

# Implementation of information technologies in the international accounting system of fuel and energy sector enterprises

*Halyna Kuzmenko*<sup>1</sup>, *Liudmyla Zakharkina*<sup>2\*</sup>, *Oleksandr Tranchenko*<sup>3</sup>, *Oksana Galenko*<sup>4</sup>, *Nazar Chuba*<sup>5</sup>, *Nataliya Petrenko*<sup>3</sup>, and *Vitalii Kravchenko*<sup>3</sup>

<sup>1</sup>Central Ukrainian National Technical University, 25000 Kropyvnytskyi, Ukraine

<sup>2</sup>Sumy State University, 40000 Sumy, Ukraine

<sup>3</sup>Uman National University of Horticulture, 20300 Uman, Ukraine

<sup>4</sup>Kyiv National Economic University, 03057 Kyiv, Ukraine

<sup>5</sup>Interregional Academy of Personnel Management, 03039 Kyiv, Ukraine

**Abstract.** The study aims the analysis the introduction of information technologies into the international accounting system of organisations in the fuel and energy sector, in particular, to establish the optimal nomenclature composition of digital transformation tools for accounting and auditing tools for the economic activities of organisations in the fuel and energy sector, as well as to establish practical steps to implement these tools in the accounting policies of the studied enterprises. The use of two principles for determining the appropriate range of technological solutions of Accounting 4.0, namely, the expert principle (based on the analysis of 10 professional resources) and the scientometric one (based on the analysis of 500 relevant publications) with their subsequent correlative and analytical comparison, allows providing an independent and high-quality solution to the issue of identifying solutions and tools for digital transformation and modernisation of accounting processes in the economic and economic activities of fuel and energy companies. It is established today, among information technologies, the following digital tools of Accounting 4.0 are the highest priority for integration into the international accounting policy of fuel and energy companies: Cloud Computing, Blockchain Technology, Big Data, Artificial intelligence (AI), AI-based automation, Machine learning and Internet of things.

## 1 Introduction

The use of information technology in the international accounting system of companies is an integral component of successful functioning and efficient management. Information technologies enable the automation and optimization of accounting, analysis, and reporting processes, ensuring data processing accuracy, speed, and reliability. The development of information technology and the proliferation of digital solutions are significantly changing how businesses operate and require organisations to adapt to a new reality in the face of

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\* Corresponding author: [l.zakharkina@biem.sumdu.edu.ua](mailto:l.zakharkina@biem.sumdu.edu.ua)

globalisation and rapid technological progress. There is a need for the modernisation of standard information technologies, which are limited and unable to meet the modern demands of businesses. In these circumstances, the activities of enterprises, particularly the fuel and energy complex, require the introduction of digital technologies into the accounting system in order to optimise business processes and improve accounting policy management in the face of global challenges [1, 2].

It is particularly expected that the introduction of digital technologies in the accounting of the fuel and energy complex will increase the management efficiency, reduce costs and rise profitability. To achieve these goals, it is necessary to use digital accounting tools, such as electronic reports, automatic accounting programs, and others [3, 4].

In addition, the introduction of digital technologies in the accounting will allow for more effective control of financial transactions, preventing money laundering, corruption and other financial crimes [5]. Moreover, digital technologies will allow for faster and more accurate accounting of financial transactions, which will ensure compliance with international standards and reduce risks in the field of financial discipline [6, 7].

Specifically, in the context of global challenges, such as the COVID-19 pandemic, climate change, military aggression, and the development of electro mobility, the introduction of digital technologies in the accounting of the fuel and energy sector will allow for a faster and more efficient response to changes in the economic environment and optimal accounting policies [8-10]. For example, digital technologies can be used to quickly track changes in market conditions and changes in the relevant legal framework, which will reduce the cost of responding to and adapting to changes [11-13].

In addition, the introduction of digital technologies in the international accounting system will allow the fuel and energy sector enterprise to cooperate more effectively with partners and customers. For example, digital technologies can be used to record contracts, fuel transportation operations, and other important business processes [14-16] quickly and accurately.

In fact, digitalisation tools are already having a significant impact on the international accounting system, particularly on accounting and auditing (including in the energy sector), as reflected in the relevant analytical findings of industry studies [17]. According to forecasts [18], the profits of companies that have introduced digital reporting and digital audit of economic activities in 2023 will amount to more than half of the world GDP, i.e., 53.3 trl. USD.

The results of the analytical study [19] indicate that 68% of financial sector companies (i.e., 63% of the total number of business organizations) have a digital transformation strategy. However, only 14% of financial companies are at the stage of implementing digitalization tools in their business activities, which is lower than the same indicator for the total number of business organisations, which currently stands at 23%. Thus, it can be concluded that about 54% of financial sector companies, although they have a project strategy for digital transformation, are in no hurry to implement it and integrate modern digital tools (including in the field of accounting and auditing) into their specific economic activities.

Similar results are declared in the study [20], which also indicate a low ratio of organizations that have an approved program for the transition to digital business to organisations that are already at the stage of digital transformation.

There are several reasons that may explain the low level of implementation of digitalisation tools in the financial sector in general, and in the international accounting system in particular:

1. Lack of a clear strategy: Business organizations may have a digital transformation strategy, but it may not be clear enough or have sufficient support from management. This can lead to companies wasting time and resources researching technologies and developing strategies but failing to put plans into action.

2. Lack of necessary skills: Transitioning to a digital business may require new knowledge and skills that are lacking in companies. This may include knowledge of technology, data analytics, cybersecurity, and other areas. If companies do not invest in staff training and development, digital transformation may not be possible.

3. Fear of change: Implementing new technologies and processes can be difficult and lead to changes in the company. Some employees may be afraid of change, or simply not comfortable with new technologies. This can complicate the process of transitioning to a digital business.

4. Financial constraints: The transition to a digital business can be costly, and for some companies, especially SMEs, it can be financially difficult. Financial constraints can lead to companies delaying the adoption of digital technologies, or not taking advantage of all the opportunities they offer.

5. Cybersecurity issues: One of the main challenges in the transition to digital business is the issue of cybersecurity. Digital technologies can become a source of new threats for companies, such as cyberattacks and data theft. Therefore, companies must develop and implement effective cybersecurity measures, which may also require additional costs and resources.

6. Problems with standards and regulatory frameworks: When adopting digital technologies in regulated industries, such as the financial sector, there may be issues with standards and regulatory frameworks. Insufficient harmonisation between different standards and regulators can complicate the adoption of digital technologies and increase costs.

All of these reasons can be obstacles for companies wishing to implement digital transformation and should be taken into account when planning and implementing projects. Successful digital transformation requires developing a clear strategy, investing in staff and infrastructure development, developing effective cybersecurity measures, and complying with relevant standards and regulatory requirements.

Given the identified issues and the relevance of researching strategies for the digital transformation of economic and economic activities of organisations, including the international accounting system (especially in the fuel and energy complex), it is advisable to focus the research vector (research objective) on determining a rational strategy for digitalising the accounting sector of the energy industry on the way to implementing the concept of Accounting 4.0 [21] in the overall strategy of the fourth wave of industrialisation - Industry 4.0 [22].

To address the identified issues, we formulate the tasks to be solved in the current study:

- Analyze statistical information on the level of implementation and impact of digital tools of the Accounting 4.0 (Industry 4.0) concept on the organization of accounting and auditing within the international accounting system.
- Analyze the current scientometrics on possible digital solutions and technologies for the accounting sector in the fuel and energy industry.
- Identify digital solutions that are optimal for the international accounting system in the fuel and energy industry.

To develop a rational strategy for the implementation of digital tools of the Accounting 4.0 (Industry 4.0) concept in the system of accounting and audit organization at enterprises of the fuel and energy sector.

Thus, the results of the current study will have direct practical implications for the dynamics of the development of the subject area and optimal strategies for integrating Accounting 4.0 (Industry 4.0) digital accounting tools and systems into the fuel and economic sector of economic activity.

## 2 Literature review

The international accounting and audit system in the fuel and energy sector is an important tool for ensuring efficient use of resources and identifying possible risks. The organisation of accounting and auditing in organizations of the fuel and energy profile of economic activity has its own peculiarities. The main ones are [23-25]:

1. Complexity of resource accounting. The fuel and energy sector uses different types of fuel and energy with different parameters that require separate accounting.

2. The need to comply with regulations. The industry is subject to various laws and regulations governing the production, storage, and transportation of fuel and energy. This involves compliance with legal requirements and ensuring that financial statements comply with norms and standards.

3. High degree of risk. In the fuel and energy sector, the production and transportation of fuel and energy is a potentially hazardous activity. Therefore, the accounting and audit system should ensure the identification of possible risks and the prevention of possible negative consequences.

4. Large amount of data. The fuel and energy sector has a large amount of diverse information that needs to be collected, analysed and processed. Therefore, it is important to have an effective data processing system and ensure its integrity and reliability.

5. The use of equipment. The fuel and energy sector uses a variety of equipment that requires separate accounting and auditing.

