure 1: ***Framework extracted from Dewu & Barghathi, 2019***



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e-ISSN: 2468-4376
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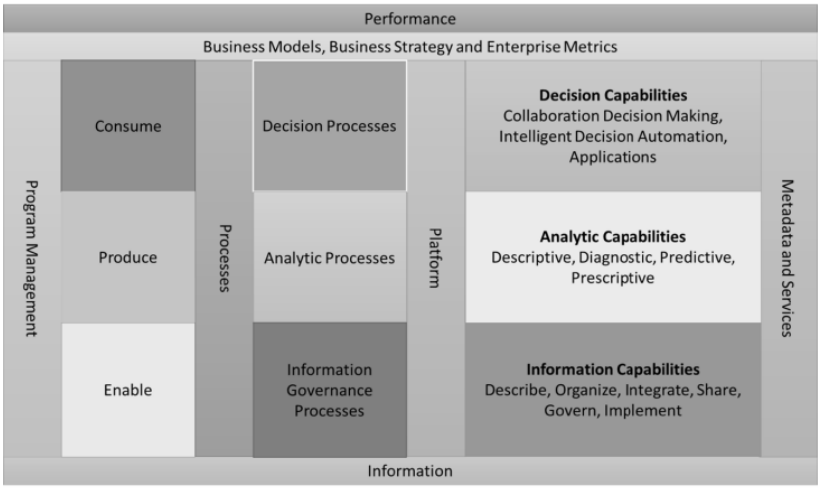
In (Augustine et al., 2020), the authors referenced the Gartner Business Analytic Framework in **Figure 2.** Their research focused centrally on curriculum redesign for accounting education. The Gartner framework below highlights the processes involved in data analytics and highlights the capabilities that are needed to successfully utilize data analytic capabilities in terms of decision-making capabilities, analytical skills and information management based on business expectations of the skills needed.

Figure 2: ***Framework extracted from Augustine et al., 2020***



In (Qassim et al., 2020), the authors recognize the need for the integration of data analytics into the accounting curriculum and suggests a method of integration through the addition of data analytics topics in the current accounting curriculum rather than through a standalone accounting course. In their study, the authors segmented their proposed model into two phases. The first phase involves building the integration based on the progression of data analytics skills based on the student's level of study. In this phase, developing students' data analytical capabilities in an incremental level when the students progressed in their course, the level of data analytics use will increase as well as shown in **Figure 3**. The second phase is through the curriculum restructuring where the authors propose course learning objectives, suggested applications and tools that can be incorporated according to the various accounting fields of study.

Figure 3: ***Framework extracted from Qassim et al, 2020***

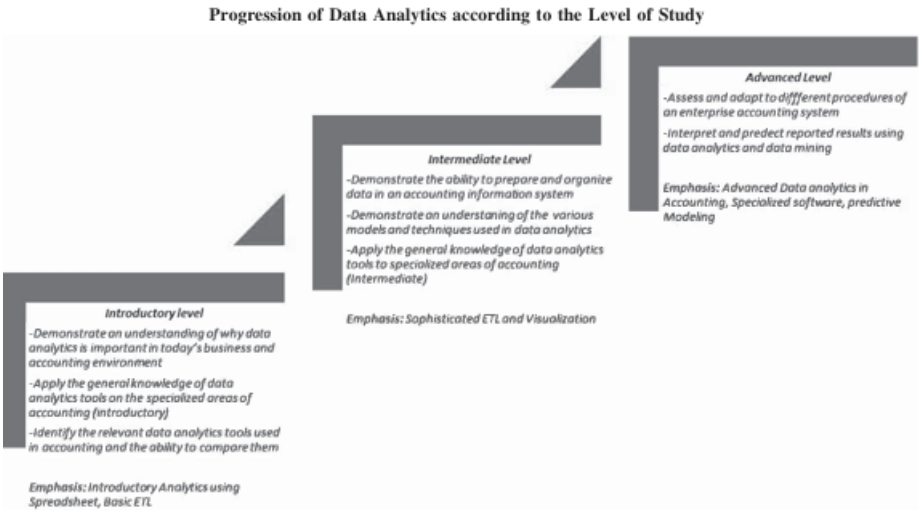


Table 1: ***Table extracted from Qassim et al, 2020***

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e-ISSN: 2468-4376
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Data Analytics CLO's Mapping in the Accounting Curriculum

