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Artificial Intelligence (AI) in Accounting & Auditing: A Literature Review

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Abstract

This is a review work in the area of application of Artificial Intelligence (AI) in Accounting and Auditing. A semi-systematic or narrative review approach was employed in analyzing relevant published books and journals. Faced with the challenges of disruptive technologies brought forth by the Industry 4.0, the accounting and auditing discipline is required to undergo a metamorphosis in order to reach the next level. Interdisciplinary collaboration is a must with regard to the research conducted in the area of AI in accounting and auditing. Wider application of AI in accounting and auditing profession is expected to provide the benefits of greater efficiency, productivity and accuracy whereas burden with the challenges of income and wealth inequality, extinction of traditional jobs and unskilled workforce. Preparation is needed on the part of educators, regulators and professional bodies by addressing the paradigm shift and preparing the students, policies and future professionals for the challenges of the world that is fraught with big data, blockchain technology, artificial intelligence and so on, ushering the fourth industrial revolution. Academia has to reconceptualize the accounting curriculum. Regulators must bring change in the form of formulating revolutionary policies. Also, professional bodies must redesign professional development and training process. Professional hybrids are expected to emerge and lead the profession in the near future. AI development and implementation in the accounting and auditing profession can be viewed as a double-edged sword. What transpires is subject to changes over time but this much is absolute that the profession of accounting and auditing as we know and have known is going to drastically change in the coming days.

Keywords

Artificial Intelligence, Accounting, Auditing, Disruptive Technologies, 4IR

1. Introduction

"Artificial Intelligence (AI)" is a pair of words that excites both the dilettante and cognoscente of the AI community all the same. The concept of man-made machine or sentient being able to think, learn and make decisions on its own is so awe-inspiring that it has taken place in popular culture for decades. Starting from Issac Asimov and Arthur C. Clarke's hard science fictions in the second half of the nineteenth century to today's widely showcased Hollywood movies, loosely based on the real science behind the AI technology, we have seen the human imagination running wild conjuring all the possibilities of Artificial Intelligence. Buchanan (2005), in his iteration of the history of AI, mentioned that the history of AI is intertwined with the history of fantasies, possibilities, demonstrations and promises. In this regard he drew examples of Homer's work where the mechanical tripods were thought to be serving the gods as mechanical assistants, Rene Descartes's work where "mechanical man" has been used as a metaphor to explain the mechanical philosophy, Gottfried Wilhelm Leibniz's work where possible mechanical reasoning devices are said to be capable of settling disputes etc. He also mentioned works of Jules Verne and L. Frank Baum in the nineteenth century, Isaac Asimov in the twentieth century to be inspiration to modern AI researchers. The idea of artificially created sentient beings can also be found in the form of Golem in the Jewish tradition, in Mary Shelly's Frankenstein and some other literary works. Though many of these instances are drawn from ancient and century old happenings, much of the actual contribution to the development of AI technology can be traced back to 1940s, in the aftermath of early twentieth century inventions in electronics and the post-World War II rise of modern computers. Since then, significant developments in the AI technology have taken place in the past century leading to immense potential in the new millennium. In today's world, we observe application of AI technology all around us. In agriculture, greenhouse automation, simulation, modeling, predictive analysis of crops produce, crop and soil monitoring and many other AI applications are found. In healthcare, artificial neural networks are being used as clinical decisions support systems for medical diagnosis. Also, computer aided and automated testing and patient evaluations are being increasingly used. Home and workplace safety and security are being ensured through the application of speech and face recognition. Companies like Tesla, Apple and Google are trying to reinvent the automotive industry by utilizing AI technology in the creation of self-driving cars. In aviation, computer simulated pilots, air traffic controllers are being used besides rule based expert systems. In maritime navigation, neural networks are being used by situational awareness systems present in the ships and boats and all types of vessels. In marketing, media, e-commerce and entertainment, AI is used to analyze customer choices and behaviors. Based on such analysis Netflix, Amazon and similar other services are facilitating greater customer satisfaction. In trading and investment, algorithmic trading is taking

place that involves the use of complex AI systems in making trading decisions at greater magnitude and speed than human capabilities. Military operations such as intelligence gathering, logistics, cyber operations, command and control, etc. are being supported by AI technologies. Besides these, AI technology has wide applications in manufacturing, publishing, utilities, various service sectors, education, gaming, and in almost every walks of life. Accounting and Auditing are not unaffected by the engulfing nature of the use of AI technology. The progress in AI technology is transitioning to a tipping point where some new innovation or development could potentially change how a profession or discipline is being practiced and perceived all over the world. Thus, understanding AI technology and keeping abreast of the interdisciplinary developments is a modern mandate.

This study seeks to present how AI technology has influenced Accounting and Audit profession thus far and in what ways these disciplines could be affected by AI technology in the days to come. Whether the professions will remain the same or not, what changes may be brought about in the profession/ discipline and its literature, how the real world practices will change, whether the countries of the world are in the right courses to embrace the AI technology applications in the Accounting and Audit profession, what could be the policy implications, ethical concerns related to AI applications etc. are some of the questions that have been addressed in this study. The study contributes to the existing literature in a number of ways. Firstly, this study reviews and compiles relevant AI-Accounting & Auditing literature, published within the year 1992 to 2020, and summarizes the focused areas therefrom. This brings out the trend and nature of content found in the current Accounting & Auditing literature with regards to AI. Secondly, as the paper demonstrates the present AI application in the accounting and auditing profession while highlighting the significant areas, it will act as a reference point for future studies in the area. Another important contribution is that the paper, without delving deep into the nitty-gritty technical aspects of the AI-technologies, introduces the accounting and auditing people with the AI phenomenon. Finally, the review work assesses the readiness of the world in AI Technology for accounting and auditing while informing about the potential benefits to be derived and risks to be taken.

This prelude is followed by an analysis of the concept and historical development of Artificial Intelligence. After that, how AI fits into the Accounting and Audit profession/discipline has been presented. In the following section, some benefits and risks associated with the AI implementation have been outlined. To make the readers understand empirically, some examples of AI-implementation in Accounting & Auditing around the world have been compiled in the next section. How the stakeholders can adapt to the AI-induced disruption—is the topic of the following section. The penultimate section of this paper lists some areas where future research endeavor can be exerted. Finally, the paper ends with a conclusive remark.