To achieve effective accounting and auditing in fuel and energy organisations, it is necessary to use specialised software tools and technologies that automate the processes of data collection, processing and analysis. Such programs help to increase the speed and accuracy of accounting, reduce the risk of errors, and increase the efficiency of financial activities.

In addition, it is important to have qualified accounting and audit professionals with sufficient knowledge and experience in working with digital technologies and programs [26-28]. They should be able to effectively use digital solutions and ensure their compliance with legislation and standards.

Therefore, the use of digital technologies and software tools can help solve the main problems that arise in the process of accounting and auditing in fuel and energy organizations and ensure the effective functioning of the international accounting system of enterprises.

The organisation of accounting and auditing in fuel and energy organisations requires solving the following problematic issues [29-32]:

1. Systematic errors in accounting for fuel and energy resources and equipment. This may be caused by the complexity of the processes of production and transportation of these resources, as well as the technical features of the equipment.

2. Insufficient knowledge and skills of employees in accounting and auditing. To solve this problem, it is necessary to conduct regular professional development and training of specialists.

3. Lack of integrated systems that would provide a holistic view of financial processes and allow for a “one-stop shop” for all information. This can lead to delays in reporting, data errors, and reduced efficiency.

4. Outdated accounting policies that do not take into account current trends in the industry and do not use the capabilities of digital technologies. The accounting policy should be reviewed and adapted to ensure that it meets the requirements of the present.

5. Insufficient use of digital technologies and software tools. The use of digital technologies can reduce errors, increase accounting efficiency, and ensure fast data processing and analysis.

6.Lack of adequate control over financial reporting and settlements with counterparties. To ensure effective control, it is necessary to use modern software tools and methods of financial data analysis.

7.Problems with the preparation and storage of financial documents. Insufficient organisation of storage and archiving of financial documents can lead to the loss of important information and problems with its further use.

8.Risks related to financial crime and cybersecurity. Organizations in the fuel and energy sector are at increased risk of criminal acts such as financial fraud, theft or cyberattacks. To prevent such risks, it is necessary to use modern cybersecurity technologies and improve the internal control system.

9.Regulatory requirements. The fuel and energy sector is one of the most heavily regulated industries, which may create challenges in ensuring compliance with regulatory requirements in the accounting and auditing process. This may include the complexity of meeting various financial reporting and documentation requirements. The need to ensure information security in the process of accounting and storage of financial information. Ensuring information security is an important task to ensure the trust of customers and partners, as well as to prevent the loss of confidential information.

The accounting and audit sector of fuel and energy companies is facing a number of global challenges, including the COVID-19 pandemic, the need to diversify fuel and energy markets, Russia's armed aggression against Ukraine, climate change and international relations, etc. [33-35]:

1.COVID-19 pandemic: The virus pandemic that started in 2019 caused global economic disruptions, which affected fuel and energy companies. This has led to the need for regular revision of financial statements, as well as difficulties in the valuation of assets, debt, and other financial indicators.

2.Diversification of fuel and energy markets: Significant dependence on energy resources from the Russian Federation has prompted the search for new energy sources and market diversification. Accounting and auditing in this context require an understanding of new standards for assessing assets, technologies and potential risks.

3.Russia's armed aggression against Ukraine: The unprovoked armed aggression of the Russian Federation against Ukraine, condemnation and sanctions of the international community and the corresponding unfriendly actions of Russian energy companies to fulfil their contractual obligations for the supply of energy resources have led to a complete redistribution of the fuel and energy market architecture. Russia's military actions against Ukraine have led to instability in the energy markets, changes in international cooperation, and affected the financial results of fuel and energy companies. This requires constant assessment of market stability, as well as consideration of political and economic risks.

4.Climate change: Global warming and climate change have become important challenge for the fuel and energy sector. Given the development of renewable energy sources, fuel and energy companies must adapt to the requirements of reducing greenhouse gas emissions and meet environmental responsibility standards. Accounting and auditing in this context should take into account changes in assets, regulatory restrictions, and liability for violation of environmental standards.

5.International relations: Fuel and energy companies operate within a global economy and therefore need to take into account changes in the international environment and relevant legislation. Accounting and auditing in this context include the assessment of international financial reporting standards (IFRS), tax legislation, and currency risks.

6.Growing volume of data and the need to analyse large amounts of data. Fuel and energy companies are faced with a large amount of data that needs to be processed and analysed to make important decisions. This requires highly efficient accounting and audit systems that can provide fast and accurate data analysis.

7. Information security: Increased dependence on information technology has increased the likelihood of cyberattacks and system hacking, which can cause the loss or alteration of important financial data. Accounting and auditing of fuel and energy companies should take into account cybersecurity risks and develop strategies to prevent and manage them.

8. Environmental standards: Due to the growing global awareness of the need to reduce negative environmental impacts, fuel and energy companies are facing stringent environmental standards and regulations. Accounting and auditing must comply with these requirements, including the assessment of environmental risks, emissions, and potential fines for violations of regulations.

9. Technological development: Continued advances in technology, such as renewable energy, the Internet of Things, artificial intelligence, and blockchain, are impacting the fuel and energy sector. Accounting and auditing must be ready to adapt to meet new technologies and maintain the efficiency of accounting and reporting processes.

10. Globalisation: In the context of globalisation, the fuel and energy sector faces constant competition at the international level, which requires adaptation to changes in international legislation, trade and standards. Accounting and auditing must be prepared to understand and accommodate these changes, as well as continually assess global risks and opportunities.

Given the previously identified features, complexities and challenges in organising the effective functioning of the accounting and auditing system of fuel and energy companies, as well as the listed global challenges, the urgent need for digital transformation of the international accounting system of energy companies becomes apparent [36-38].

Digital transformation will help to implement and integrate modern tools and means of the fourth industrial development stage, known as Industry 4.0, into analytical and accounting processes [39, 40]. This will increase the efficiency, automation and intellectualization of financial reporting and control, providing real-time feedback and accelerating decision-making [41, 42]. Modern tools and technologies, such as cloud computing, artificial intelligence, machine learning, blockchain, and big data, will allow companies to improve data analysis, risk management, and process transparency [5, 43]. It will also help companies adapt more easily to market demands, regulatory changes, and environmental challenges [44-46]. The implementation of Accounting 4.0 will allow fuel and energy companies to realize the benefits of digital transformation, including increased productivity, reduced costs, increased competitiveness, and greater resilience in response to global challenges. Accounting and auditing based on Accounting 4.0 will allow companies to optimise resource monitoring, optimise energy consumption, and reduce environmental impact [47-49].

Accounting 4.0 also contributes to the improvement of corporate governance and compliance with international standards, which will help fuel and energy companies strengthen their reputation on a global level. Since the fuel and energy sector is an integral part of the global economy, successful integration of Accounting 4.0 can contribute to the sustainable development of not only individual companies but also the global economy as a whole [50-52].

Finally, the implementation of Accounting 4.0 will help fuel and energy companies create adaptive and efficient business models that will allow them to adapt to future technological transformations and new challenges [53-55]. As a result, the digital transformation of the accounting and auditing system is becoming a necessity for fuel and energy companies seeking to achieve sustainable growth and competitive advantage in a constantly changing global environment [56-58]. Taking into account the established theoretical and factual subject area, the little-studied aspects, chaos and lack of a systematic approach to the implementation of digital tools of Accounting 4.0 (Industry 4.0), it is advisable to establish a research focus, which is implemented in the current study:

1. Analysing the state of implementation of digital technologies in the accounting of fuel and energy enterprises, including the study of modern information systems, cloud technologies, machine learning and big data analytics.

2. Assessment of the impact of global challenges, such as the COVID-19 pandemic, market diversification, armed aggression, environmental standards, technological development, globalisation and political risks, on the accounting policies of fuel and energy companies.

3. Development of recommendations on optimal accounting policies for fuel and energy enterprises, taking into account the introduction of digital technologies, transparency, compliance with international standards, and adaptation to environmental changes.

4. Study of the possibilities of applying and impact of Accounting 4.0 technology (Industry 4.0) to improve the efficiency, security, and transparency of accounting and financial reporting of fuel and energy companies.

5. Assessment of the impact of digital transformation on the role of accountants and auditors, and development of new competencies necessary for successful work in the context of integration of modern technologies in the fuel and energy sector.

### 3 Methodology

The defined research vector is implemented using the relevant methodological principles that make up the stages of the current study:

1. Statistical analysis of the current level of implementation of digital tools of the Accounting 4.0 concept (Industry 4.0) in the accounting policy of enterprises: this method allows to identify the actual level of readiness of enterprises (including the fuel and energy profile of economic and economic activity) to integrate modern technologies into the accounting and audit sector, to assess the level of modern impact on the subject area of individual digital transformation technologies and to identify their optimal nomenclature range, taking into account the peculiarities of the organisation of accounting. The data of specialised surveys of specialised resources are used as research data subject to statistical analysis (Table 1). The analytical findings and expert opinions of these specialized resources (Table 1) are used for further statistical analysis regarding the focus of the current study.