Level of Study	CLO	Suggested Applications	Suggested Data Analytics Tools
Introductory Level	Demonstrate an understanding of why data analytics is important in today's business and accounting environment.	Calculation of amortization, depreciation, trial balance, etc.	Spreadsheet software recommended: MS Excel Alternatives: Google Sheets
	Apply the general knowledge of data analytics tools on the specialized areas of accounting (Introductory).		
	Demonstrate knowledge of the relevant data analytics tools used in accounting and the ability to compare them.	Review and comparison of various analytical software and their features.	Comparison of data analytics software ETL: Tableau Prep versus Alteryx versus Excel Visualization: Tableau Desktop versus MS PowerBI versus QlikView Data analysis: IDEA versus Galvanize versus R versus SAS Specialized software: UiPath versus Automation Anywhere
Intermediate Level	Demonstrate the ability to prepare and organize data in an accounting information system.	Data preparation and cleaning: Extract, Transform, Load (ETL).	ETL software recommended: Tableau Prep Alternatives: Alteryx, Excel
	Demonstrate an understanding of the various models and techniques in data analytics.	Exploratory data analysis, presenting the data in various visual ways, visualization of results, dashboards.	Visualization software recommended: Tableau Desktop Alternatives: MS PowerBI, QlikView
	Apply the general knowledge of data analytics tools on the specialized areas of accounting (Intermediate).	Ratio analysis, cost estimation, internal control testing, substantive testing, inventory valuation, bonds valuation.	Data Analytics software recommended: IDEA CaseWare Alternatives: Galvanize, R, SAS, Python
Advanced Level	Assess and adapt to different procedures of an enterprise accounting system.	Fraud detection, Outlier detection, Variation analysis (financial statements), Robotic Process Automation, etc.	Specialized software recommended: MindBridge AI, IDEA CaseWare, UiPath Alternatives: Galvanize, Automation Anywhere
	Interpret and predict reported results using data analytics and data mining.	Predictive modeling, machine learning, visualization.	Combination of specialized software and visualization recommended: MindBridge AI, IDEA CaseWare, UiPath, Tableau Desktop Alternatives: Galvanize, Automation Anywhere, PowerBI, QlikView

In (Zhan et al., 2018), the researchers focused on understanding the changing needs of the current accounting education landscape and suggested an architectural framework for Big Data Analytics to be integrated into the accounting curriculum. The desired outcome of their framework is to systematically train students to develop their data analytical skills and mindset. Their framework suggests a step-by-step approach that begins with data extraction from source to the use of data tools to transform and analyze data before presenting the data through visualization as shown in **Figure 4**.

Figure 4: ***Framework extracted from Zhan et al, 2018***

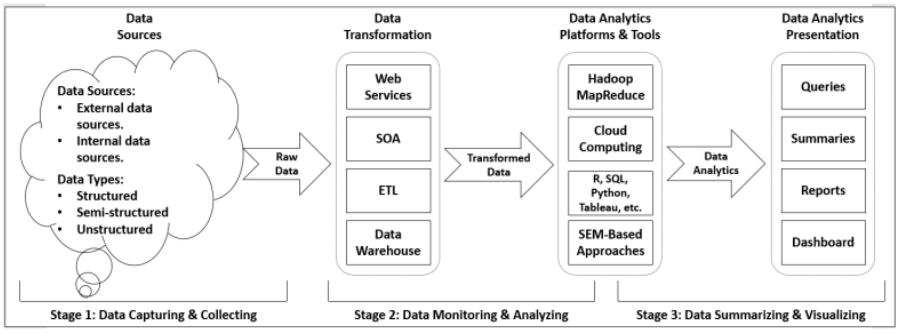

Table 2: Literature Review Matrix for Existing Frameworks

Table 2 Summary of the existing framework related to BDA

Author(s) & Year	Framework/Model	Research Focus / Objective	Methodology / Data Collection	Key Findings / Conclusions	Implications for Accounting Education