2. About Artificial Intelligence

2.1. Definitional Analysis of Artificial Intelligence

Just like Artificial Intelligence itself, the definition of the concept is also ever evolving. In trying to define AI, different perspectives have been resorted highlighting different facets of the concept. Martinez (2019) in his definitional analysis of AI suggested that as long as the definition is flexible and covers the new development of autonomous AI, a general definition can be applied across fields and applications. He also put forth that "*What is AI*" is a challenging question in and of itself, but it's made even more complex by the fact that it's unclear who can or should answer it. In this regard, the author highlighted the importance of a definition from a legal perspective. In the study, he also pointed out the limitations of existing AI-definitions by Black's Law Dictionary, a Nevada statute, and a Louisiana statute. Finally, Martinez (2019) outlined various methods for coming up with a general definition. These include—defining "Ambiguity & Descriptors", a descriptive definition and a prescriptive definition. Upon analysis of all the then existing definitions of artificial intelligence, Grewal (2014) suggested AI to be the mechanical simulation system of gathering knowledge and information that also processes intelligence of the universe. It involves collating and interpreting and finally disseminating the knowledge, information and intelligence to the eligible parties in the form of actionable intelligence. Haenlein and Kaplan (2019, as cited in Zemánková, 2019) defined AI to be the ability of a system to accurately understand external data, learn from it, and apply what it has learned to fulfill specific goals and tasks through flexible adaptation. Zhang et al. (2020) define AI a bit differently by saying that AI is the result of successful uses of big data and machine learning (ML) technology to comprehend the past and forecast the future using massive amounts of data. Lee & Tajudeen (2020) said that AI allows machines to learn from their mistakes, adapt to new input, and execute human-like jobs. Large amounts of data can be analyzed thanks to the AI technologies, making patterns in the data more recognizable. Artificial intelligence, according to Elaine R. (2000, as cited in Chukwudi et al., 2018), is the study of how to make computers perform tasks better than humans. As a result, systems that think and act like humans (rationally) exist. Chukwudi et al. (2018) shared the perspective that artificial intelligence is a device's ability to do tasks that would normally be performed by the human brain. The capacity for knowledge and the ability to acquire it are two of such tasks. Other abilities include the ability to judge, comprehend relationships, and generate novel ideas. Brown and O'Leary (1995) in trying to extend a definitional analysis of AI, said that AI can be viewed from a number of perspectives. Four of such perspectives are—intelligence, research, business and programming perspectives. Crevier (1993) called AI "a multidisciplinary science". He also pointed out the fact that the various disciplines of AI lack a unified language, values, or achievement standards. Other branches of science have a standard discipline that acts as a

moderator and allows their research community to police themselves. That sobering impact is missing in AI, and it shows. AI, according to most definitions, is hardware and software that can learn, reason, adapt, analyze, make judgments, and execute complicated and judgment-based activities in the same way as the human brain can. When we combine this skill with today's vast volumes of data, it's simple to see how AI-powered devices might boost productivity and make life easier by automating routine tasks (Tone at the Top, 2017). Huq (2014) described AI as the science and engineering of creating intelligent machines, particularly computer programs that showcase intelligence. It also includes the phenomenon of employing computers to understand human intelligence. In the end, AI is a technology that is self-sustaining and evolving. The more it does, the smarter it becomes, to the point where machines are now teaching other machines and learning on the job.

2.2. Artificial Intelligence Technology through History

The chronological development of Artificial Intelligence can be segregated into two segments—the ancient history, where concepts of intelligent machines, mechanical devices with some limited degree of capacity could be found; and the modern history, commenced by the development of modern computers in the post-World War II era. The modern history has seen the development of intricate computer programs dedicated to solving difficult intellectual problems. This era has also produced tools for wide application across various fields. In the 4th century BCE, Aristotle in his work the *Prior Analytics* introduced syllogistic logic, which is considered to be the first formal deductive reasoning system (Jenkinson, 2009). Fast forwarded to the 19th century, Charles Babbage and Ada Byron designed the Analytical Engine in 1832, which was a programmable mechanical calculating machines. In 1854, George Boole developed a binary algebra representing the "laws of thought". In the second decade of the 20th century, we can trace the first use of the word "robot" in English in Karel Capek's play "R.U.R." (Rossum's Universal Robots). The Turing Machine was first proposed by Alan Turing in 1936-37 (AAAI, 2017). This machine served as the foundation for computer and computing ideas. In 1948-49, Neurobiologist William Grey Walter made his first robots, which he dubbed *Machina speculatrix* and named Elmer and Elsie (ELectroMEchanical Robot, Light-Sensitive). They were the first robots in history to be taught to "think" in the same way as biological brains do and to be capable of exercising free will (Inglis-Arkell, 2015). Isaac Asimov published his three laws of robotics and Turing published "Computing Machinery and Intelligence" in 1950. In a proposal, dated August 31, 1955, for the renowned Dartmouth Conference, John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude E. Shannon coined the term "artificial intelligence" McCarthy et al. (2006). The Dartmouth Summer Research Project on Artificial Intelligence, held in 1956, is largely regarded as the beginning of artificial intelligence as a discipline. One of the first, most well-known, and sustained projects

on AI and law focused on the use of AI in tax law (McCarty, 1977). The Knowledge-based System that was developed was dubbed "Taxman" (O'Leary & Karlinsky, 1992), and it was created in 1977 by L. Thorne McCarty who is considered to be "the Father of AI and Law", a Harvard University assistant professor at the time (Kuźniacki, 2019). After the democratization of computer and internet, the use of AI technology grew leaps and bounds. The digital revolution played significant part to the cause. Eventually, AI has come to compete with humans in chess competitions and other intellectual duels. Modern businesses are now relying on AI technology based solutions. Applications of cognitive technologies are thus becoming more and more widespread.

The establishment of conceptual underpinnings and various forms of clockworks and automatons occurred earlier in AI history, whereas the modern ages have applied those concepts and evolved based on the failures and accomplishments of the past. Currently, the discipline is marching ahead in the era of industry 4.0 and looking forward to the democratization of AI technologies across the globe.

2.3. Various Cognitive and Non-Cognitive Technologies at Modern Workplace

The study Makridakis (2017) is quite interesting due to the fact that it overviews the predictions made by the same author in 1995, for the year 2015, regarding the then forthcoming digital (information) revolution. While some of those predictions missed the reality, a number of them actually came into fruition. Due to the digital revolution, now we witness widespread application of technological tools and solutions in the organizations across various industries. Some of these ICT tools found in the modern enterprises are non-cognitive in nature whereas some have cognitive element within it. Rezaee et al. (2002) talked about the use of Extensible Markup Language (XML) and eXtensible Business Reporting Language (XBRL) with regards to furnishing financial information of organizations over the internet. The ubiquitous presence of the Internet of Things (IoT) has made it possible to integrate various technologies within the organization. Zhao et al. (2004) suggested that the traditional auditing faces threats and challenges from the prevailing application of real-time accounting (RTA), XBRL, Electronic Data Interchange (EDI) and AI. Electronic Data Interchange (EDI), Electronic File Transfer (EFT) and Image Processing etc. tools are being used in auditing and that has already changed the ways audit process is undertaken. The presence of various Computer-assisted audit tools (CAATs) has given rise to such concept of Continuous Auditing. Zhang et al. (2020) classified some of the major cognitive technologies in use today and enumerated their application as forms of AI-based solutions that can be found in the market currently. For Natural Language Processing—Nuance, Cortana, Alexa, AlphaSense; for Machine and Deep Learning—TensorFlow, Kensho, Microsoft Cognitive Services; for Artificial General Intelligence—Skymind, IBM Watson, Accenture myWizard; for Com-

puter Vision—Clarifai etc. applications are in use these days. Database Management Systems (DMBS), Cloud Computing, and Enterprise Resource Planning (ERP)—all these are becoming part and parcel of modern enterprises. Big Data, Blockchain and Machine Learning have warranted wider application of cognitive technologies in workplace. It is expected that soon every organization will be engulfed in a way or the other by the presence of AI.

