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Sustainable Accounting Transformation Through Cloud Technologies: Evidence from Romania

Laura Nicola-Gavrilă*, Anca-Mădălina Bogdan, Gabriela-Mihaela Cocoșilă

Faculty of Juridical, Economic and Administrative Science, Spiru Haret University, 200580 Craiova, Romania

* Correspondence: Laura Nicola-Gavrilă (laura.gavrila@spiruharet.ro)

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Abstract: This study investigates how cloud accounting technologies contribute to the sustainable transformation of business management in Romania. It aims to assess the relationship between digitalization and sustainability by examining how cloud-based systems enhance financial transparency, operational efficiency, and the integration of Environmental, Social, and Governance (ESG) principles in accounting practices. The research applies a multi-utility global method (MUGM) framework to evaluate sustainability-oriented accounting practices across multiple economic sectors, including IT, automotive, energy, and food industries. Data were collected through structured surveys and expert validation to determine sector-specific performance scores. The analysis integrates both subjective assessments and objective indicators, such as reductions in paper usage, cost efficiency, and reporting timeliness—to evaluate sustainability outcomes and potential biases. The results reveal significant sectoral variation in the adoption and sustainability impact of cloud accounting. The IT and automotive sectors lead in digital integration and ESG-oriented financial reporting, while the energy and food industries demonstrate moderate progress constrained by regulatory and investment limitations. Cloud technologies are shown to facilitate improved ESG data management, enhance corporate accountability, and support the EU twin transition, the simultaneous pursuit of digitalization and sustainability. This research extends sustainability accounting literature by positioning cloud computing as a driver of responsible corporate governance and ESG transparency. It bridges the gap between digital transformation and sustainability by demonstrating how intelligent technologies can operationalize sustainability objectives in financial management and reporting.

Keywords: Cloud accounting; Sustainability accounting; ESG; Digital transformation; Automation in accounting; Sector-specific strategies

1. Introduction

In recent years, digitalization of business operations has profoundly transformed the accounting profession, positioning cloud technologies as essential tools for sustainable business management. Beyond their functional advantages, cloud-based accounting systems represent a key driver in the transition toward a sustainable and circular economy, where resource efficiency, transparency, and social accountability are central. The integration of digital tools within accounting aligns with the principles of sustainable transformation, particularly through their capacity to reduce paper consumption, optimize resource allocation, and foster real-time decision-making processes.

In the European context, the growing relevance of Environmental, Social, and Governance (ESG) reporting and the Corporate Sustainability Reporting Directive (CSRD) (Greenplaces, 2021) underscore the strategic importance of digital infrastructures capable of supporting transparent and standardized data management. For Romania, a country still bridging the gap between traditional and digital business ecosystems, the adoption of cloud accounting reflects both a technological and cultural shift towards sustainable governance models. Romanian enterprises increasingly recognize the value of digital transformation not only as a means to improve financial efficiency but also as a catalyst for sustainable business practices and alignment with the European Green Deal.

This study investigates the implications of cloud accounting adoption for sustainable business management in

Romania, addressing how technological innovation can support economic competitiveness, environmental responsibility, and social accountability. By applying the multi-utility global method (MUGM) framework and expanding it to incorporate sustainability dimensions, the research offers empirical evidence of how cloud accounting contributes to sustainable digital transformation at the enterprise level.

On one hand, the automation of tasks and processes traditionally handled by accountants may feel unsettling, as information technology enables machines to take over many routine functions (Rowbottom et al., 2021). On the other hand, digital transformation also presents an opportunity by freeing accountants from monotonous tasks, allowing them to redirect their efforts towards more strategic, value-adding activities. This shift can enhance job satisfaction and promote a more dynamic role for accountants, enabling them to focus on decision-making and analysis rather than administrative chores (Gonçalves et al., 2022).

In 2024, businesses will face an intensifying push to meet regulatory requirements for sustainability reporting, particularly concerning climate and biodiversity impacts. This shift is driven by global standards, such as the EU's CSRD, which mandates greater transparency regarding a company's environmental and social impact. Cloud-based systems facilitate real-time data collection and analysis, allowing businesses to maintain transparency and meet the diverse expectations of stakeholders such as consumers, environmental organizations, and civil society (Greenplaces, 2021).

Interestingly, while data collection and reporting technologies have seen considerable advancements, the format and structure of corporate reporting have remained relatively traditional for centuries, creating a stark contrast to the rapid pace of technological evolution. However, the nature of the stakeholders receiving these reports has evolved significantly. Today, it's not just shareholders and investors demanding accountability but also a wide range of stakeholders, including consumers, environmental organizations, and civil society groups.

This ongoing transformation poses the question: how can businesses improve the way they report essential information? The answer lies in adopting more transparent, accessible, and innovative data presentation methods, which go beyond traditional corporate reporting frameworks. Companies are now expected to provide not only accurate data but also insights that are easy to understand for diverse stakeholders.

In fact, transformations in accounting are being driven by emerging technologies such as artificial intelligence (AI), cloud computing, and blockchain, which are reshaping how financial data is collected, analysed, and reported. Atanasovski et al. (2020) critically examine the disruptive potential of blockchain technology within the accounting and assurance profession. Their study highlights key limitations, including scalability, transaction costs, interoperability, and confidentiality concerns, which hinder the widespread adoption of blockchain-based accounting information systems. AI, in particular, is enhancing the efficiency and accuracy of tasks such as data entry, financial forecasting, and anomaly detection, allowing for real-time insights that were previously difficult to obtain. With machine learning algorithms, AI can automate routine tasks like auditing, detecting fraud, and analysing financial trends, reducing human error and improving decision-making capabilities.

Cloud computing enhances accounting solutions by enabling organizations to centralize financial data on the cloud, which in turn improves collaboration, streamlines workflows, and enhances data security. This technology allows for real-time updates to financial reports, making it easier for businesses to maintain accuracy and stay agile. The flexibility of cloud solutions is particularly beneficial for businesses with remote teams or global operations, as they allow for seamless access to financial information regardless of location. Using cloud-based accounting platforms, businesses can significantly reduce the need for complex hardware infrastructure, minimize operational costs, and streamline workflows (Tiron-Tudor et al., 2022).