**Table 1.** Characteristics of specialised resources.

<b>Resource name. Brief description and links</b>
<b>Analytics Steps Infomedia LLP.</b> Analytics Steps covers a variety of topics related to analytics, data, and technology. They cover topics ranging from artificial intelligence to marketing strategies. In “How has digital transformation impacted accounting?” the author examines how digital transformation is affecting accounting. The article discusses various aspects of the impact of digital transformation on accounting, including changes in accounting processes, the use of automation, the benefits of digital technologies for auditors, and the skills and competencies that are becoming necessary for accountants in the modern world. [ <a href="https://www.analyticssteps.com/blogs/how-has-digital-transformation-impacted-accounting">https://www.analyticssteps.com/blogs/how-has-digital-transformation-impacted-accounting</a> ]
<b>The specialized resource of Maryville University Online</b> offers reviews, articles, and information on educational programs, career development, and various academic disciplines. In “Data Analytics in Accounting,” the author discusses the importance of data analytics in accounting. The article focuses on the use of data analytics in accounting to improve decision-making, forecasting, and risk assessment. The author also discusses the benefits of data analytics for businesses that implement these methods in their accounting practices. [ <a href="https://online.maryville.edu/blog/data-analytics-in-accounting/">https://online.maryville.edu/blog/data-analytics-in-accounting/</a> ]

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**Resource name. Brief description and links**

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**The specialized resource Finances Online** is a platform that provides comparative reviews, articles and information on various financial products, software and services to help businesses and individual users make informed decisions. In “Digital Transformation Statistics,” the author provides statistics and facts related to digital transformation in various industries. The article discusses the impact of digital transformation on the labour market, including changes in the demand for employee skills and competencies. The article also discusses the costs of digital transformation, investments in technological infrastructure, and the growing popularity of cloud technologies. [<https://financesonline.com/digital-transformation-statistics/>]

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**BDO USA LLP.** BDO is an international company that provides audit, tax, consulting and business services to organisations in various industries. In the article “Digital Transformation in Financial Services”, BDO describes how digital transformation is affecting financial services and offers recommendations on how to adapt to these changes. The article discusses key technology trends affecting financial services, such as cloud computing, blockchain, artificial intelligence, and data analytics. The authors emphasise that financial institutions must adapt to digital transformation in order to compete in the market and maintain a high level of customer service. [<https://www.bdo.com/insights/industries/financial-services/digital-transformation-in-financial-services>]

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**Digital Adoption** is an online platform that focuses on digital adaptation and transformation in business. They provide information and resources to help organisations adopt new technologies, ensure rapid adoption, and ensure efficiency with digital tools. In the Digital Transformation section, they describe the different aspects of digital transformation, including strategy, culture, technology, and organizational change. The articles and materials on this resource address key concepts, trends, and best practices that can help companies during the digital transformation process. [<https://www.digital-adoption.com/digital-transformation/>]

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**Profile resource Hitachi Solutions** is a company specialising in business solutions, technology, and consulting services. They offer support in implementing various technologies, including Microsoft Dynamics, CRM, ERP, and other digital tools. The article “Digital Transformation in Financial Services” on the Hitachi Solutions website discusses the impact of digital transformation on the financial sector. The article describes various technology solutions that can help financial institutions successfully transition to a digital environment. [<https://global.hitachi-solutions.com/blog/digital-transformation-financial-services/>]

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**DataIntel** is a market research company that analyses and reports on various industries, including banking, financial services, and insurance. DataIntel's Global Digital Transformation in Banking, Financial Services, and Insurance Market report examines the current state and future outlook for digital transformation in the banking, financial services, and insurance industries globally. The report analyses key players, technology solutions, strategies, and trends that influence market development in these sectors. [<https://dataintel.com/report/global-digital-transformation-in-banking-financial-services-and-insurance-market/>]

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**Consultancy.asia** is part of an international network of consulting websites that provides news, analysis and feedback on the consulting industry in Asia. They publish the latest news, research, reports, interviews and commentary from the consulting sector. The article “The Top Digitalization Trends for CFOs and the Finance Function” examines the key digitalization trends for chief financial officers (CFOs) and the finance function. The authors emphasize the importance of adapting to digital innovations and implementing new technologies in financial management. [<https://www.consultancy.asia/news/3969/the-top-digitalisation-trends-for-cfos-and-the-finance-function>]

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<b>Resource name. Brief description and links</b>
<p><b>Smart Insights (Marketing Intelligence) Ltd.</b> Smart Insights is a specialized resource focused on digital marketing and strategy. It provides tips, tools, templates, and guidelines for businesses and marketers to help them develop and implement successful digital marketing strategies. The article “Financial Services Digital Transformation for Marketing Leaders” discusses the implementation of digital transformation in the financial services marketing sector. The author emphasises the importance of adapting marketing strategies to the digital environment and using innovative technologies to improve the efficiency of financial services marketing. [<a href="https://www.smartinsights.com/digital-marketing-strategy/financial-services-digital-transformation-for-marketing-leaders/">https://www.smartinsights.com/digital-marketing-strategy/financial-services-digital-transformation-for-marketing-leaders/</a>]</p>
<p><b>Avenga.</b> Profile resource Avenga is a global IT company that provides services and solutions in IT consulting, software development, product development, and other areas. They share news, articles, and research from the world of technology and IT aimed at business professionals, technical specialists, students, and researchers. The article “Digital Transformation in Financial Services” discusses the process of digital transformation in the financial services industry. It emphasises the importance of financial companies adapting to new technologies and innovations that change the way they provide services and interact with customers. [<a href="https://www.avenga.com/magazine/digital-transformation-financial-services/?region=ua">https://www.avenga.com/magazine/digital-transformation-financial-services/?region=ua</a>]</p>

2. Collection, systematisation and clustering of scientific papers posted on recognised digital platforms such as Web of Science, Scopus, Google Scholar, Microsoft Academic, CrossRef, on the state of research on the impact of digital tools Accounting 4.0 (Industry 4.0) on the accounting system of fuel and energy enterprises. The corresponding method will allow forming a trusted array of taxonomic sets, the analysis of which will further allow to determine the likely optimal technologies for the digital transformation of the accounting policy of energy sector organizations, as well as to set benchmarks for further scientific and technological development of digitalization tools in accounting. In order to ensure the purity and independence of the study, as well as to form an appropriate trustworthy array, at least 500 relevant publications published in the current five-year period are selected. Specialised software is used to select this data (Table 2).

**Table 2.** Characteristics of the software for collecting, clustering and forming a trusted array of relevant taxonomic sets.

<b>Software name</b>	<b>Brief description and links</b>
CRExplorer	<p>CRExplorer, developed by Andreas Thor, is free and open-source software designed to explore, analyse and visualize corporate relationships and networks. It helps users explore corporate structures, identify relationships between companies, identify key nodes and connections in a network, and analyse and visualize this data. CRExplorer offers a graphical interface that makes it easy to use for users without technical training. It also supports importing data from a variety of sources, including CSV files, databases, and APIs. Thanks to its open source nature, users have the ability to customize and extend the software to meet their own needs. [<a href="https://andreas-thor.github.io/CRExplorer">https://andreas-thor.github.io/CRExplorer</a>]</p>
Publish or Perish	<p>The Publish or Perish software, developed by Professor Ann-Will Harzing, is a free tool for analysing the scientific productivity and impact of researchers based on their publications. It helps to measure metrics such as number of articles, citations, h-index and g-index to help determine the impact of researchers in their field. Publish or Perish works with data from various scientific databases, including Google Scholar, Microsoft Academic, Scopus,</p>

Software name	Brief description and links
ScientoPyUI	<p>Web of Science, and others. The program offers a user-friendly graphical interface that allows users to easily enter queries, display results, and export them in CSV or text files.</p> <p>[<a href="https://harzing.com/resources/publish-or-perish">https://harzing.com/resources/publish-or-perish</a>]</p> <p>ScientoPyUI is a free and open source software designed to analyze scientometric data, including publications, citations, and scientific productivity indices. It allows users to conveniently perform complex analytical procedures with data from many scientometric databases such as Scopus, Web of Science, and Google Scholar. ScientoPyUI has a graphical user interface that allows you to easily load and process data using built-in analysis and visualization tools. In addition, it supports advanced customization and programming capabilities, allowing users to customize the software to their needs.</p> <p>[<a href="https://github.com/jpruiz84/ScientoPy/blob/master/README.md">https://github.com/jpruiz84/ScientoPy/blob/master/README.md</a>]</p>

Among the above software tools for collecting specialised and relevant information among scientific papers and publications (Table 2), we selected Publish or Perish software. Publish or Perish is powerful and free software that allows you to determine the scientific productivity and impact of researchers in their field of study based on the analysis of their publications. The tool works with various scientific databases such as Google Scholar, Microsoft Academic, Scopus, and Web of Science and uses metrics such as number of articles, citations, h-index, and g-index to assess the productivity and impact of researchers in their field. Compared to CRExplorer and ScientoPyUI, Publish or Perish has more features and more functions that allow you to more accurately determine the scientific productivity and impact of researchers. In addition, it has a simpler and more intuitive interface that allows users to perform various tasks quickly and efficiently.