3. How Artificial Intelligence Fits into the Accounting & Audit Disciplines

Artificial Intelligence is also known as Cognitive Technology or Cognitive Computing. It encompasses a very broad scope and not all aspects of it are important and relevant to accounting (Kokina & Davenport, 2017). Even though the technical aspect of the technology of Artificial Intelligence (AI) does not fall within the jurisdiction of traditional business discipline, the far reaching influence of AI has made itself a subject matter of business education and practices. The application of AI technology can be found across various business functions including—production, distribution, procurement, sales & marketing, accounting & finance, audit, research & development, human resource management etc. Accounting and auditing, being the integral part of a business concern is also exposed to the boons and banes of AI technology. Reddy et al. (2019) called AIS as an ontology of AI. Before focusing on how AI could possibly benefit or jeopardize the Accounting and Audit function of a business concern, we must look into the ways AI could be utilized in those areas.

3.1. Evidence from Existing Literature

Davenport & Ronanki (2018), in their Harvard Business Review story, suggests that organizations should focus on AI in terms of business capabilities rather than technological skills. In general, AI can help businesses meet three key objectives: automating business processes, getting insight through data analysis, and connecting with consumers and workers. Chukwuani & Egiyi (2020) examined the impact of artificial intelligence on the accounting industry. In doing so they showed the level of advancement taking place in the accounting industry in automating the accounting process. Finally, they outlined the accountants place in the modern automation and how the accountants of the 21st century can adapt to the widespread automation in the industry. Back in the 1990s O'Leary (1995) conducted a study showing the types of researches undertaken in the then contemporary scenario relating to AI in Accounting, Finance and Management. He found out that Accounting, Finance and Management had respectively 29.63%, 28.40% and 20.99% of studies being conducted relating to the use of AI, published in the *International Journal of Intelligent Systems in Accounting, Finance and Management* (*IJISAFM*). There, multiple agents, neural networks, knowledge-based system applications, case-based learning, machine learning, constraint logic programming etc. were the mostly looked into issues. Huang (2018)

looked into the application of AI in taxation. In order to present the case, the author listed evidences of empirical applications of AI in taxation in China. In Meservy et al. (1992), some of the earlier works on Expert Systems (ES) at the Brigham Young University have been highlighted. These include—use of PLANMAN for personal financial planning, EDP-XPERT for assisting computer audit specialists (CASs) in making judgment about control in advanced digital environment and ARISC for simulating auditor's evaluation of internal controls. Chukwudi et al. (2018), through a survey-based descriptive research, presented the impact of AI on accounting functions. In this study, it was seen that the application of artificial intelligence positively influenced the performance of the accounting functions of accounting firms in South East Nigeria. In a study conducted on the Malaysian organizations using various AI-based accounting software, Lee & Tajudeen (2020) found out that AI-adoption is not exclusive to the large organizations. They also observed that organizations were using AI-based accounting software to store invoice-images and automate the information capturing process altogether. Luan et al. (2020) talked about the challenges and directions of AI technology and big data in education research, policy-making and industry. These include Accounting and Audit education, policy and industry. Their argument is that in reaction to the innovations and dilemmas brought forth by the AI and big data revolution, academia, policy-makers and professionals from variety of disciplines must engage in effectual collaboration to fully actualize the potential of the AI and big data advancements. They also pointed out that there are several overlapping spheres of interest shared by the research, policy-making and industrial community. These shared interests demand collaborative approach but the major impediment to that is the lack of vision on the part of these groups and also lack of necessary knowledge and skills. Baldwin et al. (2006) in their study pointed out the fact that in the early 2000s, the then Audit Environment was becoming more and more complex due to the emergence of myriad of rules followed by high-profile audit failures. In order to ensure quality audit and assurance services the audit profession was under intense pressure. In that regard the authors solicited and encouraged interdisciplinary collaboration between Accounting and AI experts that would result in a cornucopia of fruitful research and development instead of mere theory and prototype development works mostly found in the existing literature. The authors of this study, through review of relevant literature, presented that there had been a number of attempts in developing AI based systems to support auditing and assurance tasks. While some of those attempts rendered fruitful, most were largely scattered and at the theoretical level of development. Kokina & Davenport (2017) categorized the types of AI application into four groups and also the level of intelligence achieved so far in the technology into another four groups. The applications are—analyzing numbers, digesting words and images, performing digital tasks and performing physical tasks. For the levels of intelligence, the categories are—human support, repetitive task automation, context awareness & learning and self-aware intelligence. None of the AI applications have yet

achieved the self-aware intelligence level but using the other three levels of intelligence many of the accounting & auditing tasks can be performed. Baldwin et al. (2006) outlined through review of literature, the following auditing tasks that could use the application of AI: Analytical review procedures (neural network), classification (genetic algorithm), materiality assessment (fuzzy expert system), internal control evaluation (expert system, fuzzy model), risk assessment (neural network, fuzzy neural network, expert system), going concern decisions (expert system, neural network, hybrid system, fuzzy clustering, statistical models), bankruptcy prediction (neural network, hybrid system that involves genetic programming and rough set theory, non-linear models, classification trees) and aggregating audit evidence (belief functions and probability). Makridakis (2017) investigated the extant and forthcoming AI advancements and the capability of machines to attain real intelligence. The study highlighted major views and scenarios of how AI may revolutionize human life. Among the various ways that AI may transform human milieu, the metamorphosis of the discipline and profession of accounting & auditing is a very important one.

Table 1 summarizes few research studies that looked into the application of AI in accounting and auditing. For the purpose, research studies conducted within 1992-2020, that are also available as Open Access Resources, were selected. There

Table 1. Summary of researches conducted in the areas of AI in accounting & auditing.

