

# Blockchain adoption in auditing: A systematic literature review – Supplementary information

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This article presents a comprehensive overview of blockchain technology (BT) adoption in auditing, focusing on three key stages: pre-implementation, implementation, and post-implementation. From an initial pool of 2,610 sources, 63 relevant articles were selected and analyzed from the Scopus database. The findings reveal a promising and multidisciplinary research field, primarily driven by academic scholars, with limited practitioner involvement. The predominance of review and conceptual studies underscores the need for more empirical research. This study introduces a framework for BT adoption in auditing. It offers valuable insights into the adoption process – from when organizations justify adopting BT in auditing to fully leveraging its potential and realizing its benefits. Furthermore, the study outlines a future research agenda with 35 research questions to develop a comprehensive approach to BT adoption in auditing.

## Table of contents

<b>Appendix A:</b> Review articles on BT adoption in auditing .....	3
<b>Appendix B:</b> Conceptual articles on BT adoption in auditing .....	6
<b>Appendix C:</b> Empirical articles on BT adoption in auditing.....	10
<b>Appendix D:</b> Research streams, modus operandi, and future research agenda for BT pre-implementation .....	15
<b>Appendix E:</b> Research streams, modus operandi, and future research agenda for BT implementation.....	17
<b>Appendix F:</b> Research streams, modus operandi, and future research agenda for BT post-implementation.....	19
References.....	21

## Appendix A: Review articles on BT adoption in auditing

Authors	Clusters*	Objectives	Main Findings	Approach
(Bonsón & Bednárová, 2019)	#1 (red) #2 (blue)	Providing general insights into BT and the extent to which it might transform the accounting system.	A private BT is a solution for improving audibility, control automatization, and data reliability. It can reduce costs and human errors and help to avoid the risk of manipulation or fraud. BT also faces challenges like scalability, flexibility, a suitable architecture, and cybersecurity.	CLR
(Schmitz & Leoni, 2019)	#1 (red)	Exploring BT and its main implications for the accounting and auditing profession.	BT improves the efficiency of recording, reconciling, and auditing accounting data. It also allows the reduction of cost and time while executing these tasks. It limits the risk of human errors.	CLR
(Pimentel & Boulianne, 2020)	#3 (green)	Identifying current trends and recommendations for future research on BT in accounting.	More research is needed on the impact of BT on corporate governance or the intersection of accounting and society.	CLR
(Desplebin et al., 2021)	#3 (green)	Examining the potential impact of BT on accounting and auditing.	The effect of BT includes a partial relief from financial statement audit duties; standardization of financial data formats; real-time access to real-time auditing; decrease in the annual audit preparatory work and easy tracking of the origin and history of operations; of some internal control functions; and facilitation of reporting.	CLR
(Fullana & Ruiz, 2021)	#1 (red) #2 (blue)	Analyzing the advantages and potential issues of BT application in Accounting Information Systems (AIS).	The main advantages of a triple-entry accounting system based on BT are transparency, precision, efficiency, flexibility, and data immutability. However, due to the foreseeable adoption of BT, accountants and auditors must acquire new skills.	CLR
(Pizzi et al., 2021)	#2 (blue) #3 (green)	Analyzing the impacts of digital transformation on managerial auditing.	The research reveals the four independent research areas: continuous auditing, fraud detection, data analytics, and technological innovation. The impact caused by digital transformation can be seen as opportunities rather than limitations.	SLR
(Tiron-Tudor et al., 2021)	#1 (red)	Facilitating BT innovation absorption in accountancy organizations by providing tools that	Managers should develop a plan for BT adoption that takes advantage of employees' skills and competencies, implements procedures, and actively decides how to lead workplace	SLR

		allow an organization to manage the change.	dynamics, personalities, and responsibilities.	
(Bellucci et al., 2022)	#2 (blue) #3 (green)	Defining potential opportunities for further scientific investigation and providing a framework of BT's impact on accounting practice.	The advantages of emerging BT include reducing repetitive tasks, eliminating reconciliation, enabling real-time accounting and continuous auditing, testing the entire database instead of a sample, and reducing manual errors. Additionally, the role of auditors cannot be completely replaced.	SLR
(Garanina et al., 2022)	#2 (blue) #3 (green)	Identifying current trends, analyzing and critiquing the key research topics, and discussing future research on BT in accounting.	The most discussed topics are the changing role of accountants, new challenges for auditors, and the opportunities and challenges of the BT application. BT will influence and change accounting and auditing. Despite expecting these professions to be fully automated, accountants and auditors cannot be replaced.	SLR
(Lardo et al., 2022)	#1 (red)	Identifying main research areas, understanding, and highlighting the most relevant topics of BT in management and accounting.	The state of knowledge does not include the engagement of regulators, auditors, and public administration to use BT's potential. The research should be examined from a broader perspective.	SLR
(Lombardi et al., 2022)	#1 (red) #2 (blue) #3 (green)	Identifying trends and research areas and constructing an agenda for future research on BT in auditing.	The issue of BT disruption in auditing is a relatively unexplored research trend. Audit procedures, especially those suited to digitalization and BT adoption, may need to be reconsidered.	SLR
(Mugwira, 2022)	#1 (red) #3 (green)	Providing an overview of the research on Internet-Related Technologies (IRT) adoption in auditing.	The six broad research streams explored, and future research avenues comprise big data analytics in auditing, IRT, risk assessment and fraud, the effects of IRT on audit quality and efficiency, and the Impacts of IRT on continuous auditing, cloud auditing, and audit support systems.	SLR
(Sargent, 2022)	#2 (blue)	Examining the features of BT from the viewpoint of those responsible for external financial reporting and their auditors.	BT can improve data collection, storage, sharing, reconciliation, and security. It can also simplify and speed up auditing procedures, mitigating the year-end crunch and improving audit efficiency and quality.	SLR
(Secinaro et al., 2022)	#1 (red)	Identifying the current state of BT adoption in auditing research and accounting and	The most discussed topics include BT definition and characteristics, business models and processes, the impact of BT on auditing and accounting, type of BT and governance, connection	SLR