3. Taxonomical analysis of the trusted array of relevant taxonomical sets to identify the technological tools of Accounting 4.0 (Industry 4.0) that have the greatest impact on the accounting and audit system of fuel and energy companies, as well as to establish the likely vectors of development of digital transformation technologies in the focus industry. This method will allow us to formulate the concept of research and practical implementation links of the subject area. The analysis of taxonomic clusters is performed on taxonomic sets previously formed in the Publish or Perish software using the appropriate graphical and analytical software (Table 3).

**Table 3.** Characteristics of the software for the analytical study of clustered taxonomic sets of the focus industry.

Software name	Brief description and links
CiteSpace	<p>CiteSpace is scientific data analysis software that allows users to visualize and analyse scientific data such as publications, citations, and keywords. It has capabilities for statistical analysis and visualisation of scientific networks and graphs, as well as for identifying key topics, authors, and other parameters, allowing users to understand the structure and development of the scientific field. CiteSpace also has functions for automatically detecting information and citation matches, which increases the efficiency and accuracy of scientific data analysis. [<a href="http://cluster.cis.drexel.edu/~cchen/citespace">http://cluster.cis.drexel.edu/~cchen/citespace</a>]</p>
VOSviewer	<p>VOSviewer is software for analysing and visualising scientific data, including publications, authors, citations, and keywords. It can be used to analyse scientific networks and graphs, identify key topics and authors, and evaluate the impact of research and authors. VOSviewer has the capabilities to</p>

Software name	Brief description and links
Bibliometrix	<p>visualize scientific data in the form of graphs and charts, allowing users to understand the structure and relationships in the scientific field. It also has features for classifying and clustering data, allowing users to group similar items and identifies patterns in the data. [<a href="https://www.vosviewer.com">https://www.vosviewer.com</a>]</p> <p>Bibliometrix is free software for analysing scientific data, including scientific publications, supported by the R platform. It allows users to perform bibliometric analysis that provides an understanding of the structure of scientific data and the relationships between them. Bibliometrix applications include analysing topics, author networks, citations, and other important parameters of scientific data. In addition, Bibliometrix provides the ability to visualize the results of the analysis using graphs and charts. This software is a useful tool for scientists, researchers, and managers in the field of research and development. [<a href="https://www.bibliometrix.org">https://www.bibliometrix.org</a>]</p>

Among the software tools for analysing the graphical interpretation of relevant taxonomic sets (Table 3), VOSviewer software was selected. VOSviewer software was chosen for the purpose of analysing and visualising scientific data.

This software allows you to display scientific data in the form of graphs and diagrams, understand the structure and relationships in the scientific field, identify key topics and authors, and assess the impact of research and authors. VOSviewer has several advantages over CiteSpace and Bibliometrix. First, VOSviewer has a simpler and more intuitive interface, which makes it more accessible to users of all experience levels. Secondly, VOSviewer provides more flexible data analysis, as the user can define data selection criteria and change analysis parameters using the interface. CiteSpace and Bibliometrix work in the Java and R programming environment, respectively, they require certain programming skills, so it is advisable to use VOSviewer software.

4. Comparative analysis of the results of previous iterations of research with the formulation of conclusions on the optimal nomenclature spectrum of means of digitalisation of the accounting sector of energy industry enterprises within the framework of the defined concept of Accounting 4.0 (Industry 4.0).

5. Developing an optimal strategy for implementing a certain nomenclature range of digital transformation tools in the accounting policy of fuel and energy enterprises, taking into account the likely impact of global factors that require appropriate corrective and predictive solutions.

The proposed methodological framework of the current study allows for obtaining far-sighted conclusions with direct practical implications, as it will allow for assessing the prospects for developing the Accounting 4.0 (Industry 4.0) concept on the way to a complete digital transformation of the international accounting system.

## 4 Results

In accordance with the proposed research scheme, based on expert opinions, we will establish the current state of implementation of digital tools and technologies in the field of accounting and auditing of economic and social activities (including energy qualification) (Table 4 and Figure 1).

**Table 4.** Expert assessment of the level of implementation of Accounting 4.0 tools in the accounting sector of companies and the readiness of the surveyed organisations for digital transformation.

Level of implementation of Accounting 4.0 (Industry 4.0) tools	Analytics Steps Infomedia LLP										
	Maryville University	Finances Online	BDO USA LLP	Digital Adoption	Hitachi Solutions	DATAINTELO	Consultancy.asia	Smart Insights Ltd	Avenga	Average indicators	
Percentage of companies with a digital transformation strategy for the accounting sector, %	45	47	45	49	46	44	45	44	46	45	46
Percentage of companies integrating digital transformation tools into the accounting sector, %	15	13	13	14	14	15	14	15	15	14	14
Percentage of companies piloting the use of digital tools on the way to transforming accounting policies, %	11	12	11	11	10	12	10	12	11	11	11
Percentage of companies implementing automation of accounting processes, %	4	4	5	4	6	4	4	6	4	4	5
Percentage of companies developing a digital transformation strategy for the accounting sector and a corresponding investment plan, %	25	24	26	22	24	25	27	23	24	26	24

Analysing expert opinions on the level of implementation of Accounting 4.0 (Industry 4.0) tools in the accounting and auditing sphere of companies and organisations, the following conclusions can be drawn (Table 4 and Figure 1):

1. More than half of the companies (average 45.6%) already have a strategy for digital transformation of the accounting sector, which indicates a growing interest in implementing the latest technologies in accounting.

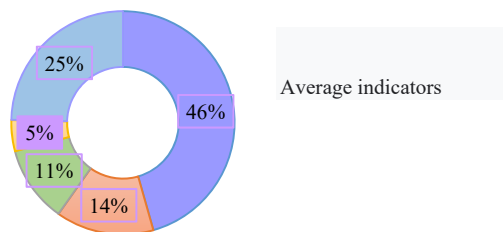
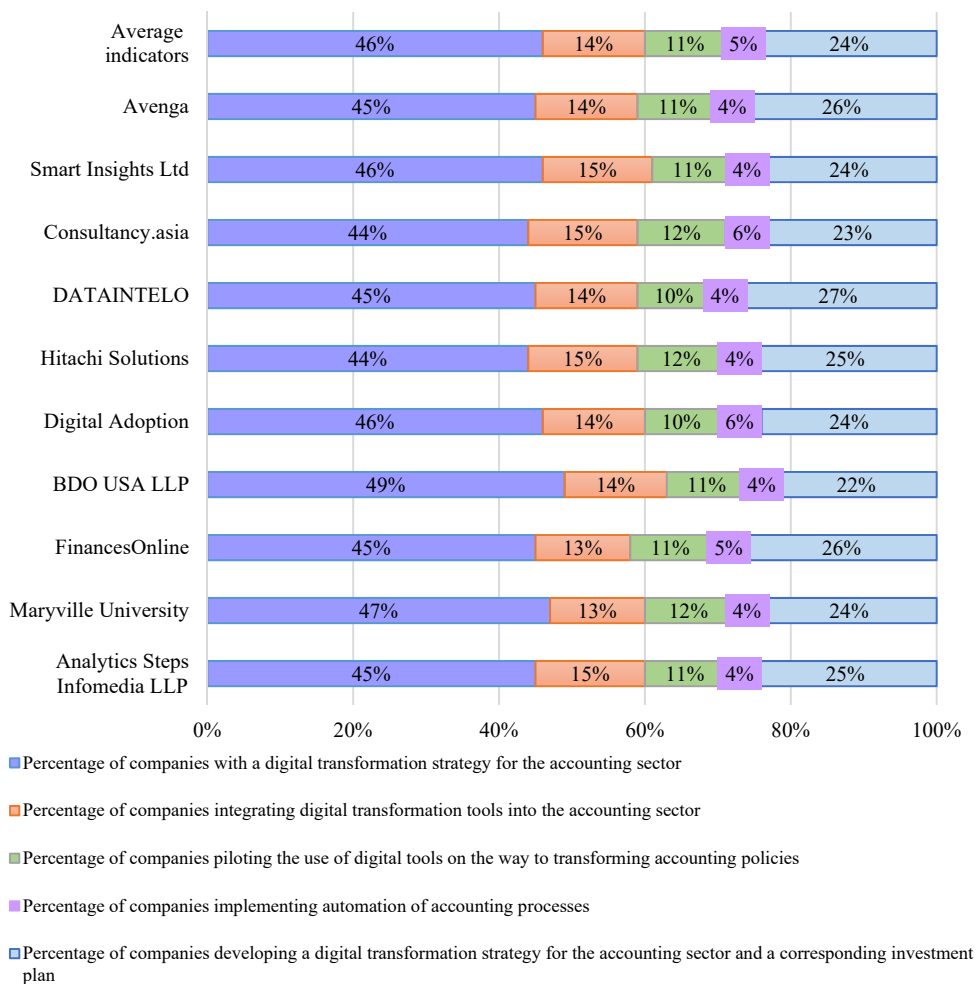
2. On the other hand, only 14.3% of companies actually integrate digital tools into the accounting sector. This may indicate the presence of certain obstacles, such as high costs, complexity of integration, or insufficient staff knowledge.