Studies	Main Focus of the Study	Discussed AI Technologies
Zhang et al. (2020)	• Holistic review of recent developments in AI, Big Data and Machine Learning. • Exploration of the evolution of accounting profession faced by various technological advancement. • Examination of inherent hurdles and opportunities of new technologies posed in front of accounting professionals and pedagogy.	• Machine & Deep Learning • Artificial General Intelligence • Blockchain Technology • Robotic Process Automation - Radio Frequency Identification (RFID) - Speech Recognition - Natural Language Processing - Artificial Neural Networks
Chukwuani & Egiyi (2020)	• Automation of Accounting Process. • Highlighting of impacts of AI on Accounting. • Adaptation to automation by the Accountants.	• Robotic Process Automation (RPA) • Expert Systems • Neural Networks • Robots • Fuzzy Logic
Lee & Tajudeen (2020)	• Impact of AI-based accounting software on organizations in Malaysia.	• Storing of Image and documents • Automation of Information Capturing • Machine Learning • OCR Technologies
Kumar Doshi et al. (2020)	• Investigating how AI creates opportunities and gives rise to threats in the profession, using 12 variables. • Examining the Accountants' aptitude to embrace technology, using six determinants.	• Overall AI application (no specific technology discussed)
Ucoglu (2020)	• Review of the present Machine Learning applications in accounting & auditing with focus on the Big 4.	• Machine Learning

Continued

Mohammad et al. (2020)	• Assessment of the impact of AI on the accounting professionals. • Extend relevant suggestions to the policymakers.	• Automation • Robotics • Machine Learning
Zemánková (2019)	• Introducing the use of AI in accounting and auditing, with special focus on blockchain technology. • Providing an analysis of audit aspects benefiting from AI application. • Highlighting the implication of blockchain in auditing. • Evaluating the AI endeavors of the BIG4.	• Decision support systems • Knowledge-based expert systems • Genetic algorithms/programming • Fuzzy systems • Neural networks • Robotic Process Automation (RPA) • Blockchain - Smart Contracts - Smart Audit Procedures
Reddy et al. (2019)	• Examining Accounting Intelligence's analytical applications and actionable insights from a more disruptive and decision-oriented approach. • Looking at the perspectives and experiences of the "4-Accounting Giants."	• Robotic Process Automation (RPA) - NLP - Speech Recognition • Accounting Intelligence Expert Systems (AI/ES) • Deep Learning • Cognitive Insights & Engagement
Ukpong et al. (2019)	• Reviewing various accounting and auditing problems and the call for AI application in the discipline. • Investigation of stakeholders' perspective regarding AI application in Nigerian Banks.	• Automation • Machine Learning • Data Mining • Cognitive Computing • Natural Language Processing • Robotics
Stancheva-Todorova (2018)	• A discussion of a few of the issues that the accounting profession faces in present day context • Shedding light on some likely future development tendencies in the domain of AI. • Drawing some conclusions on accounting education in the light of new intelligent technologies and their commercial applications.	• Automation • Expert Systems • Fuzzy Logic • Neural Networks • Machine Learning
Huang (2018)	• Application of AI in Taxation. • Case study from China and around the world.	• Automation • Facial recognition, Image and Text Recognition • Knowledge-based query addressing system
Chukwudi et al. (2018)	• Ascertain the effect of AI on the performance of accounting functions. • Ascertain the effect or Expert System and Intelligent Agents on the performance of the accounting functions.	• Expert Systems • Intelligent Agents • Neural Network • Fuzzy Logic • NLP • Genetic Algorithm
Kokina & Davenport (2017)	• Providing an overview of the emergence of AI in accounting and auditing. • Discussion on the impact of cognitive technologies on human auditors and the audit process itself. • Industry examples of AI implementation. • Looking at some of the potential biases that come with artificial intelligence development and application.	• Cognitive Technologies • Automation

Continued

Bizarro, P.A. and Dorian, M. (2017)	• Defining the benefits and risks occurring from the integration of AI in accounting and auditing.	• Automation
Greenman (2017)	• Exploring the impact of AI on the accounting profession.	• Automation • Cognitive Technologies • Document Review
Huq (2014)	• Presenting how AI aids in the development of accounting system. • Analyzing relative impact of AI on auditing and taxation.	• Machine Learning • Speech Recognition • Automation
Omoteso (2012)	• Review of existing researches and use of AI systems by the auditors. • Predicting future directions of research and software development in the area of AI. • Mapping of the development process of AI systems in auditing.	• Expert Systems (ES) • Neural Networks (NN)
Baldwin et al. (2006)	• Review of the accounting and audit problems that could use application of AI. • Breaking down and outlining audit tasks where various AI technologies can be augmented.	• Genetic Algorithms • Neural Networks • Fuzzy Systems • Hybrid Systems
Lam (2004)	• Investigating the ability of neural network to integrate fundamental and technical analysis in financial performance prediction.	• Neural Networks • Backpropagation algorithm
Zhao et al. (2004)	• Outlining threats & challenges to traditional auditing • Comparison and contrast between traditional and continuous auditing • Future outlooks on continuous auditing	• Continuous Auditing • Expert Systems
O'Leary & O'Keefe (1997)	• Analyzing relative impact of expert systems on auditing and taxation using Perrow's sociological framework.	• Expert System
Yang & Vasarhelyi (1995)	• Summarizing the then existing application of expert systems in accounting. • Classification of application of ES in accounting under five categories: Auditing, Taxation, Financial Accounting, Personal Financial Planning and Management Accounting.	• Expert System
O'Leary (1995)	• Taxonomy of papers/studies conducted in the areas of Accounting, Finance and Management relating to AI.	• Multiple Agents • Neural Networks • Knowledge-based and Expert Systems • Case-based Reasoning • Machine Learning • Constraint Logic Programming • Cognitive Models
Meservy et al. (1992)	• Application of AI in Accounting, Tax and Audit Services.	• Expert/decision support system • Simulation Model

Source: Author's Construction.

are plethora of research studies in the area of AI but not as many in the area of AI in Accounting & Auditing. In searching for the relevant papers, keywords and concepts such as Artificial Intelligence, Accounting, Auditing, Expert Systems in Business, AI application or cognitive technologies in modern business etc. were used. Though utmost care was applied in selecting the most relevant papers related to the topic, it is possible that few were left out. Nonetheless, as the objective was to bring out and highlight the commonalities and overlapping concepts addressed most often in the AI-accounting and AI-auditing literature, the selected papers serve the purpose quite aptly. According to Snyder (2019), the semi-systematic or narrative review approach is intended for issues that have been conceptualized and explored in different ways by different groups of researchers from other fields, making a full systematic review procedure impossible. Because it is impossible to review every single item that might be related to the issue using this method, a new strategy must be devised. Here, while doing the review the "Main Focus of the Study" and "Discussed AI Technologies" were stressed upon.

3.2. Focus Areas of Application of AI in Accounting & Auditing

Based on study of the existing literature, the most frequently mentioned areas of application include but are not limited to the following:

1) *Expert Systems* (*ES*):

Among various AI technologies applied in the realm of Accounting, the most developed one is the application of Expert Systems (ES). Tomás (1998) said that Expert Systems are computer programs that store an expert's knowledge and simulate his reasoning processes when solving issues in a certain topic. Expert systems are a subset of knowledge-based systems that include an expert's expertise in the system knowledge base. Empirical application of fuzzy expert system approach in assessment of Materiality is seen (Comunale and Sexton, 2005, as cited in Baldwin et al., 2006). Again in Changchit and Holsapple (2004, as cited in Baldwin et al., 2006) it is observed that an expert system of an auditor's internal control knowledge is an effectual mean of conveying knowledge to the managers. Besides these, an expert system can be used in audit planning, obtaining evidence, assessment of audit risk, audit opinion decisions, preparation of the audit report etc. tasks. In financial accounting, ES may be applied in designing AIS and financial statements, processing invoices and putting entries, assessing standards, developing worksheets etc. tasks. Finally, in cost and management accounting, ES has its application in inventory control, cost and variance analysis, diagnosis of management control systems, decision regarding investments etc. Though quite a number of research could be found in the area of audit expert systems, their use is still not prevalent due to the problem of lack of user neutrality as suggested by (O'Leary, 2003). Therefore, there is scope for looking into other AI technologies in solving accounting and auditing problems.