		providing future research insights.	with other technologies, and link with accounting theories. The main future research should be related to BT integration with audit activities, as well as the impact of BT on auditors and audit activities.	
(Silva et al., 2022)	#2 (blue) #3 (green)	Evaluating the current stage of BT application and implication for auditing.	Future research should include the adoption of Audit 4.0, the use of smart contracts as auditing procedures, the exploration of distributed consensus accounting records, the application of triple-entry bookkeeping in BT, and the investigation of privacy concerns for auditors in permissioned BT.	SLR
(Spano et al., 2022)	#1 (red) #3 (green)	Presenting an overview of BT in accounting, accountability, and assurance.	BT is still a developing topic. A new research stage deserving more investigation is the interaction of BT with other emerging technologies, such as virtual reality and the metaverse.	CLR
(Hakami et al., 2023)	#3 (green)	Examining the present condition of BT applications in auditing by analyzing journal publications.	Research on BT in auditing has quickly increased but is still in its initial phases. On the one hand, there are more and more research topics involving BT, audit, and smart contracts. On the other hand, there are fewer involving data analytics, governance, hyper ledger, distributed ledger, and financial reporting.	BLR
(Han et al., 2023)	#1 (red) #3 (green)	Investigating how BT impacts accounting and auditing and how it can improve transparency, trust, and decision-making in those fields.	Four key themes related to changes in record-keeping resulting from BT adoption were identified: the event approach to accounting, real-time accounting, triple-entry accounting, and continuous auditing. BT can mitigate information asymmetry and improve collaboration.	SLR
(Jayasuriya and Sims, 2023)	#1 (red)	Highlighting trends, differences, and gaps between academic literature and industry reports about perspectives of BT adoption in accounting and auditing.	It is essential to explore nine key research areas: data management, financial applications, sustainability, accounting and auditing, business and industry, education, governance, privacy and security, and disruptive technology.	SLR

\*Note: The cluster was assigned to the article if the article mainly focused on the cluster topic and issues. There are three clusters discussed in Section 6 below: # 1 (red) – BT pre-implementation in auditing, # 2 (blue) – BT implementation in auditing, and # 3 (green) – BT post-implementation in auditing.

**Source:** own work

## Appendix B: Conceptual articles on BT adoption in auditing

Authors	Clusters*	Objectives	Main Findings	Approach
(O’Leary, 2017)	#1 (red)	Establishing and investigating the usage of BT for transactions in accounting and supply chains.	BT is an emerging and rapidly growing technology.	Discourse analysis
(Rozario & Vasarhelyi, 2018)	#1 (red) #2 (blue) #3 (green)	Proposing the application of smart contracts to improve auditing.	Smart contracts based on BT can enhance audit quality by providing timely and transparent auditing procedures.	Discourse analysis
(Yu et al., 2018)	#2 (blue)	Shedding light on the potential application of BT in and possible impacts of BT on financial accounting.	BT could solve the trust problem, reduce errors in disclosure and earnings management, increase the quality of accounting information, and mitigate the issue of information asymmetry. However, BT will change the range of auditors’ and accountants’ duties. The threat is a problem with regulations.	Discourse analysis
(McCallig et al., 2019)	#1 (red)	Developing an accounting information system design will enhance the faithfulness of financial reporting information.	Three design ideas were developed. The first one states that the information will be provided by many entities, independent from the reporting entity, holding the necessary information to confirm the entity’s claims. The second design predicts that the financial network and accounting process that supports the entity’s claims will be more transparent to the information users. The third one insists that the information will be stored on BT, which uses a transparent and public method of recording and cannot be altered.	Modeling
(Rozario & Thomas, 2019)	#2 (blue)	Envisioning the future financial statement audit by proposing an external audit supported by BT.	BT in external audits can potentially improve audit quality and reduce the expectation gap between auditors, financial statement users, and regulators. It also can autonomously disclose the results of audit procedures near real-time on the tamper-proof BT ledger.	Modeling