3. 11.1% of companies are experimenting with digital tools on the way to transforming their accounting policies, which shows that companies are interested in testing and adapting new technologies before widespread implementation.

4. Only 5% of companies implement automation of accounting processes. This may indicate that most companies still do not use the potential of automation to optimise their accounting processes.

24% of companies are developing a digital transformation strategy for the accounting sector and a corresponding investment plan, which indicates that they are planning future steps towards digital transformation.

In general, the data show that companies are increasingly aware of the need for digital transformation of the accounting sector, but the practical implementation of such plans is still at an early stage for most companies, i.e., the strategies for digital sectoral modernisation are declarative.



**Fig. 1.** Visualisation of the analysis of expert opinion on the current level of digital transformation of the accounting sector.

The analysis of expert opinions on the reasons for the declarative nature and low level of actual digital transformation of the accounting sector contains the expected natural background (Table 5 and Figure 2).

**Table 5.** Expert assessment of typical obstacles to the implementation of the digital transformation of the accounting sector.

Typical obstacles to implementing digital transformation	Analytics Steps Infomedia	Maryville University	Finances Online	BDO USA LLP	Digital Adoption	Hitachi Solutions	DATAINTELO	Consultancy.asia	Smart Insights Ltd	Avenge	Average indicators
	LLP										
Companies' percentage that consider the lack of a central government strategy to be an obstacle to the digital transformation of the accounting sector, %	26	25	25	25	26	29	28	25	29	29	27
Companies' percentage that consider the lack of funding and resources to be an obstacle to the digital transformation of the accounting sector, %	21	22	23	20	20	24	21	20	23	23	22
Companies' percentage that consider a significant cybersecurity risk to be an obstacle to the digital transformation of the accounting sector, %	27	24	27	27	25	23	25	23	25	25	25
Companies' percentage that consider the lack of a clear understanding of the mechanisms for integrating relevant technologies and tools to be an obstacle to the digital transformation of the accounting sector, %	9	9	12	11	9	11	12	12	12	12	11
Companies' percentage that consider the digital transformation of the accounting sector to be an obstacle to a high probability of financial failure and loss of key stakeholders, %	17	20	13	17	20	13	14	20	11	11	15

Based on the analysis of expert opinions (Table 5, Figure 2), the following conclusions can be drawn about the typical obstacles to the implementation of the digital transformation of the accounting sector:

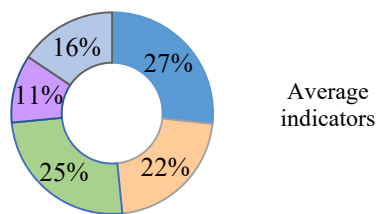
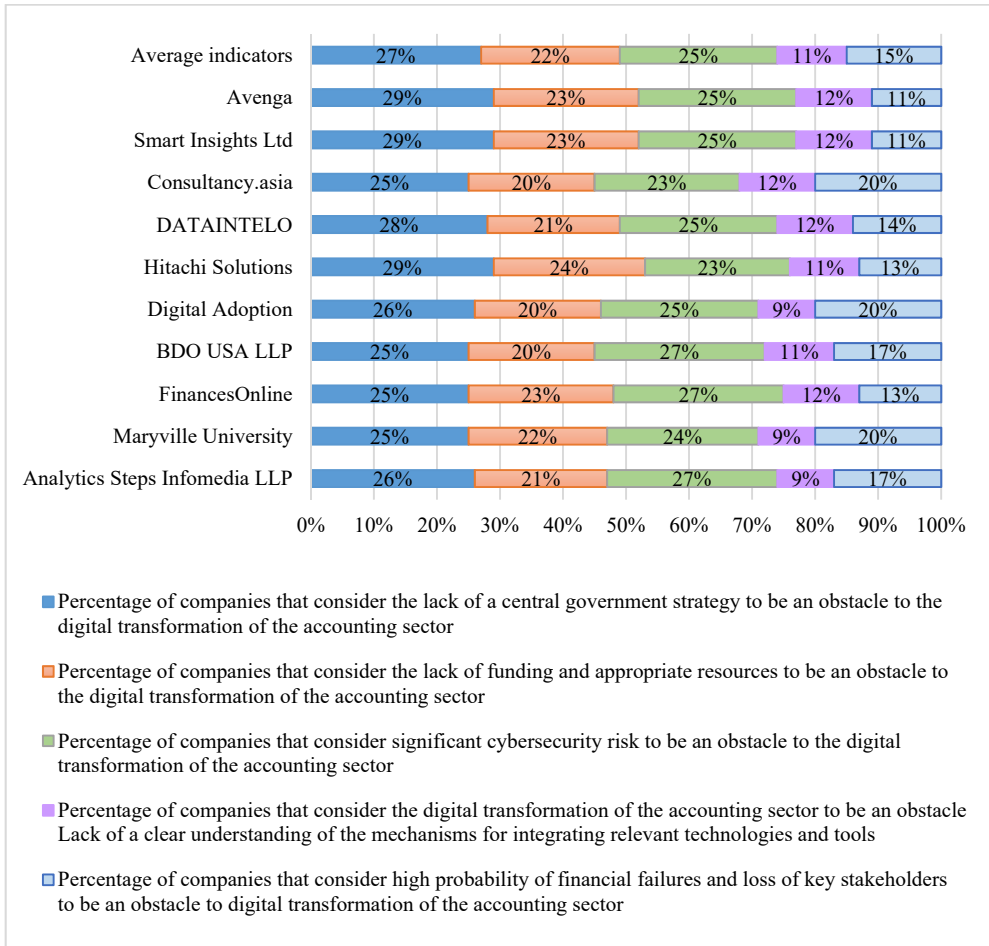
1. The lack of a central government strategy is one of the main obstacles for 27% of companies. This may indicate that government agencies should develop and maintain general guidelines and recommendations to stimulate digital transformation in the accounting sector.

2. For 22% of companies, the lack of funding and resources is a significant obstacle. This indicates that companies should be more active in attracting investments and resources to successfully implement digital transformation.

3. A significant cybersecurity risk is a problem for 25% of companies. This underscores the importance of developing robust security systems and raising employees' awareness of cybersecurity issues.

4. Lack of a clear understanding of the mechanisms for integrating relevant technologies and tools is an obstacle for 11% of companies. This indicates the need for training and consultations for staff to help them understand and master new technologies.

5. A high probability of financial failure and loss of key stakeholders is a problem for 15% of companies. This shows that companies need to develop risk management strategies to minimise the possible negative effects of digital transformation on their business processes and stakeholders.



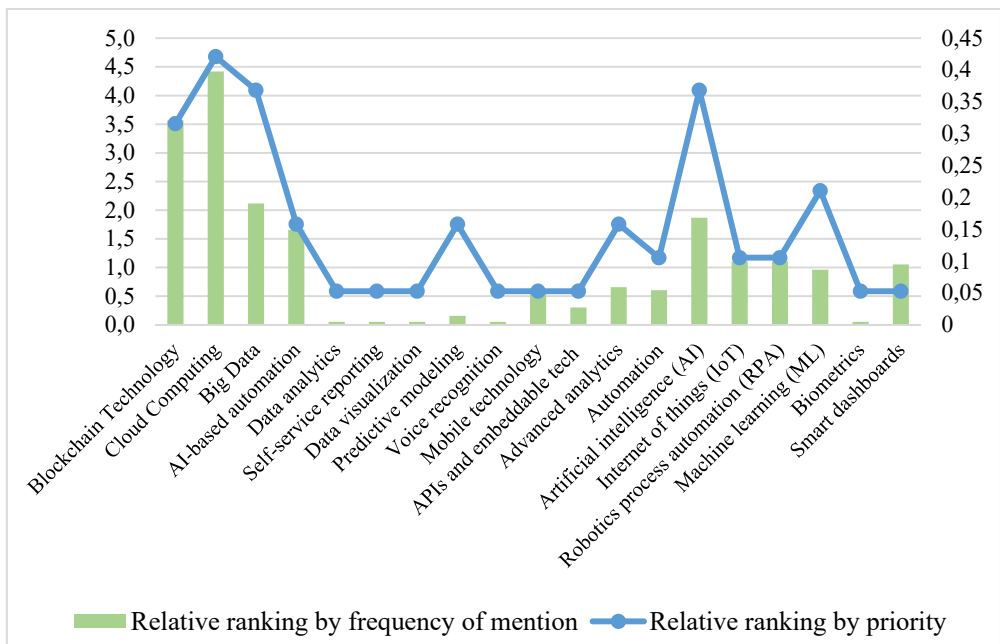
**Fig. 2.** Visualisation of the analysis of expert opinion on typical obstacles to the digital transformation of the accounting sector.

