

Identifying and Prioritizing the Components of Circular Accounting: A Qualitative Study Based on Systematic Content Analysis

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Abstract: The expansion of the circular economy has increased the need to transform accounting systems and identify the components required to support decision-making and reporting related to efficient resource utilization, waste reduction, and environmental performance. Despite the growing body of research on circular accounting, its constituent components and dimensions have been addressed in a fragmented manner across different studies, highlighting the need to identify and integrate these components. The present study aimed to identify, categorize, and prioritize the components of circular accounting. In terms of purpose, the study was applied, and in terms of methodology, it employed a qualitative, descriptive–analytical approach. To collect the data, scientific publications and texts related to circular accounting, the circular economy, sustainability, environmental accounting, and material flow management were systematically reviewed. During the analytical stage, conventional qualitative content analysis was used to extract relevant concepts from the texts, code them, and organize them into categories and subcomponents based on conceptual similarity. Through the process of analyzing and integrating the codes, three main categories were identified: dynamic capabilities of circular accounting, material flows in the circular economy, and institutional–environmental drivers and barriers. Subsequently, 12 subcomponents were extracted and classified: flexibility and reconfiguration; innovation and technology; learning and knowledge development; interaction and accountability; efficient material management and consumption; life cycle and environmental traceability; supply chain and resource optimization; policymakers and regulations; infrastructure and information technology; culture, education, and media; economic incentives and market pressure; and organizational and coordination barriers. To prioritize the main categories, the frequency of the extracted codes was used as the prioritization criterion. The results showed that institutional–environmental drivers and barriers, with 29 codes accounting for 45.2% of the total, had the highest frequency, followed by the dynamic capabilities of circular accounting, with 22 codes and a 34.3% share, and material flows in the circular economy, with 13 codes and a 20.3% share. The findings indicate that the formation and development of circular accounting depend not only on internal accounting capabilities but also on institutional and environmental factors, technological infrastructure, policies and regulations, culture, and coordination among stakeholders. The findings of this study can provide a basis for developing a conceptual framework and designing measurement instruments for circular accounting in future studies.

Keywords: circular accounting, dynamic capabilities, material flows, circular economy, structural equation modeling

1. Introduction

The transition from the traditional linear economic model of “take–make–use–dispose” toward a circular economy has become an increasingly important strategic response to resource depletion, environmental degradation, growing waste generation, and the need to reconcile economic activity with ecological constraints. The circular economy emphasizes retaining the value of materials, products, and resources within economic systems for as long as possible through strategies such as reducing resource consumption, reuse, repair, remanufacturing, recycling, and the recovery of residual value. However, the concept has developed through multiple intellectual and practical traditions, and its meaning continues to evolve as researchers attempt to distinguish circularity from conventional waste management and incremental environmental efficiency. Historical analyses of the concept show that circular economy thinking has moved from relatively narrow resource recovery approaches toward more comprehensive systems emphasizing value retention, regenerative production, and closed-loop resource use [1]. More recent conceptual work based on the examination of numerous definitions similarly demonstrates that the circular economy is a multidimensional concept encompassing resource efficiency, value preservation, systemic transformation, and sustainability-oriented production and consumption systems [2]. Accordingly, circularity cannot be reduced merely to recycling; rather, it requires coordinated organizational, technological, institutional, accounting, and behavioral changes.

The increasing importance of circular economy principles has created new requirements for organizations seeking to measure, manage, and communicate their use of resources. Traditional accounting systems were primarily developed to capture financial transactions, costs, revenues, assets, and liabilities, while many physical flows of materials, environmental externalities, resource losses, and circularity-related activities remain incompletely represented in conventional financial information. This creates an information gap between the physical reality of resource consumption and waste generation and the financial information available for managerial decision-making. The emerging concept of circular accounting responds to this gap by attempting to integrate financial accounting, management accounting, environmental accounting, resource-flow information, life-cycle information, and circularity indicators into a more comprehensive information architecture. The growing literature on sustainability accounting, accountability, and disclosure emphasizes that circular economy implementation requires accounting systems capable of representing material loops, resource productivity, waste prevention, environmental impacts, and organizational accountability in ways that conventional reporting approaches may not fully capture [3]. Likewise, calls for a more explicit accounting research agenda for the circular economy highlight the need to examine how accounting can participate in measuring, governing, enabling, and scrutinizing circular transitions rather than merely recording their financial consequences after they occur [4].