(Tan & Low, 2019)	#1 (red)	Examining the prediction that BT will transform accounting information systems (AIS) and the auditing profession.	BT will modify the current AIS by reducing costs, errors, and risk of fraud through validation and immutability, improving audit efficiency and effectiveness. However, BT-based AIS does not guarantee that financial reports will show an accurate and fair view because AIS and processes still need to be tested, and accounting judgments must be reviewed.	Discourse analysis
(Bonyuet, 2020)	#2 (blue) #3 (green)	Assessing the impact of BT in the audit profession, including new risks, changes, and opportunities.	BT can be used to auditors' advantage. Due to the increasingly complicated business world, auditors need effective and reliable tools. Auditors should learn about and understand the impact of BT on a client's business.	Discourse analysis
(Cao & Cong, 2020)	#1 (red)	Presenting a BT architecture to automate auditing.	BT is an emerging technology providing peer-to-peer communication, auditing collaboration, and financial reporting without a trusted third party (decentralization).	Modeling
(Fuller & Markelevich, 2020)	#1 (red) #2 (blue)	Investigating the potential impact of BT on the accounting profession.	The potential benefits of BT are data reliability and efficient and effective verification of transactions. However, the main challenges are scalability and cost integration.	Discourse analysis
(Kend & Nguyen, 2020)	#3 (green)	Observing stakeholders concerning the impact of BT, big data analysis (BDA), artificial intelligence (AI), and robotics on audit and assurance services.	BT, BDA, AI, and robots positively impact auditing. However, the participants in this study are not convinced that BT can be applied in auditing practice.	Exploratory research
(White et al., 2020)	#2 (blue)	Exploring the technologies underlying private BT and auditor's assessment and reaction to the risks inherent in BT utilization.	The utilization of BT for business processes is still in its infancy. The main advantages are improved efficiency, transparency, and lower costs. Despite the benefits of BT adoption, there are some risks: technological risks, data security risks, interoperability risks, and third-party vendor	Discourse analysis

			risks. That is why auditors should be equipped with the knowledge and expertise to assess risk in BT.	
(Zhang et al., 2020)	#2 (blue)	Exploring the evolution of the accounting profession following the emerging technologies and identifying challenges and opportunities posed by these technologies.	BT changes the accounting profession by reengineering accounting procedures, reducing accounting information errors and distortions, improving accounting efficiency, and promoting the transformation of accounting career structures. It also will minimize verification costs, enhance the authenticity and reliability of the data, provide clarity and transparency of information, and detect fraud and errors. BT will enable large-scale and real-time automated audits.	Discourse analysis
(Cangemi, 2021)	#1 (red)	Pointing out the potential advantages of BT in auditing, new risks, and the need for additional controls.	The key takeaways are finding companies and teams who are experts in the emerging subjects of BT and digital assets. BT involves many entities that add to complexities and risks, and regulations must evolve.	Discourse analysis
(Dunn et al., 2021)	#3 (green)	Examining students' opinions regarding the implication of Bitcoin and BT on auditing.	The students have a problem defining the impact of Bitcoin and BT audit procedures.	Discourse analysis
(Maffei et al., 2021)	#2 (blue) #3 (green)	To investigate the effects of BT adoption in accounting and auditing practices, including benefits, threats, and risks.	BT must change old practices and find new ways to take advantage of itself instead of being overwhelmed. Given their professional conscience and experience, auditors and accountants cannot be replaced by BT. Specialists must adjust to new technology and change or improve old methods and practices.	Discourse analysis
(Roszkowska, 2021)	#2 (blue) #3 (green)	Exploring the audit-related causes of financial scandals and advising on how emerging technologies can provide solutions.	BT and artificial intelligence solutions can effectively solve financial reporting and audit-related problems.	Discourse analysis
(Singhvi et al., 2021)	#3 (green)	Presenting different trends and potential	Auditors need to understand new technologies. Accountants	Discourse analysis

		of BT in the audit field	and auditors should reskill and prepare for traditional accounting and auditing changes.	
(Liu et al., 2022)	#1 (red)	The potential impact of BT on accounting and auditing processes is examined using transaction cost theory as a theoretical framework.	BT has a positive potential to influence accounting and auditing practices. BT can provide quality, safety, and traceability of information by allowing auditors to access transaction data. BT will increase the timeliness of financial reporting due to the ability to process information faster. BT can potentially decrease the probability of restatements and thus improve reporting quality. It is expected that as quality will increase, audit fees will decrease.	Discourse analysis
(Pan et al., 2023)	#2 (blue)	Proposing a triple-entry accounting protocol to allow users to report Bitcoin transactions to a third-party auditor to comply with regulations such as the travel rule.	Triple-entry accounting protocol allows the auditor to easily detect anomalies and identify the non-compliant parties, whilst BT provides a transparent and immutable record of these anomalies. It preserves privacy and offers an interoperability layer for information exchange.	Modeling