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Dewu & Barghathi (2019)	Big Data Analytics Framework	Exploring the extent of BDA equipping students with the necessary competencies by developing a framework that demonstrates the necessary skills needed for accounting students to be equipped with big data	Literature reviews and interviews with academicians and industry professionals.	Successful BDA integration requires students to not only learn technical aspects (e.g., data extraction and analytical techniques) but also develop soft skills such as analytical thinking and decision-making.	Curriculum should balance technical training with soft skill development to produce industry-ready graduates.
Augustine et al. (2020)	Gartner Business Analytic Framework	Redesign the accounting curriculum to embed comprehensive data analytics processes, emphasizing decision-making, analytical skills, and information management capabilities aligned with industry needs.	Adaptation of the Gartner framework through literature review and curriculum analysis.	Identifies gaps in current curricula and current degree of BDA integration in the curriculum while highlighting the need for integrating structured analytics processes to meet business expectations in decision-making and data management.	Embedding robust analytics capabilities within the curriculum is critical for aligning academic outcomes with industry requirements.
Qassim et al. (2020)	Two-Phase Integration Model	Proposes an incremental integration of data analytics topics within the existing accounting curriculum by proposing a model that progresses from foundational skills to advanced applications as students advance.	Conceptual model development segmented into two phases: initial skill progression and curriculum restructuring.	A phased approach can effectively build students data analytical capabilities, with early exposure followed by deeper integration as students progress in their studies.	Gradual integration of analytics topics into existing courses is recommended to enhance students competency stepwise.
Zhan et al. (2018)	Architectural Framework of Business Data Analytics	Design a systematic, step-by-step framework for BDA integration that trains students from data extraction through transformation, analysis, and visualization.	Framework design based on analysis of current educational needs and industry trends.	A structured approach from data extraction to visualization is essential to develop a comprehensive data-driven mindset among accounting students.	A systematic, process-oriented curriculum is needed to progressively build practical BDA skills aligned with evolving industry trends.