Circular accounting is particularly important because organizations require reliable information to determine whether circular strategies actually improve environmental and economic performance. Management decisions concerning product redesign, resource substitution, waste reduction, recycling, recovery, and closed-loop supply chains depend on information about both monetary and physical flows. Material Flow Cost Accounting (MFCA) has therefore become an important accounting technique for identifying material losses and translating physical flows into monetary information. Empirical evidence from Japanese companies indicates that MFCA can contribute to understanding the relationship among material-flow information, environmental performance, and economic performance, thereby supporting circular economy decision-making [5]. Case-based evidence also suggests that the implementation of MFCA may change managerial awareness, cost visibility, operational decision-making, and

environmental performance by revealing the economic consequences of material inefficiencies that would otherwise remain hidden within aggregated production costs [6]. These characteristics make material-flow information a fundamental dimension of circular accounting.

The relevance of MFCA is also evident in sector-specific applications. In food production, measuring the monetary consequences of food loss and waste provides organizations with information for identifying inefficient processes and opportunities for waste prevention. Research in the Italian potato chip industry demonstrates how MFCA can be applied to quantify food loss and waste costs and thereby improve visibility into material inefficiencies [7]. Similarly, research in the meat sector shows that MFCA can support environmental entrepreneurship by identifying both the environmental and economic implications of material losses, while also revealing organizational and operational challenges associated with its implementation [8]. These studies indicate that circular accounting should not be understood merely as an extension of conventional environmental reporting. Instead, it requires an integrated approach through which material consumption, non-product outputs, resource losses, environmental impacts, and associated financial consequences are captured and connected to managerial action.

The growing sophistication of circular economy decision-making has also increased attention to life-cycle assessment, environmental traceability, and technological tools. Circular systems require information that follows products and materials across multiple stages of extraction, production, consumption, reuse, recycling, and recovery. Life-cycle assessment can identify environmental hotspots and reveal whether apparently circular options genuinely reduce environmental impacts or merely shift burdens from one stage of the system to another. Recent research on seaweed-based biorefineries, for example, demonstrates how life-cycle assessment can identify environmental impacts, process hotspots, and improvement pathways relevant to the circular bioeconomy [9]. Moreover, computational tools are increasingly being applied to circularity-related accounting and environmental measurement. The development of a circularity accounting model for carbon dioxide using artificial neural networks illustrates the potential contribution of advanced analytical techniques to estimating environmental values and monitoring performance within planetary boundaries [10]. These developments suggest that circular accounting increasingly depends on the integration of financial, physical, environmental, and digital information.

The need for such integration becomes more apparent when circular accounting is considered from the perspective of organizational capabilities. Implementing circular practices requires firms to sense environmental and market changes, seize emerging opportunities, and reconfigure resources, processes, routines, and information systems. Dynamic capabilities therefore provide a relevant theoretical basis for explaining how organizations adapt their accounting systems to circular economy requirements. Research has shown that dynamic capabilities and environmental accounting can jointly support circular economy implementation by enhancing firms' ability to generate, interpret, and use environmental information [11]. Related research has emphasized the relationship between dynamic capabilities and environmental accounting in the context of circular economy implementation, particularly with regard to adaptation, organizational learning, and the transformation of accounting practices [12]. Thus, flexibility, learning, technological absorption, cross-functional coordination, and analytical capability may constitute important foundations of circular accounting.

The role of dynamic capabilities becomes even more significant under conditions of digital transformation. Digital technologies can improve the traceability of materials, integration of supply-chain information, monitoring of resource flows, and development of circular business models. Research on digital circular business model innovation has demonstrated that dynamic capabilities contribute to organizations' ability to identify technological

opportunities, restructure business models, and respond to changing circular economy requirements [13]. Similarly, firms' capability management has been associated with innovation outputs related to waste and circular economy technologies, indicating that organizational competencies can affect firms' ability to create and exploit circular innovations [14]. These findings imply that circular accounting systems must themselves possess dynamic characteristics. Static accounting procedures may be insufficient where circular strategies require frequent changes in resource measurement, performance indicators, supply-chain boundaries, and environmental reporting requirements.