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**Source:** own work

## Appendix C: Empirical articles on BT adoption in auditing

Authors	Clusters*	Objectives	Main Findings	Approach	Country
(Tiberius & Hirth, 2019)	#2 (blue) #3 (green)	Examining changes in auditing practices expected as a consequence of digitalization.	Although no far-reaching changes are expected, it is anticipated that an annual audit will evolve toward a continuous audit approach. Digitalization will not replace the auditor but rather will provide relief and support. Respondents in this study did not see major threats.	Delphi study  Descriptive statistics	Germany
(Austin & Williams, 2021)	#2 (blue)	Investigating how management and auditor communications regarding a company's use of BT affects nonprofessional investor judgments.	When BT references accompany a technology-related critical audit matter, nonprofessional investors indicate less investment.	Laboratory experiment	USA
(Dyball & Seethamraju, 2021)	#2 (blue)	Examining the impact of client use of BT on audit risk and audit approach.	Clients using BT are perceived to be riskier than other clients, and inherent and control risks are amplified because no accounting and technical standards exist for BT applications. This undermines the benefits of BT, such as data integrity and validation. Audit firms have yet to develop the capability to ensure BT transactions, which impacts detection risk.	Semi-structured interviews  Qualitative content analysis	Australia
(Ferri et al., 2021)	#1 (red) #2 (blue)	Providing a view on the auditing profession's readiness to embrace "disruptive" technologies and examining the factors that motivate auditors to use BT.	Performance expectancy and social influence are the main predictors of auditors' intention to use BT. Auditors' effort expectancy concerning BT adoption appears to be a reliable predictor.	Survey research  TAM3 UTAUT PLS-SEM	Italy
(Gauthier & Brender, 2021)	#2 (blue) #3 (green)	Investigating how auditors are assessing the	Auditors indicate the growing demand for information technology in	Semi-structured interviews	Switzerland

		relevance of the current auditing standards in light of the emergent use of BT.	auditing standards. Auditors have become more advanced in understanding BT, especially its impact on audit risk.	Qualitative content analysis	
(Meiryani et al., 2021)	#1 (red)	Analyzing the auditor's perception of BT adoption can affect audit quality at the Big Four.	Auditors' perception of the adoption of BT has a significant positive effect on audit quality.	Survey research PLS-SEM	Indonesia
(Pimentel et al., 2021)	#2 (blue)	Systematizing the issues relating to the BT-based assets in auditing and synthesizing the potential auditor's consideration.	Permission for auditors to verify the client's cryptographic key can solve problems with the existence, ownership, and valuation of crypto assets. Auditors should be careful of fraud in internal controls, but adequately vetting clients can reduce audit risk.	Interviews and focus groups Qualitative content analysis	Canada
(Tušek et al., 2021)	#2 (blue)	Investigating the differences in the analytical procedures' application and its usefulness for auditing BT, as an emerging technology, between external and internal auditors.	Croatia's external and internal auditors know that the analytical procedures used to audit BT require excellent knowledge of new technologies. Applying advanced analytical techniques will increase the efficiency and effectiveness of BT-supported companies. External auditors are more ready for BT than internal auditors.	Survey research Factor analysis Nonparametric tests	Croatia
(Abdennadher et al., 2022)	#2 (blue) #3 (green)	Analyzing the perception of accountants and auditors toward the adoption of BT.	BT impacts the accounting profession by recording transactions, storing documents, and providing security. BT changes audit processes and strategy and can supplement traditional auditing by providing a low-cost, decentralized audit process and automated audit evidence.	Semi-structured interviews Qualitative content analysis	United Arab Emirates
(Alshurafat et al., 2022)	#1 (red)	Examining the impact of technostress on auditors'	Technostress influences the perceived usefulness and ease of using BT. Perceived ease or usefulness are significant predictors of attitudes	Survey research TAM	Jordan

		acceptance of the use of BT.	toward decisions about use. However, perceived usefulness is an important predictor of behavioral intention to use BT.		
(Dyball & Seethamraju, 2022)	#2 (blue)	Investigating the impact of client use of BT on financial statement audits.	BT is distinctive and poses risks not encountered before in audit engagements. Audit clients that use a BT are a minority, reflecting the experimental adoption stage in Australia.	Semi-structured interviews  Qualitative content analysis	Australia
(Kabir et al., 2022)	#3 (green)	Examining how integrity and internal audit transparency affect internal audit quality and assessing the potential of BT in this domain.	Integrity and internal audit transparency substantially influence audit quality. BT has been discovered to moderate the relationship between integrity and audit quality.	Survey research  PLS-SEM	Bangladesh
(Salim et al., 2022)	#1 (red) #2 (blue) #3 (green)	Examining the mediation and moderation roles of the perceived cost on the relationship between organization technology readiness and the intention to adopt BT.	Perceived cost is not a mediator but moderates the relationship between an organization's technology readiness and the intention to adopt BT.	Survey research  PLS-SEM	United Arab Emirates
(Dong & Pan, 2023)	#3 (green)	Analyzing the new audit problems and effects of the BT used on the audit.	Applying new technologies to the audit industry may lead to increased inherent and control risks.	Survey research  Validity Test, cumulative variance	China, Australia
(Juma'h & Li, 2023)	#2 (blue)	Examining factors that influence auditors' intention to use BT.	Auditors' knowledge about BT is positively associated with their intention to use it, indicating their optimism about this technology. Their professional skepticism does not affect intention, but the perceived adequacy of accounting standards has a negative effect. This also weakens the impact of BT knowledge on	Survey research  Average Variance Extracted (AVE)  Composite Reliability (CR)  PLS-SEM	USA