2) *Continuous Auditing*:

Rezaee et al. (2002) defined Continuous Auditing as the methodical collection of electronic audit evidence as a reasonable basis for rendering an opinion on the fair presentation of financial statements made in a paperless, real-time accounting system. They also suggested that Continuous Auditing is a thorough electronic auditing method that allows auditors to provide some level of assurance on continuous data while it is being disclosed or shortly after it is disclosed. Zhao et al. (2004) highlighted that continuous auditing is associated to paper-less accounting information systems, significant technical hurdles, lack of standards and guidance, increased value of real time financial information and timely audit report. Continuous Auditing can produce either an "evergreen report" or a "report on demand". Use cases can be across all three professional services commonly provided by independent auditors—assurance, attestation and audit services.

3) *Decision Support Systems*:

Decision Support System (DSS) is a computer-based system that assists in the decision-making process. It is a computer system that's interactive, adaptable, and versatile. Essentially, it is created with the goal of assisting in the resolution of a non-structured management problem in order to improve decision making. The ulterior motive of a DSS is to establish alternatives and outcomes so that a smart decision can be made whereas ES is established with the goal of automating decision-making and ultimately replacing the human decision maker. The use cases of DSS can be found in various unstructured accounting and audit tasks.

4) *Neural Networks* (*NN*):

A neural network is a machine learning system that replicates the organization of a human brain (composed of neurons and connections) and is capable of altering its structure to better accomplish the task it has learned. The more complicated neural networks get, and the more typically they consist of multiple "layers", the more the term "deep learning" can be applied (Deloitte, 2018). Koskivaara (2004, as cited in Baldwin et al., 2006) probed the application of neural networks in Analytical Review Procedure which is undertaken by the auditors while obtaining audit evidence. Chiu & Scott (1994) suggested application of neural network in risk assessment which is a fundamental part of the auditing process.

5) *Deep learning & Machine learning*:

Machine learning is a branch of science that focuses on detecting patterns in data and creating systems that can learn from them (Deloitte, 2018). Machine learning is about computers learning to think and act with minimal human intervention. ML is a subset of AI that focuses on a specific goal that is to instruct computers to accomplish tasks without explicit programming. On the other hand deep learning is a subset of ML and is about computers learning to think using architecture modeled after the human brain. ML can assist in transaction classification with the scope of control function (Zhang et al., 2020).

6) *Natural Language Processing* (*NLP*):

Natural language processing is a field of study that focuses on teaching artificial models to understand and process human speech (Deloitte, 2018). It is a vital AI technology tool that focuses on the replication of human natural language and communication methods (Chukwudi et al., 2018). Areas of application include—processing of unstructured text information, systematic and automatic retrieval and review of documents, identification of high risk cases that deviate from the target terms (Zhang et al., 2020).

7) *Fuzzy Logic*:

Fuzzy logic, according to artificial intelligence experts, is a technique of reasoning that resembles human thinking since its methodology mimics how humans make decisions. The truth value of variables in fuzzy logic can be any real number between 0 and 1, making it a type of many-valued logic. It's used to deal with the concept of "partial truth" or "degrees of truth", where the truth value can be somewhere between absolute true and absolute false. Baldwin et al. (2006) pointed out that for materiality decisions, assessing risk of management fraud, and for various other qualitative issues, fuzzy systems can be very useful.

8) *Genetic Algorithm*:

Genetic algorithm is a search heuristic based on Charles Darwin's theory of natural selection. This algorithm mimics natural selection, in which the fittest individuals are chosen for reproduction in order to create the following generation's children. Genetic algorithms rely on biologically inspired operators including mutation, crossover, and selection to develop high-quality solutions to optimization and search problems. Genetic algorithms are a suitable approach towards solving the problems of Account and Transaction Classification (Welch et al., 1998, as cited in Baldwin et al., 2006). In the same study it is suggested that genetic algorithm may have potential application in modelling auditor behavior in fraud decisions. Other applications of genetic algorithm include—bankruptcy prediction (Zemánková, 2019), going concern decisions etc.

9) *Robotic Process Automation* (*RPA*):

According to (PwC, 2017), RPA is a type of intelligent process automation (IPA) that depicts logic-driven robots that follow pre-programmed rules and work with primarily structured data. By redefining work and reassigning individuals to higher-value tasks, RPA takes productivity optimization to the next level. Process bots can execute rudimentary human-like operations such as interpreting, deciding, acting, and learning on their own. RPA is a technology solution that uses scripts to automate rule-based and standardized tasks. By replicating human actions while accessing different systems, documents, and applications, software robots can be readily trained or programmed to do rule-based, repetitive, high-volume operations (Chukwuani & Egiyi, 2020). According to Zemánková (2019), RPA is a software that can be used to automate established business processes by running other application software. RPA differs from AI in that it is process-driven while AI is data-driven. Data preparation for audits, file organiza-

tion, data integration from different files, basic audit tests in Excel, data copying and pasting, and manual annotations—all these are the use cases of RPA.

10) ***Hybrid Systems***:

All the audit tasks are not of the same nature i.e. some involve quantitative analysis, some involve qualitative judgment whereas some may involve both. In such cases hybrid system of AI technologies are more appropriate (Baldwin et al., 2006). Hybrid Systems may involve combination of any of the above discussed AI technologies.

4. Benefits and Caveats of Implementing AI in Accountancy and Audit & Assurance

4.1. Benefits

Several studies as cited in Omoteso (2012) pointed out various upsides of AI implementation in accounting and auditing. These benefits include but are not limited to—efficiency and effectiveness, consistency, structure for audit tasks, improved decision making and communication, enhanced staff training, expertise development for novices and shorter decision time. Chukwuani & Egiyi (2020) suggested that AI will have impact on accounting by reducing the possibility of fraud, improving the quality of accounting information and promoting the reform of traditional accounting and auditing. Mohammad et al. (2020) identifies that by keeping abreast of continuous improvements of AI in the field of accounting and auditing, accountants as well as firms will eventually be able to reduce the accounting costs, add value to the accounting industry by moving the focus of accountants from the existing monotonous tasks to data-driven and analytics-based decision. Bizarro, P.A. and Dorian, M. (2017) point out that at the metadata level, source documentation, paperwork processing, conference calls, emails, press releases, and news media from both internal and external sources can all be evaluated and compared, facilitated by the AI-driven automation. According to Makridakis (2017), those who embrace and implement AI widely and are ready to take entrepreneurial risks in order to transform breakthrough goods or services into global commercial success stories will continue to gain significant competitive advantages.