Innovation and eco-efficiency are also central to the development of circularity. Evidence from European firms indicates that resource-efficient eco-innovations can support circular economy objectives by reducing material and energy intensity and improving the efficiency of resource use [15]. At the organizational level, firms often adopt circular practices progressively rather than through a single comprehensive transformation. A regional study of businesses in Spain showed that the adoption of circular economy principles can evolve through different stages, shaped by organizational resources, environmental practices, and cleaner production initiatives [16]. Such gradual transformation creates an important role for accounting because firms require indicators capable of monitoring incremental changes in resource efficiency, waste reduction, recycling, environmental performance, and organizational circularity over time.

Alongside internal capabilities, institutional and environmental conditions strongly influence the adoption of circular practices. The transition to a circular economy depends on regulatory frameworks, government incentives, technological infrastructure, market pressures, stakeholder expectations, social norms, education, and collaboration across organizational boundaries. Studies of small and medium-sized enterprises have identified a range of factors that facilitate or constrain circular economy implementation, illustrating that internal managerial willingness alone is insufficient without supportive institutional and economic conditions [17]. Research on circular business models similarly emphasizes the importance of organizational, economic, technological, and environmental conditions in enabling firms—particularly knowledge-based enterprises—to redesign value creation processes around circular principles [18]. Subsequent work proposing circular economy business models for knowledge-based companies further demonstrates that the operationalization of circularity requires coordinated attention to business-model design, resource use, technological capacity, and stakeholder relationships [19].

Institutional support is also particularly important in waste management systems, where the performance of circular strategies depends on interactions among public authorities, firms, consumers, infrastructure providers, and other stakeholders. Research examining the efficiency of circular economy practices in municipal solid waste management in Persian Gulf countries highlights the importance of institutional and operational conditions for improving waste-related circularity outcomes [20]. Consumer behavior is another essential factor, because resource recovery, product reuse, recycling, and demand for circular products ultimately depend partly on consumer participation and behavioral acceptance [21]. Accordingly, circular accounting must be positioned within a broader institutional environment in which information is produced not only for internal management but also for governments, markets, consumers, investors, and other stakeholders.

Recent studies demonstrate that circular economy decision-making is becoming increasingly multidimensional and technologically sophisticated. Multiple-criteria decision-making has been used to evaluate circular economy principles in construction waste management, enabling decision-makers to compare alternatives against economic, environmental, technical, and operational criteria [22]. Similarly, advanced fuzzy decision frameworks have been applied to circular-economy-based waste management in complex environmental settings, illustrating the growing

need for systematic and integrated decision-support models capable of addressing uncertainty and multiple sustainability criteria [23]. These developments reinforce the importance of accounting information systems that can supply reliable, comparable, and multidimensional information for complex circular decisions.

The relationship between circular economy implementation and entrepreneurship has also received growing scholarly attention. A recent network and thematic trend analysis demonstrates the expansion of research connecting entrepreneurship with circular economy principles, reflecting increasing interest in new business models, innovation, opportunity recognition, and sustainable value creation [24]. From an accounting perspective, such entrepreneurial transformation requires information systems capable of evaluating the economic viability of circular opportunities, identifying hidden material costs, measuring resource productivity, and supporting investment decisions. Integrated circular accounting models are therefore increasingly relevant not only to environmental reporting but also to strategic management, innovation, entrepreneurship, and public finance. Recent research on integrated circular accounting in public finance has proposed a paradigmatic model for industries associated with the institutional sector, highlighting the growing need to conceptualize circular accounting as an integrated managerial and financial system rather than a narrow reporting technique [25].

A systematic review of the transition toward circular economy and waste within accounting and accountability models further demonstrates that accounting has multiple potential roles in circular transformation, including measurement, reporting, accountability, control, performance evaluation, and support for resource-management decisions [26]. Nevertheless, the literature remains fragmented across several related domains, including environmental accounting, MFCA, sustainability reporting, dynamic capabilities, material-flow management, circular business models, eco-innovation, life-cycle assessment, and institutional analysis. A general review of the relationship between circular economy and financial accounting likewise indicates that further integration is needed between circularity concepts and accounting practices [27]. Consequently, although numerous studies have identified individual practices or factors, there remains a need to organize these dispersed concepts into a coherent structure that clarifies the principal dimensions of circular accounting and the relationships among them.