			intention, revealing the status quo bias in BT use.		
(Parmoodeh, 2023)	#1 (red) #3 (green)	Exploring a prospect of BT on audit practice.	Adopting BT can potentially impact audit procedures, for example, through more automated verification processes and decreased audit budget time.	Interviews Qualitative content analysis	United Arab Emirates
(Rahman & Ziru, 2023)	#1 (red)	Examining how clients' degree of digitalization and audit firms' expertise in information technology influence audit quality.	Clients with high digitalization attain higher audit quality. Additionally, a significant and positive correlation exists between audit fees and audit quality, indicating that audit quality is higher when an audit firm's IT infrastructure is mature and well-developed.	Data from CSMAR (China Stock Market & Accounting Research Database) Statistical analysis, i.e., correlation, regression	China
(Shbail et al., 2023)	#1 (red)	Examining how technostress affects auditors' plans to adopt BT technology.	Technostress affects the perceived usefulness and ease of use of BT. Perceived usefulness and ease of use significantly predict attitude toward adoption decision, whereas attitude toward adoption decision significantly predicts the behavioral intention to adopt BT.	Survey research TAM AVE CR	Jordan
(Zayed & Othman, 2023)	#3 (green)	Analyzing the effect of BT in innovating accountants' skills as a multimethodology study in the industrial companies listed on the Amman Stock Exchange.	Practitioners believe that implementing BT technology will innovate accountants' skills. However, BT is a replacement for bookkeeping and reconciliation work, which could threaten accountants' work.	Interviews	Jordan
(Akteer et al., 2024)	#1 (red)	Examining the organizational adoption of BT accounting systems and the possessing the following research question: "What are the reasons for the	BT causes challenges, including its complex integration with existing accounting systems and the increased costs associated with the adoption intention. Practitioners demonstrate a lack of knowledge of the	Semi-structured interviews	Australia USA

		limited uptake of BT accounting?''.	usage and benefits of BT in accounting.		
(Alkhwaldi et al., 2024)	#2 (blue)	Understanding the factors affecting the usage behavior of BT from accountants' and auditors' perspectives and its impact on their performance.	Performance expectancy, social influence, BT transparency, and BT efficiency significantly affected individuals' behavioral intentions toward using BT-based systems.	Survey research UTAUT SEM	Jordan
(Elmaasrawy et al., 2024)	#2 (blue)	Investigating the effect of audit clients' use of BT on auditing accounting estimates, especially the inherent risk, control risk, and collection of audit evidence.	There is a positive relationship between the audit client's use of BT and both inherent risk and control risk when auditing accounting estimates. The results also showed that BT improves the collection of sufficient and appropriate audit evidence when auditing accounting estimates.	Survey research	Middle East and North Africa
(Huang et al., 2024)	#2 (blue)	Examining whether audit clients' BT activities affect audit risk by studying the association between BT disclosures and audit fees.	BT and its applications are emerging. Clients' BT activities influence audit risk as assessed by external auditors.	Data from 10-K filings (US Stock Market)  Statistical analysis, correlation, regression	USA
(Majeed, Taha, 2024)	#2 (blue)	Exploring the factors influencing auditors' behavioral intentions towards BT adoption in Iraqi government banks.	Auditor's skill and four government features of BT adoption are major factors in government bank auditors' adoption of BT. Also, social influence is a potent indicator of one's intention to adopt BT in the banking industry.	Survey research UTAUT PLS-SEM	Iraq
(Qader, Kemal, 2024)	#2 (blue)	Investigating the influence of BT and AI on audit quality.	BT and AI utilization in their financial system positively impacts audit quality by assisting in the audit process and detecting fraud.	Survey research PLS-SEM	Turkey

\*Note: The cluster was assigned to the article if the article mainly focused on the cluster topic and issues. There are three clusters discussed in Section 6 below: # 1 (red) – BT pre-implementation in auditing, # 2 (blue) – BT implementation in auditing, and # 3 (green) – BT post-implementation in auditing.