4.2. Risks or Insufficiencies

Several studies as cited in Omoteso (2012) pointed out various downsides of AI implementation in accounting and auditing. These risks or drawbacks include but are not limited to—prolonged decision processes as a result of exploring more alternatives, the huge cost of building, updating and maintaining systems, the inhibition of novices' knowledge base, the inhibition of developing skills of exercising professional judgment, the risk of the tools being transferred to competitors and the possibility of those being used against the auditor in a court of law for having over-relied on the evidence of decision aids. Bizarro, P.A. and Dorian, M. (2017) pointed out that no matter how much efficiency AI technolo-

gy can extend towards the accounting and audit tasks, it cannot replace the abilities of human beings to practice reasoning, express emotions, exercise professional skepticism and exert professional judgment. They also discussed about the possibilities of "technological unemployment". According to Kumar Doshi et al. (2020), Artificial Intelligence as a digital disruptor has a "double impacting potential"—it may create possibilities while also igniting threats. Thereby, it has the potential to complement or totally replace a profession, making the latter's long-term viability dubious. Agnew (2016, as cited in Kokina & Davenport, 2017) highlighted the fact that according to one of the Ernst & Young (EY) sources, the number of new recruits each year could drop by half as a result of AI advent, drastically altering the industry's employment model. According to Luo et al. (2018) some of the problems associated with the application of AI in the field of accounting include preliminary lack of experience, slow return against high investment, lack of required skills and qualities in the professionals. One of the obstacles of using AI in practice, highlighted by Huang (2018) is the frequent changes in law and regulations that would require also the AI system to be updated. Example can be the case of changes in tax laws. Zemánková (2019) pointed out that application of AI in accounting and auditing may result in creating possible income inequality, reduction in the need of labor, jeopardized financial safety etc. Also, AI application runs the risk of the algorithms being exploitative, deceptive, internally biased or containing human logic errors or imbedded human biases. Makridakis (2017) lists possible negative consequences of AI application that include-increased unemployment, wealth inequality, ending of human supremacy and approaching technological singularity. Mohammad et al. (2020) suggested that the major challenges facing the adoption of AI include development of effective strategic policy for AI, mobilizing skilled manpower, lack of motivation and commitment to AI from the leadership. **Table 2** summarizes the spectrum of benefits to be derived and risks to be confronted from the implementation of AI.

4.3. Some Other Concerns

In this day and age, when information is in abundance and disruptive technologies are emerging at a higher frequency than ever before in human history, the way people think and act also changes and thereby causing the need for reconceptualization of various understandings. In a virtual roundtable of experts in the field, insights about what the future holds for auditing were brought up and discussed (Accounting Today, 2017). There, it was agreed upon that the accounting and auditing profession will undergo tremendous changes due to the wide application of new technologies. The areas of concern thus revolve around—blockchain, automation, cognitive technologies, machine learning, data analytics, cyber security, sustainability, so on and so forth. As the AI technologies move forward by leaps and bounds, the need for addressing various associated issues also emerges. Some of the concerns associated with wide use of AI are discussed below:

Table 2. Summary of the benefits and risks associated with the implementation of AI.

Perceived Benefits	Probable Risks
• Cost savings and operational efficiencies. • Improved productivity. • Improved customer services. • Greater accuracy. • Flexible working style. • Process governance. • Manpower saving. • Risk management. • Metadata Analysis. • Moving focus away from repetitive, time-consuming and rules based tasks. • Reallocation of saved times and prioritize more complex and value-added tasks.	• Conflict of interest and/or threat to independence (on the part of the external auditor) in case of organization under greater monitoring by AI. • Extinction of conventional jobs/tasks. • Rise of income inequality and wealth inequality. • At the present level of intelligence in AI applications, it is not possible for the AI system to update itself in response to changes in laws, regulations and policies. So, frequent changes may hamper the process. • Greater cost commitment. • Lack of expertise on the part of the accountants and auditors. • Resistance from existing workforce.

Source: Author's Construction.

1) ***Blockchain Technology***:

Blockchain technology allows for the secure and cost-effective transmission of any value (data, assets, cash, and information) in real time (Zhang et al., 2020). All of the features of blockchain contribute to the development of a new generation of auditing that is based on continuous assurance. Professional auditing standards, on the other hand, are not equipped to incorporate these new changes into the old audit process (Zemánková, 2019). For blockchain to be transformative, it will need practically universal adoption and agreement on standards. There is a considerable learning curve associated with this adoption. The use of blockchain in accounting and auditing has the potential to change the nature of corporate reporting, payment technology, audit design, audit evidence, transaction validation, and many other facets of accounting and auditing. Real-time monitoring and audits, instant third-party verification, independent data extraction, population check for data instead of sampling, and many other things may be possible as blockchain technology develops in the coming years along with other emerging technologies such as AI, ML and so on. Another very useful application of blockchain in accounting & auditing and all in all business activities is the Smart Contracts. Nonetheless, before people and businesses commit their data to a blockchain based systems and solutions, there will be cyber-security and privacy concerns that demand reconciliation. Finally, the integration of nascent technologies with old infrastructure is always a challenge (Accounting Today, 2017).

2) ***Paradigm Shift in Ethical Concern & Fraud***:

Artificial intelligence in accounting and auditing raises a slew of ethical and moral concerns (Zemánková, 2019). What constitutes ethical practice in the

realm of AI is something that needs to be answered and be made aware of. Just as the applications and practices are changing, the ways in which frauds are committed are also changing. New forms of white collar crimes are emerging. Ucoglu (2020) called for ethical and regulatory guidance and oversight with regards to accounting and audit firms.

3) *Policy Formulation*:

Due to the widespread application of AI, blockchain, and other disruptive technologies, a need for policy formulation will emerge. Cyber security law, data protection law, artificial intelligence law etc. will need to be formulated and implemented. Policy formulation at both national and international level will be required to standardize the usage of cognitive technologies.

4) *Emergence of Big Data*:

Big data is a double-edged sword that is characterized by four Vs—large volume, high velocity, wide variety, and uncertain veracity (Zhang et al., 2020; Luan et al., 2020). It can be used to the benefit of modern entities and on the contrary can be considered to be threat if appropriate measures are not taken by the organizations to deal with the plethora of data.

5) *Emergence of Gig Economy and Professional Hybrids*:

Griffin (2019) suggested that wider AI application will cause remote working to become more prevalent. Digitation of work and emergence of gig economy will transform the jobs and workplace dynamics. Many of the works will become freelance and professional hybrids will be of much demand in that scenario.