Recent research has also highlighted how the integration of business intelligence and digital technologies contributes to sustainable development through enhanced data-driven performance evaluation, supporting transparency and efficiency in decision-making (Awamleh et al., 2024). Furthermore, cloud computing ensures that critical financial data is backed up and protected against potential data breaches, providing enhanced security compared to traditional on-premise systems (Dawood et al., 2023).

Looking toward the future, it is fascinating to think about how accounting professionals in 2060 will assess the technologies we rely on today. It is likely that they will have access to significantly more advanced data analysis tools, powered by artificial intelligence, for financial forecasting and auditing. Blockchain could be a foundational element in ensuring transparent, tamper-proof records, while AI may evolve to assist in more complex decision-making processes in business management. Neural interfaces for managing accounting data, however, remain speculative for now, as the integration of brain-computer interfaces is still in early stages of development. Technological advancements remind us that what seems ground-breaking today may soon be seen as standard practice. As we look to the future, it is exciting to consider the innovations that will emerge over the next few decades, transforming the accounting profession and providing solutions to challenges that have yet to arise. These advances will continue to reshape how financial data is processed, analysed, and used in decision-making, improving efficiency and accuracy across industries (Jiménez-Partearroyo & Medina-López, 2024; Odonkor et al., 2024).

2. Background Research

The digital transformation of accounting is rooted in a long history of technological advancement, beginning with the shift from manual bookkeeping to computerized systems. Manual bookkeeping, while foundational, was labour-intensive and prone to human error, creating a need for greater efficiency and accuracy. The introduction of computerized accounting systems addressed these limitations by automating repetitive tasks, standardizing procedures, and employing software capable of handling complex calculations. Early research (Corkern et al., 2015; Zhang, 2014) emphasized the resulting productivity gains, particularly reductions in processing time and error frequency.

A major turning point came with the emergence of Software-as-a-Service (SaaS) in the early 2000s. SaaS enabled the widespread adoption of cloud-based accounting platforms, offering organizations scalable, cost-effective, and real-time access to financial data. By removing the need for local installations and extensive IT infrastructure, SaaS solutions democratized access to advanced accounting tools (Raghavan et al., 2020). This technological shift also marked the beginning of the green digital transition, reducing hardware waste and resource consumption while fostering sustainable operational practices (Moro-Visconti, 2022).

Today, cloud computing stands at the centre of this transformation, redefining how financial information is managed, analyzed, and disclosed. Cloud platforms such as QuickBooks Online and NetSuite not only enhance accessibility and data security but also support the ESG agenda by promoting transparency, energy efficiency, and responsible data management. Real-time information access improves decision-making and reduces the environmental footprint associated with paper-based and server-intensive systems (Abou-El-Sood, 2024). Earlier research (Groșanu et al., 2020; Gulluscio et al., 2020; Rittinghouse & Ransome, 2009) highlighted the theoretical benefits of these advancements, focusing on their potential to enhance flexibility and automation. Recent studies, however, go further. For instance, Koehler et al. (2020), Marnila & Octafian, (2024) and Sastararuji et al. (2022) demonstrate that cloud accounting contributes directly to sustainability reporting, enabling the integration of financial and non-financial indicators required under frameworks such as the EU CSRD and Global Reporting Initiative (GRI).

The integration of automation and artificial intelligence (AI) has further accelerated the sustainability impact of digital accounting. Technologies such as Robotic Process Automation (RPA) and machine learning improve the accuracy and speed of transactional processes (Costa et al., 2022; Ribeiro et al., 2021) while freeing human capital for analytical and governance-related tasks. This transition supports the social dimension of sustainability by promoting higher-value work and continuous professional learning. Moreover, recent research (Aldemir & Uçma Uysal, 2025) emphasizes that AI-driven accounting systems enhance accountability and facilitate real-time monitoring of ESG performance metrics across organizations.

Another milestone in the profession's evolution is the adoption of digital financial reporting standards (La Torre et al., 2018), notably eXtensible Business Reporting Language (XBRL). XBRL enables standardized, transparent, and machine-readable financial disclosures, improving data comparability and auditability across jurisdictions (Hoitash et al., 2020; Hwang et al., 2021). Its mandatory use under the European Single Electronic Format (ESEF) since 2021 reinforces the connection between digital transformation and sustainable governance. Recent literature (de Villiers et al., 2022; Tawiah & Borgi, 2022) highlights XBRL's role in enhancing the reliability of sustainability-related information, thereby bridging financial accounting with ESG and integrated reporting frameworks.

In summary, the evolution from manual bookkeeping to cloud-based, automated, and standardized digital systems has not only optimized accounting efficiency but also embedded sustainability and ESG principles into the profession's core functions. Contemporary accounting technologies contribute to environmental goals by reducing resource consumption, to social goals by empowering professionals and enhancing transparency, and to governance goals by enabling standardized, verifiable reporting. This transformation positions accounting as a proactive component of the European "twin transition", the simultaneous pursuit of digitalization and sustainability (European Commission, 2022), and as a cornerstone of responsible, data-driven corporate governance.

3. Research Methodology

The conceptual framework of this study situates cloud accounting within the broader paradigm of sustainable digital transformation, emphasizing how technology adoption supports ESG objectives. Cloud accounting is not merely a digital tool for operational efficiency; it represents a strategic enabler of sustainable business management, fostering transparency, accountability, and responsible resource use.

This study builds on the principles of Sustainable Accounting (Laine et al., 2021), which highlight the integration of financial and non-financial performance in decision-making, and on Green Information Systems (Green IS) theory (Mat Nawi et al., 2025), which frames digital technologies as drivers of environmental and social performance. Within this context, cloud accounting systems contribute to environmental sustainability through paperless operations, reduced energy consumption, and optimized resource use; to social sustainability through

improved data accessibility and collaboration; and to governance through enhanced auditability and compliance with sustainability reporting standards such as the CSRD and the GRI.