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DISCUSSION & CONCLUSION

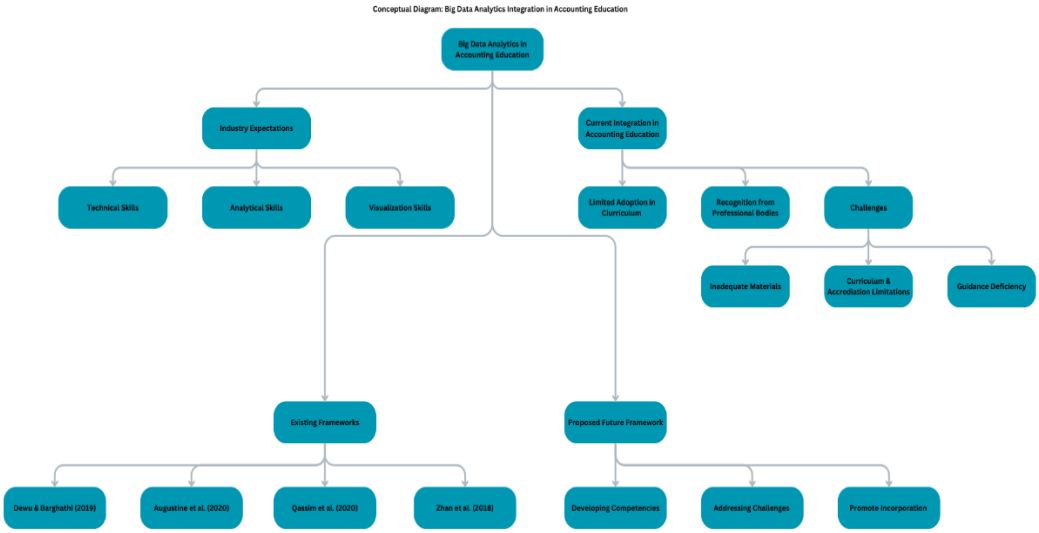
The integration of big data analytics into various accounting fields has resulted in a need to reevaluate the method in which accountants are taught and examine by understanding what the current relevant skills are required by accounting and finance graduates to successfully use big data analytics in the industry. In this study, the past literature reviewed highlighted the importance that big data analytics brings to industry and the expectations that industry has on upcoming accounting graduates. These expectations have been categorized based on the expected skills into three major pillars: technical, analytical, and visualization. Technical skills focus on knowledge of digitalization tools, including big data, cloud computing, and artificial intelligence, which are vital for accountants in adapting towards current technological advancements (Awang et al., 2022; Younis, 2020). Analytical skills involve the ability to discern various forms of analytics in forms of descriptive, prescriptive, predictive, and diagnostic analytics, which enables accountants to use the data accurately to make informed decisions (Chu & Yong, 2021; Md Zin et al., 2022). Visualization skills which require graduates to use tools like Microsoft Excel, PowerBI, Tableau, and Qlik to present data effectively (Dalwai et al., 2021; Md Zin et al., 2022). The importance of these skills aligns with the evolving landscape of the accounting profession, demanding a shift toward digital literacy and data analytics competencies (ACCA, 2020.).

In the context of tertiary education, the integration of BDA into accounting curricula is now crucial. While more initiatives have now been undertaken to integrate big data; challenges still persist, including factors such as inadequate textbooks, outdated curricula, faculty skills gaps, and accreditation issues that limit the integration process (Richardson & Shan, 2019; Dewu & Barghathi, 2019; Qassim et al., 2020, Hoodlebrink et al., 2021, Han, 2022, Md Zin et al., 2022, Sufian et al., 2023). Notably, incorporating BDA into tertiary education requires the ability to overcome challenges that pose a gap in aligning graduates with industry expectations.

To overcome these challenges and align with the expectation of industry, the review of past frameworks proposed by past researchers on the topic was reviewed to understand the extent to which the challenges have been addressed while evaluating the adequacy of the frameworks in addressing the expected skills industry requires. Through the review, it was noted that while the frameworks proposed by the past authors are able to address the problems and expected skills from industry, it still lacks a comprehensive guide to teach students how to develop their data analytic skills.

Figure 5 illustrates a summary of the findings obtain through this literature review that sets the focus for future work.

Figure 5: Conceptual Diagram of Big Data Analytics Integration in Accounting Education



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The future focus of this research is to address existing challenges and build upon current frameworks by creating an improved model that evaluates the current status of big data analytics integration in accounting education. Using the insights obtained this study intends to present a framework that tackles these obstacles and encourages the appropriate implementation of big data analytics in the curriculum. The new framework will focus on growing students' big data competencies progressively throughout their academic path, ensuring them learn the critical skills required to flourish in the dynamic sector. Furthermore, it will offer significant recommendations to academics for addressing challenges associated with the incorporation of big data analytics, thus connecting educational processes with industry requirements. Future study will address difficulties and build on existing frameworks by building a better model that enhances the application of big data analytics in accounting education. The aim is to create a comprehensive framework that incorporates big data analytics into the curriculum and aligns outcomes with industry standards, utilizing insights from this study. This framework will methodically develop students' big data competencies during their academic tenure, guaranteeing the acquisition of adaptable skills vital for the contemporary business landscape, while equipping academia with pragmatic strategies to address challenges and promote the incorporation of big data analytics into accounting education, thereby ensuring career preparedness.

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