Thus, it can be stated that companies of different profiles of economic activity (including the fuel and energy sector) are in the mode of waiting for global decisions of government regulators, while understanding the benefits and difficulties of implementing declarative strategies of digital transformation of the accounting system of enterprises at the international level.

The expert resources also collected information on the digital tools of the Accounting 4.0 concept (Industry 4.0) and, based on the results of the professional focus groups' assessment of the benefits and impact on the accounting profession, formed the corresponding ratings, which have a fairly wide variation (Table 6 and Figure 3).

**Table 6.** Analysis of expert ratings of digital transformation tools for the accounting sector in the international accounting system.

Tools for digital transformation of the accounting sector	Analytics Steps Infomedia LLP	Maryville University	Finances Online	BDO USA LLP	Digital Adoption	Hitachi Solutions	DATAINTELO	Consultancy.asia	Smart Insights Ltd	Avega	Frequency of mention	Relative ranking by frequency of mention	Number of times the first leading position was taken	Number of times the second leading position was taken	Number of times the third leading position was taken	Relative ranking by priority
Blockchain Technology	1			6			1	8	1	3	6	0,31	3	0	1	3,6
Cloud Computing	2	2		1	4	1	2		2	5	8	0,421	2	4	0	4,4
Big Data	3	3	1				5	5	3	6	7	0,368	1	0	3	2,1
AI-based automation	1					2				4	3	0,158	1	1	0	1,7
Data analytics		4								1	0,053	0	0	0	0	0,1
Self-service reporting		5								1	0,053	0	0	0	0	0,1
Data visualisation		6								1	0,053	0	0	0	0	0,1
Predictive modelling		7		5				4		3	0,158	0	0	0	0	0,2
Voice recognition		8								1	0,053	0	0	0	0	0,1
Mobile technology			2							1	0,053	0	1	0	0	0,6
APIs and embeddable tech			3							1	0,053	0	0	1	0	0,3
Advanced analytics				3		4		3		3	0,158	0	0	2	0	0,7
Automation				2	6					2	0,105	0	1	0	0	0,6
Artificial intelligence (AI)				4	4	3	3	7	4	1	7	0,368	1	0	2	1,9
Internet of things (IoT)				5	1					2	0,105	1	0	0	0	1,1
Robotics process automation (RPA)					2			2		2	0,105	0	2	0	0	1,1
Machine learning (ML)					3			6	5	2	4	0,211	0	1	1	1,0
Biometrics						4				1	0,053	0	0	0	0	0,1
Smart dashboards								1		1	0,053	1	0	0	0	1,1



**Fig. 3.** Comparison of the parameter of the relative rating of expert assessments of tools and technologies for digital transformation of the accounting sector of economic activity.



In order to identify the median values, an approximation line of relative ranking (by priority) was formed, which takes into account the frequency of mentioning a particular technology or digital tool, as well as the frequency of occupation of the higher levels (TOP-3) of expert ratings of the compared tools for digital transformation of the accounting and auditing sphere.

According to the analysis of expert ratings of digital transformation tools for the accounting sector, experts have identified the most popular technological solutions: Cloud Computing, Blockchain Technology, Big Data, Artificial intelligence (AI), AI-based automation, etc.

After analysing the practical subject area, it is advisable to study the dynamics of research support of the focus area, taking into account the peculiarities of digital modernisation of the content of the accounting policy of fuel and energy companies. In accordance with the proposed research scheme, using the Publish or Perish software, we will establish a relevant array of taxonomic sets of 500 publications published in the period from 2018 to 2023 (Table 7).

Based on the analysis of 500 scientific articles for 5 years (2018-2023) using the Web of Science, Scopus, Google Scholar, Microsoft Academic and CrossRef databases (Table 7) on the implementation of digital technologies in the accounting system of fuel and energy enterprises, the following conclusions can be drawn:

1.The total number of citations of the articles is 19,866, which indicates a significant interest in this topic among scholars and practitioners.

2.The average number of citations per article is 39.73, which indicates the high relevance and importance of the study of this problem.

3.The number of authors per article is 2.88, indicating that the research is usually conducted by small groups of scientists or individually.

4.Scientometric indicators, such as h (62), g (134), hc (84) and hI (18.05), reflect the high scientific productivity and influence of authors publishing on the subject.

5.The frequency of publications and the growth in the number of citations, especially in recent years, indicate an increasing interest in digital technologies in the accounting system of fuel and energy enterprises.

**Table 7.** Results of the selection of relevant scientific publications in the Publish or Perish software.

Parameter	Value
Query	Implementation of digital technologies in the accounting system of the enterprise of the fuel and energy complex: management of the accounting policy in the conditions of global challenges
Source	Web of Science, Scopus, Google Scholar, Microsoft Academic, CrossRef
Papers	500
Citations	19866
Years	5
Cites Year	3973.20
Cites Paper	39.73
Cites Author	8091.96
Papers Author	253.50
Authors Paper	2.88
h_index	62
g_index	134

Parameter	Value
hc_index	84
hI_index	18.05
hI_norm	40
AWCR	9489.55
AW_index	97.41
AWCRpA	4054.55
e_index	106.99
hm_index	39.06
Cites_Author_Year	1618.39
hI_annual	8.00
h_coverage	77.0
g_coverage	91.0
star_count	147
year_first	2018
year_last	2023
ECC	19866
acc1	350
acc2	292
acc5	208
acc20	94
hA	43

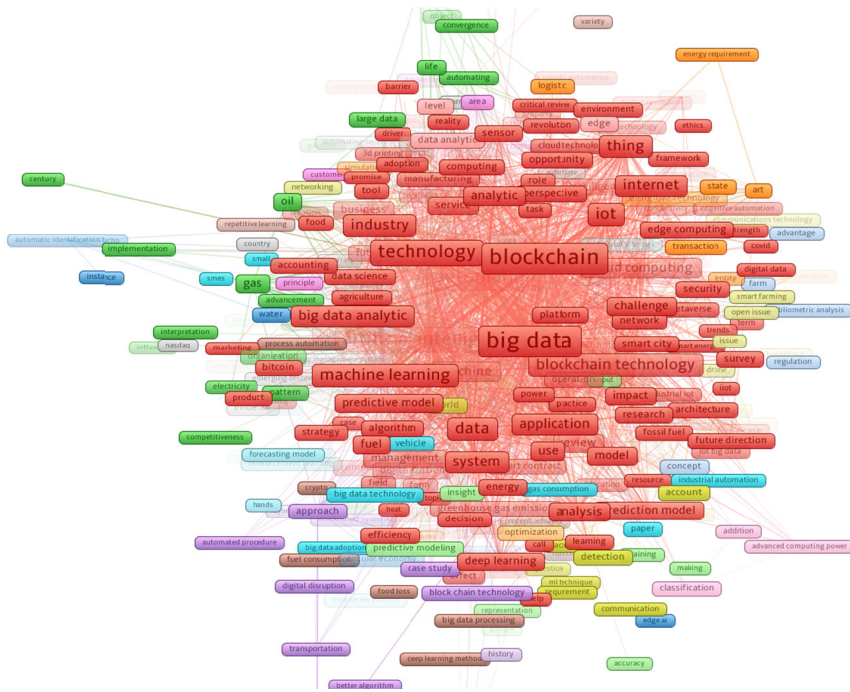
Given these conclusions, it can be argued that the implementation of digital technologies in the accounting system of fuel and energy enterprises is an urgent and important issue that attracts the attention of scientists and practitioners.

In accordance with the proposed research scheme, the next step is a graphical and analytical study of the relevant array of taxonomic sets generated in the Publish or Perish software using the VOSviewer software (Figure 4).

The resulting taxonomic set (Figure 4) consists of 522 taxonomic units, which are systematised into 22 clusters, connected by 12417 relationships with total linkage strength of 22472 relative units. The focal cluster (Figure 5(a)) contains references to all currently known tools and technologies of the Accounting 4.0 concept, and also demonstrates a strong scientometric connection with the accounting sector of fuel and energy companies (Figure 5 (b)).