The framework incorporates the MUGM model, originally designed for multi-criteria decision analysis (MCDA), which allows for the simultaneous assessment of technological, economic, and sustainability dimensions. The model captures trade-offs among key criteria (software, automation, data analysis, security, positioning cloud accounting as an integral component of ESG-oriented information systems and the broader sustainability transition of Romanian enterprises. Each of these dimensions is examined not only from a theoretical standpoint but also through the lens of professionals' practical experiences, with the aim of understanding how cloud technologies reshape accounting practices, enhance financial efficiency, and support the integration of ESG principles within organizations.

Dimension 1: Cloud-Based Accounting Software

Cloud-based accounting software underpins the modernization of financial operations by enabling real-time data access and integration across a virtual environment. This eliminates reliance on traditional hardware infrastructures while reducing maintenance costs. Furthermore, it fosters collaboration between financial departments and other organizational units. For example, in the IT sector, the scalability and flexibility of cloud solutions align with the dynamic nature of the industry. Conversely, in the automotive sector, cloud software supports the seamless integration of global financial processes, addressing complex operational needs.

Dimension 2: Automation of Accounting Processes

Replacing manual and repetitive tasks with automated solutions enhances both efficiency and accuracy. Activities such as data entry and bank reconciliation are streamlined, minimizing human error while enabling accounting professionals to focus on high-value strategic activities. This research explores the varying benefits across industries: in the food sector, automation simplifies supply chain management, while in the energy sector, it facilitates resource allocation and reduces operational costs.

Dimension 3: Data Analysis and Financial Reporting

Advanced data analytics transforms financial decision-making by generating actionable insights from vast datasets. Tools integrated into cloud solutions enable organizations to identify trends, forecast performance, and optimize resources. The IT sector leverages these capabilities to navigate its complex and fast-evolving market landscape, while in the automotive industry, data-driven insights support strategic decisions regarding production and sales.

Dimension 4: Data Security and Compliance

In an era where the complexity of financial data is growing, robust cybersecurity measures and regulatory compliance are indispensable. Cloud accounting solutions address these priorities by implementing advanced protections, such as encryption and multi-factor authentication, ensuring the confidentiality and integrity of sensitive data. Compliance with regulations, including GDPR and financial reporting standards, is automated, reducing the risk of errors and enhancing transparency. The IT sector prioritizes stringent data protection due to the nature of its operations, while the energy sector emphasizes securing critical infrastructures.

3.1 Study Design and Data Collection Methodology

This research aims to analyse the perceptions and level of involvement of accounting professionals in Romania regarding the digitalization of accounting, focusing specifically on members of the Body of Expert and Licensed Accountants of Romania (CECCAR). This professional group, which is actively engaged in accounting processes, provides valuable insights into the transition toward modern financial management technologies.

The primary data collection tool employed in this study was a structured questionnaire, designed to capture the perspectives and experiences of accounting professionals regarding the transition to digital accounting processes and their adaptation to emerging technologies. The questionnaire, detailed in Appendix 1, comprised seven sections, each targeting distinct facets of digital accounting adoption and implementation. To collect the necessary data, a survey was conducted among accountants across four distinct sectors: the automotive industry, information technology, energy, and food. The selection of these sectors reflects a strategic approach to capturing a diverse range of perspectives and challenges related to the implementation of digital accounting within various organizational contexts. This structure allowed the identification of the four main dimensions of cloud accounting (D1–D4), with two or three sub-criteria specified for each dimension, providing a nuanced framework for analysis (see the Appendix 1).

This study employs MCDA approach using the MUGM to evaluate the degree to which cloud accounting supports sustainable business transformation across different economic sectors in Romania. The MUGM method is theoretically consistent with sustainability-oriented evaluations because it allows for the aggregation of diverse quantitative and qualitative indicators into a unified utility score, reflecting the multidimensional nature of sustainable performance (Aktaş & Demirel, 2021; Zhang et al., 2023). Compared with other MCDA methods such as AHP or TOPSIS, MUGM offers a flexible structure that facilitates sensitivity testing**,** inter-criteria comparison**,** and the inclusion of subjective expert judgments alongside objective performance indicators.

To enhance methodological rigor, the weight assignment process followed a two-step validation procedure:

(1) A Delphi-style consultation with six academic and professional experts (three university accounting scholars and three practitioners affiliated with CECCAR Romania), who rated the relevance of each dimension on a five-point scale.

(2) A sensitivity analysis testing ±10% variations in weights to evaluate the robustness of the final utility scores. Results confirmed that such variations did not significantly alter the overall sectoral rankings, thus supporting the method's stability and reliability.

The five evaluation dimensions include: software efficiency and interoperability, automation and workflow integration, data analysis and decision support, security and regulatory compliance.

The survey data, consist in 323 valid responses across the IT, automotive, energy, and food sectors, were analyzed to assess both perceived and objectively reported sustainability outcomes. Objective indicators such as paper reduction, cost savings, and reporting timeliness were included to complement perception-based scores and to mitigate potential subjective bias in responses. The study focused on four core dimensions of cloud accounting, each assigned a specific weight, and gathered the perspectives of accounting professionals from four strategically selected sectors. These sectors were chosen to represent the diverse challenges and opportunities associated with implementing cloud-based accounting solutions:

IT (v1): A sector known for its rapid adoption of digital technologies.

Automotive (v2): An industry with stringent requirements for operational efficiency.

Energy (v3): A domain with a strong focus on data security.

Food (v4): A sector emphasizing flexibility in financial processes.

Table 1 presents an organized overview of how these four dimensions of cloud accounting (D1–D4) align with the needs and characteristics of the four selected sectors: IT, Automotive, Energy, and Food. Each dimension is analysed for its relevance and specific contribution to the efficiency and effectiveness of business management within the respective sector.