**Source:** own work

## Appendix D: Research streams, *modus operandi*, and future research agenda for BT pre-implementation

Research streams	<i>Modus operandi</i> (Research findings)	Future research agenda
1. Choice of BT type and integration of BT with AIS	<p>1. The choice of BT is needed, which differs in transferring and sharing information depending on its type and a consensus protocol (Schmitz &amp; Leoni, 2019). Permissioned BT is gaining traction in mainstream business environments and can be adopted in auditing for several reasons (Han et al., 2023; McCallig et al., 2019). For example, it provides increased control over participants, offers enhanced security for sensitive auditing information, allows differentiated access to auditing information for stakeholders based on their specific needs, and facilitates selective information sharing with internal departments, auditors, regulators, and investors.</p> <p>2. BT-based AIS requires BT integration with the AIS's three-tier architecture, which embraces the data management tier (database engine) for managing the application's data, the application tier (business logic layer) for providing the logic to transform data into information, and the presentation tier for ensuring interface functionality (Tan &amp; Low, 2019).</p> <p>3. BT-based AIS creates a new BT-based audit environment, eliminating repetitive audit tasks by automated accounting processes such as invoicing, payment processing, contracts, and procurement, and highly transparent and traceable, timely and tamperproof financial statements (Tiron-Tudor et al., 2021). The main characteristics of BT-based AIS include enhanced information transparency, increased precision and efficiency, flexibility, and, crucially, data immutability (Fullana &amp; Ruiz, 2021). This technology significantly impacts information quality, aligning with the International Financial Reporting Standards requirements and enabling a form of real-time auditing by default (Lardo et al., 2022).</p> <p>4. Fully automating the audit environment is not feasible due to the complexity of accounting transactions and measurements (Tiron-Tudor et al., 2021). There is a need for a holistic audit model based on BT-based AIS that combines BT smart audit procedures with auditing procedures performed outside BT (Rozario &amp; Vasarhelyi, 2018). This hybrid approach is essential for meeting the auditing requirements that involve human expertise and reasoning (Tiron-Tudor et al., 2021).</p>	<p>1. What type of BT can organizations use and how can BT influence AIS architecture and AIS adoption?</p> <p>2. How can BT be adopted in the three-tier architecture of the AIS to support auditing requirements?</p> <p>3. What knowledge and skills are needed to create BT-based AIS and a holistic audit model based on BT-based AIS?</p> <p>1. Which auditing processes and procedures can BT support, and how should we redefine them?</p> <p>2. What is the role of each auditing stakeholder in auditing a BT-based audit environment?</p>
2. Factors influencing BT adoption in auditing	<p>1. The success of BT adoption in auditing depends on technological factors, encompassing BT's technical complexity, scalability, flexibility, suitable architecture, and cybersecurity. Four crucial decisions regarding BT control, data ownership, privacy, and access are imperative (Bonsón &amp; Bednárová, 2019).</p> <p>2. The success of BT adoption in auditing depends on organizational factors, such as managers' willingness to</p>	<p>1. What technological, business, and auditing knowledge and skills are necessary to successfully adopt BT in auditing, particularly in the</p>

	<p>embrace this innovative approach influenced by BT performance expectancy, social influence, auditors' effort expectancy (Alkhwaldi et al., 2024; Ferri et al., 2021), and auditors' perceived usefulness and perceived ease of use (Alshurafat et al., 2022; Majeed, Taha, 2024; Shbail et al., 2023).</p> <p>3. The success of BT adoption in auditing hinges on auditors' knowledge and understanding of the principal features, functions, and risks of BT (Akter et al., 2024). It also relies on their awareness of BT's impact on businesses, accounting, and auditing processes, their proficiency in advising on BT adoption, and their ability to bridge technology and auditing stakeholders (Jayasuriya, 2023; Mugwira, 2022).</p> <p>4. To fully integrate BT into a real auditing ecosystem and reap the benefits resulting from this, a broad consensus between auditors, regulators, and other users (e.g., companies, tax authorities, and investors) is needed (Secinaro et al., 2022). Users must resolve concerns over costs, data privacy, security issues, and willingness to adopt common standards (Fuller &amp; Markelevich, 2019).</p>	<p>planning and designing stages?</p> <p>2. How can managers improve their willingness to adopt BT in auditing?</p> <p>3. How can a broad consensus among BT stakeholders be achieved?</p>
<p>3. Steps, tasks, and processes of BT pre-implementation</p>	<p>1. BT pre-implementation can include (1) assessing the costs and benefits of BT adoption,(2) providing some advice on BT adoption for their clients, (3) actively participating in BT adoption with an emphasis on risk control, and (4) expanding advisory services such as control design, change management, and BT governance (Liu et al., 2022).</p>	<p>1. What steps should be part of a comprehensive approach to planning and designing BT in auditing, and what specific tasks, procedures, standards, and guidelines compose these steps?</p> <p>2. What are the good practices of planning and designing BT in auditing?</p>