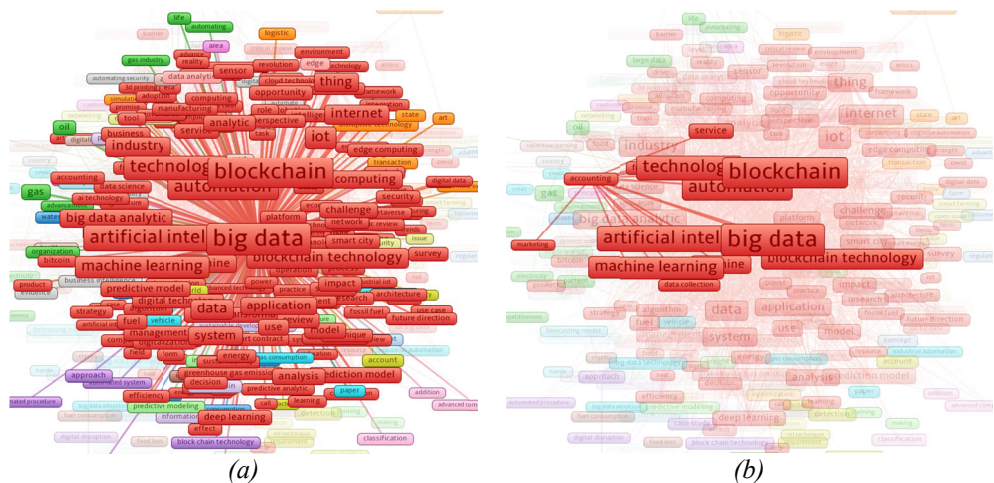
It is also interesting to analyse the dynamics of the development of the relevant array of taxonomic sets (Figure 6), which allows us to observe the formation of new digital factors of influence on the subject area, namely repetitive learning technologies, machine learning techniques, cognitive automation, etc.

Using the parameters of taxonomic and cluster relationships of the relevant data set, we will compare the digital tools of Accounting 4.0 (Industry 4.0) established in the previous research iteration (Table 8, Figure 7).

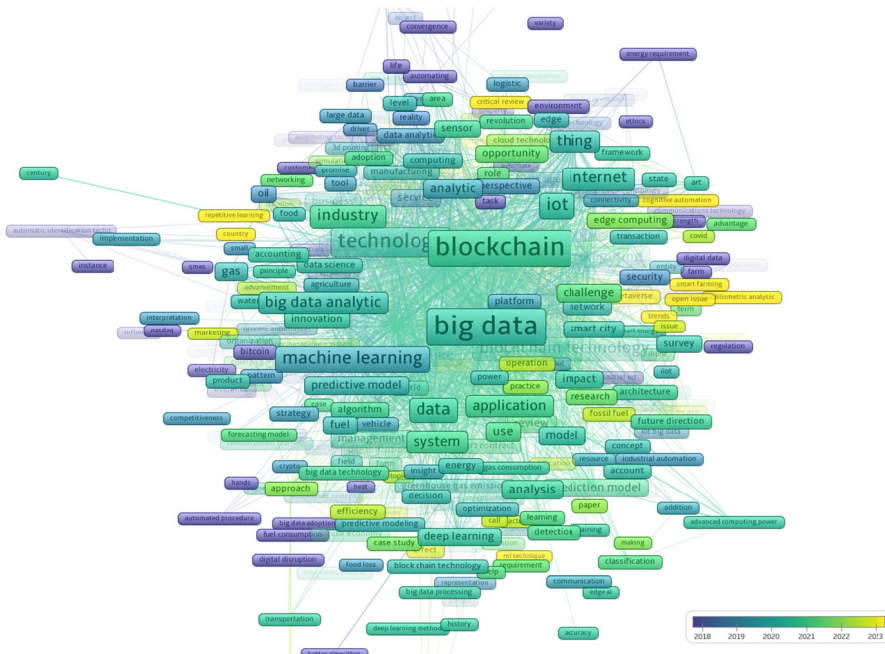


Source: Created by the authors in VOSviewer software

**Fig. 4.** Clustering of the relevant array of tasonometric sets on the impact of digital transformation on the accounting policy of enterprises of the fuel and energy profile of economic activity.



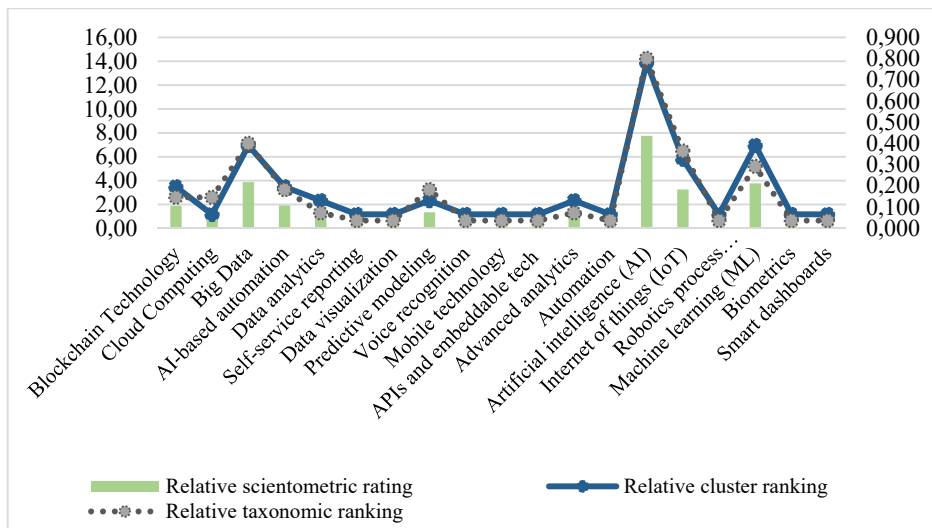
**Fig. 5.** Identification of the focal cluster (a) and the accounting sector's links to digital tools and technologies of the Accounting 4.0 concept (Industry 4.0) (b)



**Fig. 6.** Analysis of the chronometric dynamics of the relevant array of taxonomic sets on the impact of digital transformation tools on the accounting sector of fuel and energy companies.

**Table 8.** Establishing the relative scientometric rating of digital tools of the Accounting 4.0 concept (Industry 4.0).

Tools for digital transformation of the accounting sector	Power of taxonomic relationships	Relative taxonomic rating	The power of cluster connections	Relative cluster ranking	Relative scientometric rating
Blockchain Technology	4	0,146	3	3,5	1,88
Cloud Computing	4	0,146	1	1,2	0,72
Big Data	11	0,400	6	6,9	3,87
AI-based automation	5	0,182	3	3,5	1,92
Data analytics	2	0,073	2	2,3	1,23
Self-service reporting	1	0,036	1	1,2	0,62
Data visualisation	1	0,036	1	1,2	0,62
Predictive modelling	5	0,182	2	2,3	1,34
Voice recognition	1	0,036	1	1,2	0,62
Mobile technology	1	0,036	1	1,2	0,62
APIs and embeddable tech	1	0,036	1	1,2	0,62
Advanced analytics	2	0,073	2	2,3	1,23
Automation	1	0,036	1	1,2	0,62
Artificial intelligence (AI)	22	0,801	12	13,9	7,75
Internet of things (IoT)	10	0,364	5	5,8	3,26
Robotics process automation (RPA)	1	0,036	1	1,2	0,62
Machine learning (ML)	8	0,291	6	6,9	3,76
Biometrics	1	0,036	1	1,2	0,62
Smart dashboards	1	0,036	1	1,2	0,62



**Fig. 7.** Comparison of the relative scientometric ranking for digital transformation tools for the accounting sector of fuel and energy companies.

According to the comparative analysis of the relative scientometric ranking (Figure 7), it was found that Artificial intelligence (AI), Big Data, Machine learning (ML), Internet of things (IoT) and Blockchain Technology are the leading tools for digital transformation of the accounting sector of fuel and energy companies.

Thus, it can be stated that the redistribution of digital transformation tools in the accounting and auditing sector according to the relative scientometric rating parameter is different compared to the same indicator of the relative expert rating, particularly, the desire of the scientific community to integrate technologies based on the use of artificial intelligence and machine learning is clearly visible. Nevertheless, a correlation point has been recorded, namely the use of Big Data analytical tools.

According to the results of the analysis of the means of digital transformation of the accounting policy of economic and economic activities of fuel and energy companies obtained in the first two iterations of the current study, the optimal nomenclature of technical solutions that can potentially be integrated into the accounting and audit system is Cloud Computing, Blockchain Technology, Big Data, AI, ML, IoT.

Using the proposed research scheme, we will form an optimised strategy for the implementation of digital tools of the Accounting 4.0 (Industry 4.0) concept in the system of accounting and audit organization at enterprises of the fuel and energy sector - Table 9.

**Table 9.** Optimised strategy for the implementation of digital tools of the Accounting 4.0 concept (Industry 4.0) at enterprises of the fuel and energy industry.

Parameter	Meaning
Analysis of the current situation	Assessment of the existing infrastructure, technologies, accounting processes and systems at fuel and energy companies. Identification of the main challenges and opportunities related to the implementation of Accounting 4.0.
Defining goals and expected results	Setting specific goals related to increasing the efficiency of accounting, auditing, regulatory compliance, cybersecurity and the use of innovative technologies.
Determining the necessary range of technologies and tools	Selecting the Accounting 4.0 technologies and tools that are most suitable for achieving the set goals. Developing an implementation plan that includes resource allocation, timeframes, and responsible parties.