5. Examples of AI Implementation in Accounting & Auditing around the World

Many countries have been competing in recent years to conduct artificial intelligence research and application, and the push for its usage is becoming increasingly stronger in academia (Luo et al., 2018). The accounting firms are also deploying resources at their disposal to venture into the development of AI based service solutions for their wide range of clientele. The big four accounting firms are expectedly the ones leading the AI implementation revolution in the field of accounting and auditing. **Table 3** summarizes some of the major breakthroughs the big four accounting firms have had in the recent years in the application of AI. Tools and technologies developed, integration of IT and AI in services etc. are also presented in the table.

Examining the Big 4 accounting firms' use of AI technologies unfolds two distinct tendencies. Firstly, the accounting profession is progressively investing in artificial intelligence (AI) and its integration into core business. Secondly, the Big 4 assert that AI is a critical determinant for future accounting success (Zhang et al., 2020). According to Griffin (2019), small businesses that do not adapt to changing times run the risk of being left behind. As technology has eventually caught up with accounting, it is now essential for organizations of all sizes to keep up with technology trends in order to stay competitive.

Table 3. Application of AI technology by the Big 4 Accounting firms.

Big 4 Firm	Application or adoption of AI technologies
Deloitte Touche Tohmatsu Limited	In March 2016, Deloitte and Kira Systems forged an agreement to bring innovation and machine learning to the workplace. Deloitte then developed *Argus*, a cognitive tool designed exclusively for auditing, based on the partnership (Ucoglu, 2020; Zemánková, 2019; Kokina & Davenport, 2017). *Guided Risk Assessment Personal Assistant* (*GRAPA*) is a Deloitte application that works with a database of 10,000 cases, each with roughly 50 risks, to aid auditors in comparing their selected risk strategy to other previously utilized risk methods (Zemánková, 2019). Besides these, Deloitte is looking into using machine learning technologies to help with data integration and structuring (Kokina & Davenport, 2017). Deloitte also wants to implement smart chatbots that will successfully guide staff through rules, law, auditing and accounting standards, and specialized literature (Deloitte, 2018). In addition to these Audit applications, Deloitte has been implementing AI technologies in other branches of their operations as well that include—*Similarity Observant Network Analytics Report* (*SONAR*) dedicated to finding labelling errors in databases and supporting the Tax and Legal operation, smart robot named *Edgy*, that has application for robotics-based automation within HR, a self-learning application called *DocQMiner* that can read through and analyze contracts and has application in the Risk Advisory services, a state-of-the art AI tool called *Eagle Eye* that uses the web for early detection of credit migrations, a smart tool called *BrainSpace* that is used in Financial Advisory Services to cluster unstructured information. Deloitte has also created the *Insight-Driven Organization* (*IDO*) framework to assist businesses in achieving their strategic objectives. Deloitte has also developed a voice analysis tool called the *Behavior and Emotion Analytics Tool* (*BEAT*) that uses deep learning technology to monitor and analyze voice interactions (Zhang et al., 2020). Some other technology solutions that put Deloitte in a special position include—Deloitte Signal, Deloitte Optix, Deloitte Connect and I-count (Bizarro & Dorian, 2017).
Ernst & Young	EY uses machine reading (e.g. QR codes and barcode labels). Drones are also used by EY for inventory observation and real-time analysis (Zhang et al., 2020; Zemánková, 2019). Whenever new regulations are issued, instead of re-examining all pre-existing contracts EY uses NLP to extract information and a human-in-the-loop to validate the results. This is an application of *NLP technology* by EY. *EY Helix GL Anomaly Detector* (*GLAD*) is a tool developed by EY that is capable of using its algorithm to detect fraudulent journal entries and furnish reasons for such detection (Ucoglu, 2020; Zemánková, 2019). EY has also implemented machine learning technology to detect fraud in order to boost professional productivity. Using machine learning, EY's *Fraud Investigation and Dispute Service* (*FIDS*) was able to identify questionable invoices with a 97 percent accuracy rate.
Klynveld Peat Marwick Goerdeler (KPMG) International Limited	KMPG views artificial intelligence as an entire ecosystem and therefore has developed the *KPMG Ignite* concept which is a portfolio of AI products and capabilities. The accounting firm works in collaboration with Microsoft to provide clients with integrated innovation such as—Intelligent Underwriting Engine, Sales Intelligence Engine, Sales Cycle Optimization Tool, Strategic Profitability Insights, and Digital Solution Hub etc. (Zemánková, 2019). KPMG is a proponent of adopting a broad set of AI capabilities using one single platform. In that regard they have used IBM's cognitive computing technology called *Watson* (Kokina & Davenport, 2017; Greenman, 2017). KPMG has also developed a new method of risk assessment. To detect, link, and depict four-dimensional risks (severity, likelihood, interconnectivity, and velocity), KPMG's *Dynamic Risk Assessment* (*DRA*) integrates actuarial theory, complicated algorithms, mathematics, and advanced data with analysis (Zhang et al., 2020). The "Tax Service" solution from KPMG can prepare VAT and corporate income tax returns automatically, as well as local additional tax calculation tables, trend analysis, and quick detection of any errors, risks, or abnormal conditions (Huang, 2018). KPMG developed *K-analyzer*, a tax analytic program based on RPA technology that can assess thousands of transactions in a span of minutes (Zhang et al., 2020). Besides these, KPMG uses—Payroll Tax Automator tool, Automatic Exchange of Information (AEOI) reporting tool, FBT Automator etc.

Continued

Pricewaterhouse Coopers	PricewaterhouseCoopers (PwC) offers a wide range of data and analytics solutions, both industry-specific and cross-industry. By employing RPA technology to collect data, PwC determines the filing status of all the entities, review their trial balance sheets and finally convert data into tax bases (Zhang et al., 2020). Because of its capacity to cut costs and refocus attention on tasks that provide value and job satisfaction, RPA can have a big influence on a Tax organization. RPA technology is also simple to implement and works with all financial systems and processes (PwC, 2017). PwC has created the *GL.ai* robot in partnership with H2O.ai, a Silicon Valley firm, to integrate AI technology into accounting practice. *GL.ai* uses machine learning (ML) technology to absorb PwC's global knowledge and experience, stimulating the thinking process and making conclusions in the same way that an experienced auditor would (Zhang et al., 2020; Zemánková, 2019). PwC also created another technology called the *Cash.ai* that automates cash audits, including cash balances, bank reconciliations, bank confirmation letters, foreign exchange, and the bank's financial health (Zemánková, 2019). Besides these, PwC successfully leverages Natural Language Generation (NLG) by implementing AI power engine *Quill* developed by Narrative Science. *Automated narratives* for anti-bribery and anti-corruption (ABAC) reporting have also been developed by PwC (Zhang et al., 2020). *Halo* is used by PwC to analyze accounting journals, the majority of which is traditional human support-based business intelligence (Kokina & Davenport, 2017).

Source: Author's Construction.