**Source:** own work

## Appendix E: Research streams, modus operandi, and future research agenda for BT implementation

Research streams	<i>Modus operandi</i> (Research findings)	Future research agenda
1. Examples of implemented BT solutions in auditing	<ol style="list-style-type: none"> <li>1. Implementation requires fighting the resistance observed among auditors mainly due to a lack of background and training in IT and a perception of insurmountable risk from clients using BT (Pimentel et al., 2021) together with perceived low adequacy of accounting standards (Juma'h &amp; Li, 2024).</li> <li>2. In UEA, governmental agencies' initial implementation of BT expects private entities, including audit companies, to follow suit (Salim et al., 2022).</li> <li>3. A low level of BT application in Croatia indicated that external auditors are 1.716 times more ready to audit BT used by the audited company than internal auditors, as the internal audit department's ICT development is highly dependent on the company's ICT development phase (Tušek et al., 2021).</li> </ol>	<ol style="list-style-type: none"> <li>1. What are the differences in BT's initial usage and stabilization in external and internal audits (public vs private auditing)?</li> <li>2. What are the boundaries of internal alignment of BT implementation with public and private audit priorities?</li> </ol>
2. Enhanced audit efficiency	<ol style="list-style-type: none"> <li>1. During the initial usage stage, new audit procedures must be developed incorporating previously unknown types of audited clients' risks (Bonyuet, 2020; Fuller &amp; Markelevich, 2020), such as clients' data security risk and privacy of data when auditors gain access to the general ledger. Other types of risks, i.e., risks known in the past, are mitigated by the audited company and the auditor adopting BT.</li> <li>2. In the initial usage stage, procedures used in audits of clients that use BT should be concentrated on verifying how internal control over the register of transactions (blocks) is organized within the audited company (White et al., 2020). There is a positive relationship between audit clients' use of BT and inherent as well as control risk (Elmaasrawy et al., 2024). Thus, new control procedures for an innovative IT environment should be developed.</li> <li>3. An advantage in the form of low cost, increased transparency, and traceability of accounting data – when the audited company uses BT for statutory account purposes – is the main reason for increased audit efficiency during the stabilization phase (Fullana &amp; Ruiz, 2021; Garanina et al., 2022; Maffei et al., 2021; Elmaasrawy et al., 2024).</li> <li>4. Increased efficiency in the stabilization stage of BT adoption in auditing comes from real-time instead of a once-a-year statutory audit (Fuller &amp; Markelevich, 2020; Sargent, 2022).</li> </ol>	<ol style="list-style-type: none"> <li>1. Which auditing procedures require reconsideration in the initial usage of BT in the auditing process?</li> <li>2. What are the proper analytical tools for auditors to deal with new clients' risks?</li> <li>3. What auditors' competencies could stabilize BT adoption?</li> </ol>
3. Stabilization of BT adoption in auditing through smart contracts	<ol style="list-style-type: none"> <li>1. The feature of smart contracts that activates a transaction according to predefined rules is not unique to BT. Thus, smart contracts using BT are seen as an extension of many database configurations with unique increased assurance and low-cost features, even assuming continuous audits instead of once-a-year audit tasks (Bonsón &amp; Bednárová, 2019). This can be used in the initial usage of BT in the implementation stage if only an auditor or audited company uses BT.</li> </ol>	<ol style="list-style-type: none"> <li>1. What are the examples of transactions in which the auditor and the audited company can set up rules to make the audit process easier?</li> </ol>

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| <p>2. Smart contracts – also considered as the second generation of BT use in the stabilization stage - enable automatic, intelligent execution and recording of paid transactions and invoices (Hakami et al., 2023; Silva et al., 2022), increasing the control capacity not only for the company using BT for statutory accounts but also for the audit company.</p> <p>3. Smart contracts enable the preparation of financial reports (also those with non-financial information) in real-time and allow both parties of the contract (e.g., the auditor and the audited company) to pre-define, agree upon, and program business logic that informs all participants in case of an error (Yu et al., 2018; Roszkowska, 2020).</p> | <p>2. How do we develop a framework for audit procedures based on smart contracts and BT?</p> |
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**Source:** own work

## Appendix F: Research streams, *modus operandi*, and future research agenda for BT post-implementation

Research streams	<i>Modus operandi</i> (Research findings)	Future research agenda
1. Changes and impact of BT adoption on the auditing profession	<ol style="list-style-type: none"> <li>The potential impact of BT on accountants and external auditors profession can be perceived in three areas of future changes in these professions: (1) the transformation of accounting techniques; (2) the transformation of accounting tasks and main evolutions in accounting and auditing; (3) the main evolution in the work, skills, and education of auditors (Desplebin et al., 2021).</li> <li>BT would influence and change accountants and, consequently, auditors' practices by implementing new procedures, primarily automated (Zayed &amp; Othmna, 2023; Garanina et al., 2022).</li> <li>Changes in the auditors' profession will include understanding how BT can be used to their advantage and recognizing BT's impact on the client's audited business (Bonyuet, 2020). BT also allows auditors to understand clients' organizations and needs to conduct efficient, productive, and exact audits (Singhvi et al., 2021).</li> <li>BT has a positive impact by limiting manual work and allowing auditors to focus on professional judgment (Kend &amp; Nguyen's, 2020). However, auditors doubted whether BT adoption could meet the need for efficiency and speed. In particular, auditors from small firms are skeptical and do not understand the potential of BT (Kend &amp; Nguyen, 2020).</li> <li>Regarding the implementation stage, experts do not expect or foresee direct changes or threats to auditing practice (Tiberius &amp; Hirth, 2019). While some auditors claimed that BT has already changed audit processes and audit strategy and that the profession's development will continue through BT adoption (Abdennadher et al., 2022).</li> <li>The prevailing perception is that BT will not replace auditors and their professional judgment (Bellucci et al., 2022; Garanina et al., 2022; Maffei et al., 2021; Tiberius &amp; Hirth, 2019) but will complement traditional auditors' jobs by automatizing audit evidence, reporting or processes, and leaving space for analyses of financial data (Abdennadher et al., 2022; Cao &amp; Cong, 2020; Han et al., 2023).</li> </ol>	<ol style="list-style-type: none"> <li>What tools will be useful for auditors to adapt to future changes?</li> <li>What is a comprehensive educational framework for auditors to get acquainted with BT?</li> <li>How will BT implementation in clients' firms influence auditing procedures?</li> <li>What kind of training do auditors need to use BT more efficiently?</li> <li>What changes do auditors foresee/ expect in the next few years?</li> <li>Do auditors feel threatened in their profession?</li> </ol>
2. Legal and professional regulations required by BT adoption in auditing	<ol style="list-style-type: none"> <li>The main obstacle to BT adoption in auditing is a lack of guidelines, procedures, established regulations, and standards by the government (Han et al., 2023; Parmoodeh, 2023; Silva et al., 2022). For that reason, the authors highlighted the importance of the fact that it is needed (or even required) to apply new legal regulations (within accounting and auditing), new professional auditing standards, and change accounting policies compatible with BT since any existing regulations are vague (Garanina et al., 2022; Lombardi et al., 2022; Yu et al., 2018).</li> </ol>	<ol style="list-style-type: none"> <li>Which current regulations and standards require change?</li> <li>What new legal solutions should organizations implement?</li> </ol>