Table 1. Dimensions of cloud accounting and sector relevance

Dimension	Sector	Relevance
D1. Cloud Accounting Software	IT (v1)	Critical for scalable infrastructure, easy integration with other software systems.
	Auto (v2)	Facilitates global financial process integration and supply chain management.
	Energy (v3)	Essential for managing large volumes of financial & contractual data.
	Food (v4)	Enhances efficiency in monitoring costs and inventory.
D2. Automation of Accounting Processes	IT (v1)	Maximizes efficiency for agile environments.
	Auto (v2)	Essential for managing high transaction volumes.
	Energy (v3)	Supports efficient resource allocation and reduces operational costs.
	Food (v4)	Simplifies order management and billing processes.
D3. Data Analysis and Reporting	IT (v1)	Offers competitive insights through predictive analysis.
	Auto (v2)	Supports strategic decisions on production and sales.
	Energy (v3)	Aids in consumption forecasting and resource allocation.
	Food (v4)	Facilitates seasonal demand analysis and supply chain optimization.
D4. Data Security and Compliance	IT (v1)	High relevance due to the sensitive nature of data.
	Auto (v2)	Critical for safeguarding client and partner data globally.
	Energy (v3)	Vital for protecting critical infrastructure
	Food (v4)	Ensures transparency in the supply chain and protects client data.

Table 1 demonstrates the cross-sector relevance of cloud accounting dimensions, with each sector prioritizing these dimensions differently based on its operational demands and challenges. This differentiation underscores the need for sector-specific strategies when implementing cloud-based accounting solutions. The table also highlights the versatile role of cloud technologies in enhancing operational efficiency, decision-making, and compliance across diverse industries.

3.2. Application of the MUGM

To analyse the complexity and diversity of the collected data, this research adopts the MUGM, an advanced multi-criteria analysis technique that allows for the evaluation of the impact of different cloud accounting solution implementation options. This method involves assigning a weight to each of the four dimensions of cloud accounting based on their relative importance within each sector. Additionally, each dimension is evaluated in terms of performance, with respondents assigning scores on a scale from 1 to 5. This approach facilitates a rigorous comparative assessment, providing an overview of how various economic sectors value and implement cloud accounting technologies.

For each sector, the relative importance of the dimensions (D1–D4) is determined, considering the needs and priorities of each industry. For example, the IT sector may place greater emphasis on data security, while the food

sector may prioritize data analysis. In this context, the distribution of weights is designed so that the sum of the weights for all dimensions equals 1. Within each dimension, the weights for sub-criteria are assigned proportionally based on perceived importance. As a result, the weight distribution for dimensions D1–D4 in the study is as shown in Table 2.

Table 2. Weight distribution for dimensions

Dimension/Criterion	Weight (W_i)
D1. Cloud Accounting Software	0.30
D2. Automation of Accounting Processes	0.25
D3. Data Analysis and Reporting	0.20
D4. Data Security and Compliance	0.25

Each sector will be evaluated based on the performance of digital solutions in each of the selected dimensions. Scores for each criterion are assigned on a scale from 1 (low impact) to 5 (high impact). For instance, cloud accounting solutions may receive different scores depending on the sector in which they are implemented. Table 3 presents the scores assigned to each sector based on the specific dimensions of cloud accounting. Each sector's performance in the relevant dimension is rated according to the weight assigned, allowing for a clear comparison of how the sectors perceive and implement cloud accounting technologies.

Table 3. Sector performance scores for each criterion

Criterion/Sub-Criterion	Weight (W_i)	IT (v1)	Auto (v2)	Energy (v3)	Food (v4)
D1. Cloud Accounting Software	0.30	5	4	3	4
D2. Automation of Accounting Processes	0.25	4	5	3	4
D3. Data Analysis and Reporting	0.20	5	4	3	3
D4. Data Security and Compliance	0.25	4	4	5	3

The global utility (U_G) for each sector is determined through the weighted sum of each sector's performance across the four key dimensions of cloud accounting. The calculation method uses the formula:

$$U_G = \sum_{i=1}^{n} W_i * U_i$$

where, W_i represents the weight of each criterion (or dimension), U_i represents the score assigned to each sector for a specific criterion.

The scores reflect how each sector values the different dimensions of cloud accounting, considering their specific needs and priorities. The global utility for each sector, which takes into account the weights and the sector-specific scores, is summarized in Table 4.

Table 4. Global utility scores for cloud accounting across different sectors

Sector	Global Utility (U_G)
IT (v1)	4.35
Automotive (v2)	4.10
Energy (v3)	3.50
Food (v4)	3.90

3.3 Integration of Sub-Criteria into the Analysis

To enhance the depth of the initial analysis and provide a comprehensive understanding of the impact of cloud accounting across various economic sectors, it is essential to incorporate sector-specific sub-criteria for each of the key dimensions being analysed. These sub-criteria facilitate a more granular and nuanced evaluation, allowing for the identification of not only the strengths and weaknesses inherent to each sector but also uncovering areas with significant potential for improvement in the adoption and implementation of cloud accounting solutions. By assessing the unique needs, challenges, and priorities of each sector, these sub-criteria help to create a tailored framework that can more effectively inform decision-making, ensuring that cloud accounting technologies are implemented in ways that maximize their benefits while addressing specific sectoral requirements. This approach also allows for a better understanding of how different industries prioritize various aspects of cloud accounting, such as data security, automation, and real-time analytics, and how these priorities shape their approach to technological adoption and integration.

D1. Cloud Accounting Software

Proposed sub-criteria:

- D1.1. Scalability and Adaptability of the Cloud Solution

Scalability analyses the software's ability to adapt to the growing needs of the organization. Especially for sectors such as IT and Energy, where data volume can fluctuate significantly, scalability and adaptability are essential for maintaining performance and efficiency. Examples include rapidly expanding storage space or integrating with other financial applications used by the company, providing organizations with flexibility and operational efficiency.

- D1.2. Costs Associated with Implementation and Maintenance

Costs are a significant factor in adopting cloud solutions, particularly in sectors such as Food and Automotive, where IT budgets may be limited. This sub-criterion evaluates implementation and maintenance costs, including monthly subscriptions and technical support fees. Analysing costs per user compared to savings gained through process automation and improved accessibility is crucial for determining the return on investment.

D2. Automation of Accounting Processes

Proposed sub-criteria:

- D2.1. Degree of Automation of Repetitive Processes

Evaluating the degree of automation focuses on core processes such as data entry, bank reconciliation, and invoice processing. A high degree of automation can significantly reduce the time required for these activities, which is beneficial for sectors such as Automotive, where process efficiency is a key factor for operational success.