Parameter	Meaning
Integration of new technologies and processes	Implementation of the implementation plan and integration of new technologies, tools and processes into the existing accounting system of fuel and energy companies. Ensure a smooth transition and minimise obstacles to successful implementation.
Staff training and development	Organizing training courses, seminars and workshops for staff to familiarise them with new technologies, tools and processes related to Accounting 4.0. Providing support and motivation to employees to learn and adapt to new working methods.
Monitoring and control	Establishing monitoring and control mechanisms to track progress in the implementation of Accounting 4.0 identify problems and ensure timely resolution of these problems. Evaluate the effectiveness of implemented technologies and processes for continuous improvement.
Evaluation of results	Conducting regular assessments of the achievement of goals and results of Accounting 4.0 implementation. Identify possible improvements and adapt the strategy in accordance with the results.
Communication and reporting	Ensure transparent communication with all stakeholders on the progress of Accounting 4.0 implementation. Reporting on results and tracking goals at different levels of management.
Support and updates	Providing support and regular updates of Accounting 4.0 technologies and tools. Creating a transparent mechanism for updating and modernising accounting systems, adapting to changes in the regulatory environment and responding to the needs of the enterprise.
Contingent plan	Development of contingency plans in case of delays, problems or unforeseen circumstances during the implementation of Accounting 4.0. Include risk scenarios, possible deviations, and strategies to overcome them. Contingency plans should be flexible and adaptive to take into account unforeseen circumstances and ensure the successful implementation of Accounting 4.0 in the fuel and energy sector.

The implementation of the proposed strategy for implementing digital tools of the Accounting 4.0 concept (Industry 4.0) into the international accounting system at fuel and energy enterprises will help to optimise accounting processes, improve control and ensure compliance with regulatory requirements. As a result, enterprises will be able to increase their competitiveness in the market, ensure sustainability and business growth in the face of global challenges.

## 5 Discussion

The results of analytical iterations of the introduction of information technologies into the international accounting system of organisations in the fuel and energy sector, in particular, to establish the optimal nomenclature spectrum of means of digitalisation of the accounting and audit system of companies with a fuel and energy profile of economic and economic activity allowed us to form two corresponding sets of tools:

- according to the expert assessment: *Cloud Computing, Blockchain Technology, Big Data, Artificial intelligence (AI) and AI-based automation;*

- according to scientometric evaluation: *Artificial intelligence (AI), Big Data, Machine learning (ML), Internet of things (IoT), AI-based automation and Blockchain Technology.*

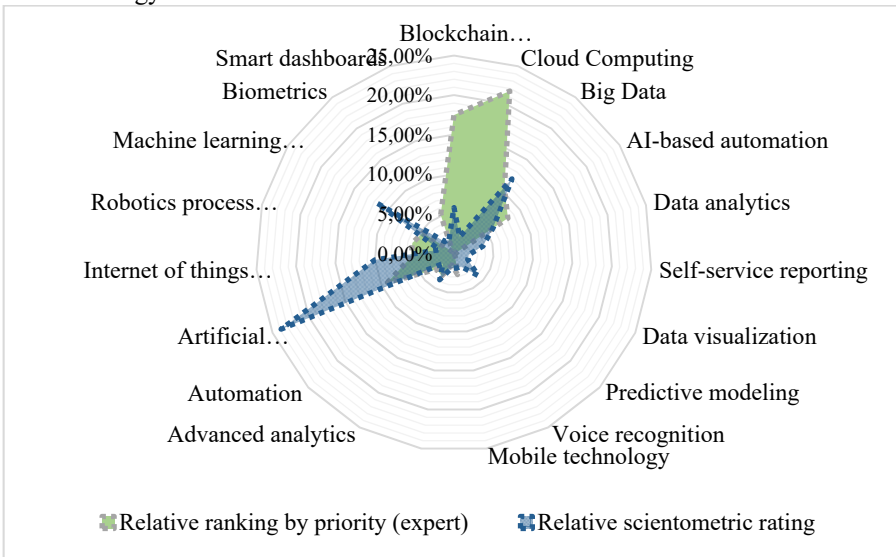
Let us perform a correlative comparison of the studied points of view using the percentage representation of the estimated relative coefficients (Table 10).

**Table 10.** Correlation analysis of the studied methods for determining the optimal nomenclature of digital transformation tools for the accounting and audit sector of fuel and energy companies.

Tools for digital transformation of the accounting sector	Relative ranking by priority (expert)		Relative scientometric rating	
	Rank	Percentage	Rank	Percentage
Blockchain Technology	3,6	17,48%	1,88	5,79%
Cloud Computing	4,4	21,68%	0,72	2,23%
Big Data	2,1	10,39%	3,87	11,92%
AI-based automation	1,7	8,13%	1,92	5,90%
Data analytics	0,1	0,26%	1,23	3,79%
Self-service reporting	0,1	0,26%	0,62	1,89%
Data visualisation	0,1	0,26%	0,62	1,89%
Predictive modelling	0,2	0,77%	1,34	4,12%
Voice recognition	0,1	0,26%	0,62	1,89%
Mobile technology	0,6	2,71%	0,62	1,89%
APIs and embeddable tech	0,3	1,48%	0,62	1,89%
Advanced analytics	0,7	3,23%	1,23	3,79%
Automation	0,6	2,97%	0,62	1,89%
Artificial intelligence (AI)	1,9	9,16%	7,75	23,83%
Internet of things (IoT)	1,1	5,42%	3,26	10,02%
Robotics process automation (RPA)	1,1	5,42%	0,62	1,89%
Machine learning (ML)	1,0	4,71%	3,76	11,58%
Biometrics	0,1	0,26%	0,62	1,89%
Smart dashboards	1,1	5,16%	0,62	1,89%

According to the data presented in Table 10, we observe a fundamental difference between the results of the expert and scientometric evaluation (Figure 8):

- Both assessments identify Blockchain Technology, Big Data, Artificial Intelligence (AI), AI-based automation and Internet of Things (IoT) as key technologies for digital transformation in the accounting sector;
- The expert evaluation gives a higher priority to Cloud Computing compared to scientometric evaluation. This may indicate that experts consider Cloud Computing to be more important for practical implementation, while scientific research may be less focused on this technology.



**Fig. 8.** Correlation analysis of the principles of expert and scientometric methodology in determining the optimal composition of digital transformation tools for the accounting sector of fuel and energy companies.

## 6 Conclusion

Based on the comparative analysis, it was established that the expert assessment favours tools that are usually associated with data processing and cybersecurity (Cloud Computing, Blockchain Technology, Big Data, AI-based automation). Whereas scientometric evaluation favors tools related to the development of artificial intelligence (Artificial intelligence (AI), Machine learning (ML), Internet of things (IoT), Blockchain Technology). Thus, the expert evaluation is more focused on the practical applicability of tools in the accounting sector, while scientometric evaluation is based on technological development. Despite some differences, both evaluation principles have a correlative point of contact – Big Data analytical tools, which, according to the concept of Accounting 4.0 (Industry 4.0), should be modernised with artificial intelligence and machine learning technologies, which will automate accounting processes, ensuring high accuracy and quality of accounting data, which is especially important for fuel and energy companies against the background of global challenges and cataclysms.

The identified optimal set of Accounting 4.0 (Industry 4.0) tools has the potential to reduce the negative impact of global challenges for fuel and energy companies:

1. Cloud Computing: Cloud computing provides businesses with the ability to scale their infrastructures and ensure the efficiency of their accounting systems. It also helps to reduce hardware and infrastructure costs and facilitates access to data from any location and device.

2. Blockchain Technology: Blockchain can increase the security and transparency of accounts, as the technology guarantees data immutability, traceability, and decentralization. It can also facilitate the automation of processes, such as instant payments and third-party settlements.

3. Big Data: The use of big data can help companies in the fuel and energy industry analyse and process large amounts of data to better understand market trends, identify financial risks, and identify opportunities for efficiency gains.

4. Artificial Intelligence (AI) and Machine Learning (ML): Artificial intelligence and machine learning can automate routine accounting processes and analyse large amounts of data for pattern detection and forecasting. This can help businesses in the fuel and energy industry improve efficiency, reduce errors, and provide better planning and control.

5. Internet of Things (IoT): The Internet of Things can help collect detailed data on the condition of infrastructure, equipment, and processes in the fuel and energy industry. This can help identify malfunctions and maintenance needs, ensuring the reliability and safety of production processes.

Consequently, the use of these technologies can help fuel and energy companies effectively address the effects of global challenges by providing more transparent and secure accounting processes, increasing efficiency and reducing equipment and infrastructure costs, and enabling more accurate and efficient planning and control.

The proposed strategy for implementing digital transformation tools in the accounting of fuel and energy sector companies (Table 9) will allow shifting the identified declarative intentions of these organisations and move to the practical implementation of optimisation solutions and technologies in the international accounting system of enterprises.

Study of the impact of digital transformation on accounting policy of enterprises was performed within the framework of state budget research: No. 0122U000774 «Digitalization and transparency of public, corporate and personal finance: the impact on innovation development and national security».



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