	<ol style="list-style-type: none"> <li>To introduce a new solution for this obstruction, old practices and methods should be changed and replaced by new regulations, or the current standards should be adjusted for amended audit procedures (Maffei et al., 2021).</li> <li>A different approach presents BT's need for regulations for audited clients using BT for statutory accounts and business transactions with financial assets (Gauthier &amp; Brender, 2021). They considered introducing regulations and updating auditing standards tailored to the audited clients who use BT.</li> </ol>	<ol style="list-style-type: none"> <li>How to audit clients using BT?</li> </ol>
3. Future opportunities related to BT adoption	<ol style="list-style-type: none"> <li>BT adoption might bring more opportunities than threats, challenges, and limitations (Dong &amp; Pan, 2023; Parmoodeh, 2023; Pizzi et al., 2021). BT provides a chance to anticipate a difficult financial situation better and assess the audited company's future profitability (Singhvi et al., 2021).</li> <li>BT is perceived as an opportunity for auditing by improving analytical procedures, decreasing audit time budget, increasing efficiency, enhancing the reliability of financial statements, and reducing risk and costs (Hakami et al., 2023; Kabir et al., 2022; Parmoodeh, 2023; Roszkowska, 2021).</li> <li>BT could mitigate risks and simplify auditing (Dyball and Seethamraju, 2022). Furthermore, BT could allow companies to reduce the cost associated with fraud detection by providing a tamper-proof and immutable audit (Parmoodeh, 2023).</li> </ol>	<ol style="list-style-type: none"> <li>What are other opportunities for BT implementation for audited companies?</li> <li>How will the scope of auditors' duties change due to increased efficiency, time, and lower cost?</li> <li>What are the real benefits of the opportunities of BT adoption for the auditors' profession?</li> </ol>
4. Challenges of BT adoption in auditing	<ol style="list-style-type: none"> <li>Pending challenges for BT are connected with scalability, flexibility, a suitable architecture, and cybersecurity (Bonsón &amp; Bednárová, 2019).</li> <li>Procedures such as reviewing transactions and verifying the existence of digital assets present new challenges for auditors (O'Leary, 2017; White et al., 2020).</li> <li>Auditors face potential obstacles, i.e., upgrading IT skills, strategic decision-making, data analysis, and visualization tools. The auditing profession should adjust to accommodate BT's needs or requirements (Parmoodeh, 2023; Singhvi et al., 2021).</li> </ol>	<ol style="list-style-type: none"> <li>How to mitigate challenges related to the cost and risks of BT adoption?</li> <li>What procedures are the most challenging for auditors?</li> <li>What tools do auditors have to face new challenges and solve problems?</li> </ol>
5. Changes in BT adoption in auditing	<ol style="list-style-type: none"> <li>BT can improve audit quality, transparency, efficiency, trust, and real-time auditing (Han et al., 2023; Rozario &amp; Vasarhelyi, 2018; Silva et al., 2022).</li> <li>BT implementation in auditing practice can enhance audit outcomes (Kend &amp; Nguyen, 2020). BT could change how companies operate (Roszkowska, 2021) and have a great potential to complement traditional auditing, ensuring low cost (Abdennadher et al., 2022; Hakami et al., 2023).</li> <li>Current accounting challenges could be solved by changing to multi-party validation (Han et al., 2023). However, for successful BT adoption, auditors and audit firms must manage the challenges that appear (Mugwira, 2022).</li> </ol>	<ol style="list-style-type: none"> <li>What BT tools should organizations implement to facilitate and improve auditing procedures?</li> <li>How can auditors' decisions about BT adoption influence traditional auditing?</li> <li>What consequences can audit companies expect if they do not meet the BT adoption requirements?</li> </ol>

**Source:** own work

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