- D2.2. Impact on Operational Efficiency

Automation not only reduces the time spent on repetitive tasks but also optimizes the resources needed for daily operations. Its impact on operational efficiency manifests through reduced errors and increased speed in accounting processes, which is essential for sectors such as IT, where performance and agility are crucial.

- D2.3. Integration of Artificial Intelligence (AI)

Integrating AI into accounting processes can address more complex challenges, such as financial risk analysis, cash flow forecasting, and automatic transaction classification. For sectors like IT, AI can add significant value by improving accuracy and decision-making based on predictive analysis.

D3. Data Analysis and Reporting

Proposed sub-criteria:

- D3.1. Accessibility and Customization of Reports

Accessibility to financial reports, as well as the ability to customize them, are essential to ensuring an optimal user experience. In sectors like Automotive and Food, where financial decisions must be made quickly and accurately, the ability to customize reports to suit organizational needs is a critical success factor.

- D3.2. Quality and Accuracy of Data Analysis

This sub-criterion examines the details and accuracy of financial analyses generated by cloud solutions, being essential across all sectors. Particularly for IT, where analysing trends and market behaviour is important, the quality of reports can provide valuable insights for strategic decisions.

- D3.3. Use of Predictive Data and Advanced Analytics

Integrating predictive analytics technologies, such as machine learning, into financial data analysis presents an opportunity for organizations in sectors with rapid data fluctuations (such as IT and Energy) to improve financial forecasting and make decisions based on relevant, up-to-date data.

D4. Data Security and Compliance

Proposed sub-criteria:

- D4.1. Cybersecurity Protection Level

Cybersecurity measures, such as data encryption and two-step authentication, are essential for ensuring the integrity and confidentiality of financial information. This sub-criterion is particularly relevant for sectors like Energy, where the security of financial data is critical to preventing unauthorized access.

- D4.2. Compliance with International Regulations

Cloud solutions must comply with international regulations, such as GDPR and SOX, to avoid penalties and ensure legal compliance. In sectors like Automotive and IT, where regulations are stringent, this sub-criterion plays a crucial role in determining the choice of cloud accounting solution.

- D4.3. Risk Management and Data Recovery

Assessing the capacity to prevent data loss and implement effective recovery plans is an essential aspect of security. The Energy sector, in particular, needs to ensure that cloud solutions include adequate measures for protecting vital data and recovering it in the event of cyber incidents.

Application of the Global Utility Method for D1–D4 with Sub-Criteria

To apply the global utility method, we will calculate the utility of each criterion and sub-criterion based on the weights from Table 4 and the scores assigned to each sub-criterion. The global utility for each dimension and, subsequently, for cloud accounting solutions, is obtained by multiplying the weight of each criterion by the associated score and summing these values. The global utility method assists in the overall evaluation of a cloud

accounting solution by aggregating the utilities for each dimension and sub-criterion, providing a detailed view of the solution's efficiency and adaptability to the organization's needs.

To apply the global utility method for the cloud accounting criteria (D1–D4) with the selected sub-criteria, a script (see Appendix 2) was developed to automate these calculations, ensuring consistency and accuracy in the analytical process. The following steps were undertaken:

Step 1: Identification of Weights for Each Criterion and Sub-Criterion: The weights provided in Table 4 were utilized. These weights reflect the relative importance of each criterion (D1–D4) and their respective sub-criteria.

Step 2: Assignment of Scores for Each Sub-Criterion: Scores were assigned based on expert opinions from professionals in the relevant sectors. These scores range from 1 (low impact) to 5 (high impact), reflecting how each sector assesses the significance of each sub-criterion. The assigned weights and scores for each sub-criterion across the four sectors are summarized in Table 5, which illustrates how sectoral differences influence the utility values obtained for each dimension."

Step 3: Calculation of Utility for Each Dimension and Sub-Criterion: The score for each sub-criterion was multiplied by its respective weight to determine the utility for each sub-criterion.

Table 5. Assign scores and calculate utility for each sub-criterion

Criterion/Sub-Criterion	Weight (W)	Score IT (v1)	Score Auto (v2)	Score Energy (v3)	Score Food (v4)	Utility IT (v1)	Utility Auto (v2)	Utility Energy (v3)	Utility Food (v4)
D1. Cloud Accounting Software	0.30	5	4	3	4	1.50	1.20	0.90	1.20
D1.1 Degree of Automation of Repetitive Processes	0.15	5	4	3	4	0.75	0.60	0.45	0.60
D1.2 Costs Associated with Implementation and Maintenance	0.15	4	4	3	3	0.60	0.60	0.45	0.45
D2. Automation of Accounting Processes	0.25	4	5	3	4	1.00	1.25	0.75	1.00
D2.1 Degree of Automation of Repetitive Processes	0.10	4	5	3	4	0.40	0.50	0.30	0.40
D2.2 Impact on Operational Efficiency	0.10	5	5	4	4	0.50	0.50	0.40	0.40
D2.3 Integration of Artificial Intelligence (AI)	0.05	3	3	2	3	0.15	0.15	0.10	0.15
D3. Data Analysis and Reporting	0.20	5	4	3	3	1.00	0.80	0.60	0.60
D3.1 Accessibility and Customization of Reports	0.08	5	4	3	3	0.40	0.32	0.24	0.24
D3.2 Quality and Accuracy of Data Analysis	0.07	5	4	3	3	0.35	0.28	0.21	0.21
D3.3 Use of Predictive Data and Advanced Analytics	0.05	5	5	4	3	0.25	0.25	0.20	0.15
D4. Data Security and Compliance	0.25	4	4	5	3	1.00	1.00	1.25	0.75
D4.1 Cybersecurity Protection Level	0.10	4	4	5	3	0.40	0.40	0.50	0.30
D4.2 Compliance with International Regulations	0.08	4	4	5	3	0.32	0.32	0.40	0.24
D4.3 Risk Management and Data Recovery	0.07	4	4	5	3	0.28	0.28	0.35	0.21

Step 4: Aggregation of Utilities: The utilities of the sub-criteria within each dimension (D1–D4) were summed

to calculate the total utility of each dimension. The total utility for each dimension, derived by aggregating the sub-criterion utilities, is presented in Table 6, showing how each dimension contributes to the overall performance in different sectors.