6. Adapting to the AI Disruption

Disruptive technology is a type of innovation that drastically changes how customers, industries, or businesses work. Because it has features that are clearly superior, disruptive technology sweeps away the systems or behaviors it replaces. AI has been dubbed by many "an enabler for disruptive innovation". Readiness of the world against AI technology disruption needs to be assessed properly in order to navigate the unchartered territory well. The job description of today's accountant differs significantly from that of a 20-year-ago accountant. Accountants will have a different role in another 20 years. Over the next ten years, their job description will shift dramatically. Consulting, business development, advisory services, and risk management will warrant more attention. Specialization and the use of technology will be required of accountants. Different people have different opinions about how the accountant's job will change (Greenman, 2017). Based on recent study conducted from the University of Oxford, accountants have a 95% risk of losing their jobs as machines take over number-crunching and data processing (Griffin, 2019). However, as a recent Deloitte report pointed out, technological advancements have historically eliminated some occupations while creating others. There's no reason to believe this pattern won't continue. Even if ground breaking AI technology emerges in the coming days, it is not quite possible to outright democratize the application thereof. It will take some time before widespread application is seen. One of the reasons for that is the lack of preparedness on the part of the stakeholders. This allows for the stakeholders to adapt to the changing ecosystem.

When the advancement in a field reaches the tipping point, the only thing that remains to do on the part of the practitioners of that field is to adapt quickly.

Accountants and auditors, along with their stakeholders, in adapting to the changes shaped by the emergence of AI technology and preparing for the greater AI-Accounting & Audit integration, may resort to the following:

1) Qualitative improvements have to be brought forth by the accountants and auditors in terms of developing their professional skills, management skills, IT skills, analytical and decision making skills (Chukwuani & Egiyi, 2020; Zhang et al., 2020).

2) One of the groups from whom greater adaptation is desired is the accounting academia. Faced with the challenges of AI technologies and pressures from professional bodies, employers and other stakeholder groups, accounting educators are in need to review and re-conceptualize their curricula and syllabi to cater to the needs and demands of the AI-driven markets and industries. AACSB (2014, as cited in Stancheva-Todorova, 2018) calls for an interdisciplinary approach in disseminating knowledge where input from professionals and pedagogues will be needed from various areas including information systems, statistics, computer science and engineering, ethical issues and big data. Academia must not focus only on the traditional teaching of accounting information systems but also on data analytics, information & technology management among many other things. AI technology concepts have to be incorporated in the business education to familiarize the potential Accounting & Audit practitioners and researchers with the world of Artificial Intelligence. This would open the door for extensive crossing of paths between AI practitioners and Accounting and Auditing practitioners. Finally, Capstone Projects involving the industry leaders could be introduced to present the practical problems faced in the organizations and let the students have a go at solving them.

3) The accounting and audit tasks and processes have to be dismantled into individual executable parts. Abdolmohammadi (1991, as cited in Baldwin et al., 2006) argued that even though the study of audit decision aids has been going to for some time, there exist lack of systematic model identifying different audit tasks for the decision-aid development process.

4) Integration of and collaboration with AI researchers in developing AI-in-Accounting-and-Audit literature has to be ensured. This will contribute towards bridging the gap between business and computer science.

5) Exploring rather unpopular AI approaches in Accounting, besides the more explored ones like expert systems, is one way to go ahead.

6) Costs to be incurred and benefits to be derived from the application of AI in an enterprise has to be quantified. If such cases are presented to the business community, greater interest in the AI technology on the part of the people at the helm of affairs at the enterprises could be kindled. Omoteso (2012) concurred that such efforts need to be exerted to reduce the vacuum in AI-Accounting & Auditing literature.

7) Accounting and Audit firms, professional bodies have to rethink and conceptualize their professional development and trainings in light of contemporary

AI application in accounting and auditing.

8) National policy and strategy on implementation of AI Technology have to be introduced.

9) To encourage organizations and accounting firms to use AI in their audit operations, existing auditing standards that demand certain labor-intensive procedures will need to be changed (Bizarro & Dorian, 2017).

10) Kumar Doshi et al. (2020) outlined six points as the accounting profession's path towards digital success. Those are—digital strategy mapping, pilot project creation, harnessing right capabilities, becoming a data virtuoso, developing digital enterprise and planning an ecosystem. All these apply to the AI implementation as well.

11) Zemánková (2019) stressed on the need of regulatory body overseeing the development of AI with regards to application in accounting and auditing.

7. Future Research Avenues

As the field is still new, most of the existing AI-accounting and AI-auditing literature revolve around understanding the concepts, finding out the use cases, potential impacts and so on. There are few studies that have looked into AI-implementation at specific industries in specific countries but there has not been any study that looks into the determinants of such AI-implementation. Besides, there remains lack of research that ties AI-implementation with firm performance or efficiency. The paucity of such studies is justified by the fact that AI application is yet to be widespread. In order to enrich the AI literature in the area of accounting and auditing, case study type research needs to be conducted more. Organizations based in many developed countries are offering and engaging in AI based solutions more and more. Their success and failure stories along with the contributing factors need to be well documented and served to the many stakeholders so that wider awareness of the phenomenon can be achieved that can eventually contribute towards greater implementation of AI in accounting and auditing disciplines.

Future research studies should focus more on the interdisciplinary collaborative approach. In doing that the following issues could be addressed to a greater length:

1) What could be the implications of AI technology implementation on accounting as well as auditing standards?

2) Examining various kinds of bias in AI (e.g. data-driven bias, bias through interaction, emergent bias, and conflicting-goals bias) and the role of transparency as suggested by Kokina & Davenport (2017).

3) Compilation and assessment of case studies of AI implementation success and failures across various industries in the area of accounting and auditing.

4) Finding out the determinants of AI implementation in accounting and audit functions of business organizations.

8. Conclusion

Anything that can be turned into data, according to some technology analysts, will eventually be taken over by machines. That leaves imagination and judgment, which are human-only domains and are frequently what distinguishes one organization from another. AI, like spreadsheets and databases, is a tool that is only valuable if people know how to use them to streamline business processes. Accountants and auditors cannot be replaced by artificial intelligence when it comes to exercising human creativity and judgments. Technological, regulatory, and economic shifts will continue to test the profession's historical approaches and ways of thinking, which is a good thing. The market's response to these changes will ultimately influence how audits are carried out. Accountants and auditors must be able to respond quickly to changes in user demand as well as the creation of new and emerging metrics of organizational performance beyond traditional financial statements. Centralization and standardization are required as the auditing profession moves away from the apprenticeship model and toward areas with deeper specialization. Accountants and auditors will see a renaissance in the next decades, with huge opportunity for individuals entering the profession to drive innovations and progress (Accounting Today, 2017). The essential concept at the heart of auditing—enhancing information confidence—will remain unchanged. However, as technology and analytics continue to advance, the way engagement teams perform audits will change. Auditors' capacity to exercise judgment and professional skepticism will be more vital than ever as they use new technologies. In the field of accounting, AI will not replace accountants; rather, it will shift the focus (Greenman, 2017). No matter how much disruption to the profession AI causes in the future, it is quite unlikely that the need for human professionals will abolish. Therefore, as a society, we must continue to use AI to ensure that value and efficiency always come first.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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