Step 5: Calculation of Global Utility for Each Sector: The overall global utility for each sector was calculated by summing the utilities of each dimension (D1–D4), using sector-specific weights. Finally, the overall global utility scores for each sector, obtained by summing the utilities of all four dimensions (D1–D4), are presented in Table 7. These results provide a comparative overview of the level of cloud accounting adoption and sustainability performance across the IT, automotive, energy, and food industries.

Table 6. Calculate total utility for each dimension

Criterion	Total Utility IT (v1)	Total Utility Auto (v2)	Total Utility Energy (v3)	Total Utility Food (v4)
D1. Cloud Accounting Software	1.50	1.20	0.90	1.20
D2. Automation of Accounting Processes	1.00	1.25	0.75	1.00
D3. Data Analysis and Reporting	1.00	0.80	0.60	0.60
D4. Data Security and Compliance	1.00	1.00	1.25	0.75

Table 7. Calculate global utility for each sector

Sector	Global Utility (U_G)
IT (v1)	4.50
Automotive (v2)	4.25
Energy (v3)	3.50
Food (v4)	3.55

4. Results Interpretation and Discussions

4.1 Dimensions (D1–D4) Without Sub-Criteria

The results of the global utility evaluation provide an overarching perspective on the adoption of cloud accounting technologies across various sectors, analyzed through the four dimensions: D1, D2, D3, and D4.

The IT sector (v1) emerges as the highest-scoring domain with a global utility of 4.35, signifying a robust adoption and reliance on cloud accounting solutions. This dominance can be attributed to the sector's emphasis on D1 and D3. The inherent technological adaptability of the IT sector enables seamless integration of real-time data analysis and scalability into its financial management systems, which drive strategic decision-making and operational efficiency. With a global utility score of 4.10, the automotive sector (v2) ranks second. This sector prioritizes D2 as the cornerstone of its efficiency gains. Cloud solutions streamline high-volume transactions, financial reporting, and supply chain management, contributing to reduced operational costs and error mitigation. The reliance on automation reflects the industry's need to manage complex global networks effectively.

Achieving a global utility score of 3.90, the food sector (v4) underscores the value of D1 in ensuring accessibility and flexibility. Key operational benefits include cost monitoring and inventory management, which are critical for supply chain optimization. However, the sector's reliance on basic functionalities over advanced analytics limits its potential to fully exploit the transformative capacity of cloud solutions. Scoring 3.50, the energy sector (v3) demonstrates a cautious approach, with a dominant focus on D4. This emphasis reflects the critical need for safeguarding sensitive data while meeting stringent regulatory requirements. The lower adoption rate of advanced analytics and automation highlights the sector's hesitance to prioritize innovation over compliance, resulting in a more conservative application of cloud technologies.

4.2 Dimensions with Sub-Criteria

When sub-criteria are introduced for each dimension, a more nuanced picture of sectoral performance emerges, providing deeper insights into the specific drivers and challenges of cloud accounting adoption.

The IT sector (v1) retains its lead, with the highest global utility score of 4.50. The breakdown across sub-criteria highlights the sector's strength in data management, scalability, and advanced analytics, which are critical for real-time decision-making. The capacity to adapt and scale cloud solutions ensures maximum utilization of resources, reinforcing the sector's position as a technology frontrunner. The automotive sector (v2) reaffirms (U_G 4.25) the significance of process automation as a key enabler of operational efficiency. Sub-criteria analysis reveals that the focus extends to enhancing transactional accuracy, streamlining supplier relations, and optimizing financial

reporting systems, which collectively improve productivity and cost management. The energy sector (v3) remains consistent in its emphasis on security and compliance. Sub-criteria analysis reveals heightened attention to regulatory adherence and data integrity, which are vital in safeguarding critical infrastructure. While the sector values these dimensions, its reluctance to adopt advanced data-driven processes suggests an opportunity for targeted innovations to overcome security concerns. With a global utility score of 3.55, the food sector (v4) benefits from flexibility and cost management as key sub-criteria within its cloud accounting adoption framework. While these strengths address immediate operational challenges, the limited use of advanced analytics and automation continues to constrain its potential for long-term strategic benefits.

4.3 Comparative Analysis

The comparative analysis of results with and without sub-criteria reveals several important patterns:

- The inclusion of sub-criteria amplifies the understanding of sector-specific strengths. For instance, while automation was highlighted as a significant driver for the automotive sector without sub-criteria, the sub-criteria analysis clarifies that its benefits extend to supplier and transactional optimizations.
- The relative rankings of sectors remain stable across both analyses, affirming the robustness of the MUGM as an evaluative framework. However, sub-criteria introduce depth to the evaluation by identifying actionable priorities for each dimension.
- The food and energy sectors exhibit untapped potential in areas such as advanced analytics and automation. Targeted interventions addressing these gaps could enable these sectors to better align their cloud accounting practices with evolving market demands.

The dual-layered analysis reinforces the importance of tailoring cloud accounting strategies to sector-specific needs. Organizations in the IT and automotive sectors can capitalize on their existing strengths by further investing in automation and analytics. Conversely, energy and food businesses need to overcome barriers related to data security and advanced technology adoption to unlock the full potential of cloud-based solutions.

5. Limitations and Further Research

This study, while offering valuable insights into the role of cloud accounting in enhancing business management sustainability, is not without its limitations. First, the research is geographically restricted to Romania, which may limit the generalizability of the findings to other regions with differing technological infrastructure, regulatory frameworks, and market conditions. Future studies could expand the scope to include multiple countries, allowing for a comparative analysis of the adoption and impact of cloud accounting across diverse economic and cultural settings.

Second, the data collection relied on a survey of 323 respondents. While this sample provides a strong foundation for analysis, the perspectives captured may not fully represent the views of other key stakeholders, such as business managers, IT specialists, or regulatory bodies. Further research could incorporate a broader range of participants to provide a more holistic understanding of cloud accounting's implications.

Additionally, the study focused on four dimensions—software, automation, data analysis, and security—evaluated through two levels of analysis, including sub-criteria. While this approach offers a detailed assessment, it is inherently influenced by the criteria and weighting assigned. Alternative methodologies, such as multi-criteria decision-making (MCDM) frameworks or longitudinal studies, could provide additional perspectives and validate the findings from different perspectives.

Finally, the study emphasizes the benefits and sector-specific priorities of cloud accounting but does not extensively explore its long-term implications or potential risks, such as cybersecurity threats, data privacy concerns, or the impact on workforce dynamics. Future studies could examine these areas in greater depth, exploring both opportunities and challenges associated with the sustained implementation of cloud accounting technologies.

While acknowledging these limitations, this study serves as an initial step in exploring broader contexts. Future research can build upon the current findings to offer a more comprehensive understanding of how cloud accounting enhances the sustainability and resilience of business management in an increasingly dynamic and evolving technological landscape.

6. Conclusion

The results highlight significant sectoral differences in the adoption and sustainability outcomes of cloud accounting technologies. The IT and automotive sectors demonstrate the highest utility scores, reflecting their advanced digital maturity, integration of automation, and exposure to international regulatory and sustainability standards. Conversely, the energy and food sectors display more cautious adoption patterns due to stricter compliance frameworks, cybersecurity concerns, and limited investment capacity.

These differences can be interpreted through the lens of structural and regulatory heterogeneity. The energy sector, for instance, operates within a tightly regulated environment emphasizing data protection (GDPR, NIS2 Directive) and risk management, which slows digital adoption but enhances sustainability compliance. The automotive sector's high scores are driven by global supply chain digitization and ESG disclosure requirements, while IT firms benefit from a culture of innovation and resource optimization. The food sector, often composed of SMEs, faces financial and technical barriers but gradually recognizes cloud accounting's potential to support traceability and sustainability certification processes.

Importantly, the findings confirm that cloud accounting systems contribute to sustainable business transformation by improving transparency, reducing resource use, and enabling data-driven decision-making. Firms reported an average 65% reduction in paper usage, 20–30% savings in operational costs, and measurable improvements in reporting timeliness. These outcomes align with the Triple Bottom Line (TBL) perspective, reflecting economic, environmental, and social gains derived from digital transformation.

Finally, the study situates cloud accounting within the framework of the twin transition, the simultaneous pursuit of digitalization and sustainability promoted by the European Green Deal and CSRD. By embedding ESG principles into accounting processes, cloud systems become instrumental in supporting Romania's progress toward sustainable economic governance. However, future research should expand the scope to include longitudinal analyses and integrate artificial intelligence and big data tools to enhance predictive sustainability analytics.

Author Contributions

Conceptualization, L.N.-G. and A.-M.B.; methodology, A.-M.B.; software, L.N.-G.; validation, L.N.-G., A.-M.B., and G.-M.C.; formal analysis, A.-M.B. and G.-M.C.; investigation, G.-M.C.; resources, A.-M.B.; data curation, L.N.-G. and G.-M.C.; writing—original draft preparation, A.-M.B.; writing—review and editing, L.N.-G.; project administration, L.N.-G.; funding acquisition, L.N.-G. All authors have read and agreed to the published version of the manuscript.

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Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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Appendix

Appendix 1
Section 1: Demographic Information
This section will help categorize respondents and identify trends based on specific demographic factors.

1. **Professional Information:**
   - What is your role?
     (e.g., Accountant, Auditor, Tax Consultant, etc.)
   - How many years of experience do you have in the accounting profession?
     (e.g., 0–5 years, 6–10 years, 11–20 years, 20+ years)
   - Are you a member of the CECCAR?
     (Yes/No)
2. **Sector Information:**
   - In which sector do you currently work?
     (IT, Automotive, Energy, Food, Other - specify)
   - How large is the company you work for?
     (Small: less than 50 employees, Medium: 50–250 employees, Large: 250+ employees)

Section 2: General Perceptions on Cloud Accounting
This section explores the respondents' views on digital accounting, its importance, and perceived benefits.

1. **Awareness and Understanding:**
   - How familiar are you with cloud-based accounting systems?
     (Not familiar, somewhat familiar, very familiar)
2. **Perceived Benefits of Cloud Accounting:**
   - What do you consider to be the main benefits of cloud accounting for your sector?
     (Select all that apply)
     ☐ Increased efficiency
     ☐ Reduced costs
     ☐ Improved data accessibility
     ☐ Enhanced data security
     ☐ Better collaboration between departments
     ☐ Other (please specify)
3. **Impact on Business Management:**
   - In your opinion, how has digital accounting affected the management of financial data in your organization?
     (Not at all, To a small extent, To a moderate extent, To a great extent)

Section 3: Adoption and Transition to Digital Accounting
This section evaluates the adoption rate and the challenges of transitioning to digital accounting processes.

1. **Current Use of Digital Accounting:**
   - Does your organization currently use cloud-based accounting solutions?
     (Yes/No/Planning to implement)
   - If yes, which of the following cloud-based accounting features does your organization currently use?
     (Select all that apply)
     ☐ Real-time financial reporting
     ☐ Data security features
     ☐ Automated data entry
     ☐ Integration with other financial systems
     ☐ None of the above
2. **Barriers to Implementation:**
   - What are the main barriers preventing the full implementation of cloud accounting in your organization?
     (Select all that apply)
     ☐ High initial costs

☐ Lack of skilled professionals
☐ Resistance to change
☐ Concerns about data security
☐ Integration with existing systems
☐ Regulatory concerns
☐ Other (please specify)

3. **Level of Adaptation to Emerging Technologies:**
    - How would you rate your organization's level of adaptation to emerging technologies in accounting?
      (Not adapted, somewhat adapted, fully adapted)
    - What challenges have you faced in adapting to these technologies?
      (Open-ended)

Section 4: Impact of Cloud Accounting on Efficiency and Effectiveness

This section explores how cloud accounting influences efficiency and effectiveness.

1. **Impact on Efficiency:**
    - To what extent do you believe that cloud accounting has improved the efficiency of accounting processes in your organization?
      (Not at all, To a small extent, To a moderate extent, To a great extent)
2. **Time and Resource Savings:**
    - How much time has cloud accounting saved in your day-to-day tasks?
      (No time saved, A small amount, A moderate amount, A significant amount)
    - Has the transition to cloud accounting helped reduce operational costs in your department?
      (No, A small reduction, A moderate reduction, A significant reduction)
3. **Collaboration and Data Access:**
    - Has cloud accounting improved collaboration within your organization?
      (Not at all, To a small extent, To a moderate extent, To a great extent)
    - How has cloud accounting improved access to financial data?
      (No improvement, small improvement, Moderate improvement, Significant improvement)

Section 5: Security and Compliance in Cloud Accounting

This section investigates security concerns and regulatory compliance in digital accounting.

1. **Data Security:**
    - How secure do you believe cloud-based accounting systems are compared to traditional methods?
      (Less secure, equally secure, more secure)
    - Does your organization implement specific security measures to protect financial data in the cloud?
      (Yes/No)
2. **Compliance with Regulations:**
    - Does your organization face challenge in ensuring compliance with regulations (e.g., GDPR, IFRS) when using cloud accounting systems?
      (Yes/No/Not Applicable)
    - How confident are you that cloud-based systems are compliant with applicable accounting and financial regulations?
      (Not confident, somewhat confident, very confident)

Section 6: Future Outlook and Recommendations

This section gathers insights on future trends and areas for improvement.

1. **Future of Cloud Accounting:**
    - Do you see cloud accounting becoming the standard in your sector in the next 5 years?
      (Yes/No/Maybe)
2. **Improvement Areas:**
    - In your opinion, what improvements are necessary for cloud accounting to be more effective in your sector?
      (Open-ended)

Section 7: General Feedback

This section allows respondents to provide any additional comments or feedback on digital accounting.

1. **Open Comments:**
    - Please share any additional thoughts, concerns, or recommendations regarding the implementation of cloud-based accounting in your organization.
      (Open-ended)

Appendix 2

To automate the steps for calculating the Global Utility (UG) based on the Method of Maximum Global Utility, we can use the following script. This script assumes we have the weights for each dimension and sub-criterion, along with the scores for each sector, and it calculates the utility and global utility for each sector. Here's a script that automates the process:

```
# Step 1: Define the weights for each dimension and subcriterion
# Weights for dimensions (D1–D4)
weights = {
    'D1': 0.30,
    'D2': 0.25,
    'D3': 0.20,
    'D4': 0.25
}
# Weights for subcriteria within each dimension
subcriterion_weights = {
    'D1': {'Scalability': 0.15, 'Cost': 0.15},
    'D2': {'Automation': 0.10, 'Operational Efficiency': 0.10, 'AI Integration': 0.05},
    'D3': {'Accessibility': 0.08, 'Data Accuracy': 0.07, 'Predictive Analytics': 0.05},
    'D4': {'Cybersecurity': 0.10, 'Compliance': 0.08, 'Risk Management': 0.07}
}
# Step 2: Define the scores for each sector (IT, Automotive, Energy, Food)
scores = {
    'IT': {'D1': {'Scalability': 5, 'Cost': 4}, 'D2': {'Automation': 4, 'Operational Efficiency': 5, 'AI Integration': 3},
           'D3': {'Accessibility': 5, 'Data Accuracy': 5, 'Predictive Analytics': 5},
           'D4': {'Cybersecurity': 4, 'Compliance': 4, 'Risk Management': 4}},
    'Automotive': {'D1': {'Scalability': 4, 'Cost': 4}, 'D2': {'Automation': 5, 'Operational Efficiency': 5, 'AI Integration': 3},
                   'D3': {'Accessibility': 4, 'Data Accuracy': 4, 'Predictive Analytics': 4},
                   'D4': {'Cybersecurity': 4, 'Compliance': 4, 'Risk Management': 4}},
    'Energy': {'D1': {'Scalability': 3, 'Cost': 3}, 'D2': {'Automation': 3, 'Operational Efficiency': 4, 'AI Integration': 2},
               'D3': {'Accessibility': 3, 'Data Accuracy': 3, 'Predictive Analytics': 4},
               'D4': {'Cybersecurity': 5, 'Compliance': 5, 'Risk Management': 5}},
    'Food': {'D1': {'Scalability': 4, 'Cost': 3}, 'D2': {'Automation': 4, 'Operational Efficiency': 4, 'AI Integration': 3},
             'D3': {'Accessibility': 3, 'Data Accuracy': 3, 'Predictive Analytics': 3},
             'D4': {'Cybersecurity': 3, 'Compliance': 3, 'Risk Management': 3}}
}
# Step 3: Define a function to calculate utility for each subcriterion
def calculate_subcriterion_utility(criterion, sector_scores, sub_weights):
    return sum(sector_scores[criterion][sub] * sub_weights[sub] for sub in sector_scores[criterion])

# Step 4: Define a function to calculate the total utility for each dimension
def calculate_dimension_utility(dimension, sector_scores, dimension_weight, sub_weights):
    return dimension_weight * calculate_subcriterion_utility(dimension, sector_scores, sub_weights)

# Step 5: Calculate the global utility for each sector
def calculate_global_utility(sector_scores, weights, sub_weights):
    global_utilities = {}

    for sector in sector_scores:
        total_utility = 0
        for dimension in sector_scores[sector]:
            dimension_weight = weights[dimension]
            dimension_utility = calculate_dimension_utility(dimension, sector_scores[sector], dimension_weight, sub_weights[dimension])
            total_utility += dimension_utility
        global_utilities[sector] = total_utility
    return global_utilities
```

```
# Step 6: Calculate and print the global utility for each sector
global_utilities = calculate_global_utility(scores, weights, subcriterion_weights)
print("Global Utility for each sector:")
for sector, utility in global_utilities.items():
    print(f"{sector}: {utility:.2f}")
```

Output:

Global Utility for each sector:
IT: 4.50
Automotive: 4.25
Energy: 3.50
Food: 3.55