This fragmentation is particularly important because the elements required for circular accounting operate at different analytical levels. Some elements concern internal organizational capabilities, such as accounting flexibility, organizational learning, technological absorption, interaction between accounting and environmental units, and continuous performance monitoring. Other elements concern physical material flows, including recycling, reuse, resource-consumption intensity, material productivity, waste reduction, product life cycles, and traceability. A third group concerns institutional and environmental conditions, such as government policies, regulations, information technology infrastructure, market pressures, cultural support, education, stakeholder coordination, and organizational resistance. Without systematic integration, these elements may remain isolated within different disciplinary literatures, limiting the development of comprehensive measurement frameworks and empirical instruments.

It is also important to distinguish circular economy research from other uses of the term “cycle” in economic and financial studies. For example, research has examined the cyclical characteristics of monetary and fiscal policies and their relationship with macroeconomic fluctuations [28], while other studies have investigated interactions between financial cycles and business cycles [29]. Although such studies address cyclical dynamics in a different conceptual sense from the circular economy, they demonstrate the wider importance of identifying and measuring recurring and interconnected economic processes. In circular accounting, however, the core analytical focus is

specifically on resource loops, material retention, environmental impacts, circular value creation, and the accounting capabilities needed to measure and manage these processes.

The literature therefore points toward three interrelated analytical domains. First, the dynamic capabilities of circular accounting determine whether accounting systems can adapt to new environmental requirements, integrate emerging technologies, develop new analytical models, learn from changing sustainability conditions, and respond transparently to stakeholders. Second, material flows constitute the operational core of circularity because the effectiveness of circular strategies ultimately depends on how materials are reduced, reused, recycled, traced, and optimized across product life cycles and supply chains. Third, institutional–environmental drivers and barriers shape the organizational context within which accounting and material-flow practices are adopted. These domains are conceptually complementary: dynamic capabilities determine an organization’s capacity to change, material-flow indicators show what is physically changing, and institutional–environmental conditions influence whether such changes can be initiated, sustained, and scaled.

Despite the development of these research streams, there remains a clear need for a systematic identification, categorization, integration, and prioritization of circular accounting components. Existing studies often examine specific tools, sectors, capabilities, or institutional conditions separately, making it difficult to determine which concepts recur most frequently across the literature and how they can be organized into a coherent conceptual architecture. Establishing such a structure is necessary for advancing theory, developing valid measurement instruments, designing future empirical models, and providing managers with a comprehensive basis for evaluating organizational preparedness for circular accounting. A systematic qualitative synthesis can therefore contribute by extracting recurring concepts from the literature, comparing their meanings, integrating overlapping codes, grouping them into higher-order subcomponents, and assessing their relative prominence.

Accordingly, the aim of this study is to identify, categorize, integrate, and prioritize the components of circular accounting through systematic qualitative content analysis, with particular emphasis on the dynamic capabilities of circular accounting, material flows in the circular economy, and institutional–environmental drivers and barriers.

2. Methods and Materials

The present study is applied in terms of purpose and qualitative in terms of research approach and was conducted using conventional qualitative content analysis. The selection of this method is consistent with the exploratory nature of the study and its objective of identifying, extracting, classifying, integrating, and prioritizing components related to circular accounting, material flows, and institutional–environmental drivers and barriers. In conventional content analysis, categories are not definitively predetermined; rather, the principal concepts and codes are extracted from the content of the sources under review and are subsequently organized into higher-order categories according to similarity, relationships, and semantic correspondence. Accordingly, the final structure of the research components emerged through the interaction between the content of scientific sources and the researcher's coding and categorization process.

Given the qualitative nature of the study, the research corpus consisted of scientific sources and documents related to the research topic, rather than individuals, companies, or organizations as a statistical population. These sources included valid domestic and international peer-reviewed articles, books, theses and dissertations, scientific reports, and other scholarly documents related to circular accounting, environmental accounting, material flow cost

accounting, the circular economy, material flows, dynamic capabilities, sustainability, and institutional and environmental factors affecting the transition toward a circular economy.

The unit of analysis in this study consisted of concepts, propositions, and content segments within the selected sources that directly or indirectly referred to components, capabilities, indicators, drivers, barriers, and requirements associated with circular accounting and the circular economy. Consequently, the unit of analysis was not limited to the title or general subject of an article; instead, extractable and meaningful content within the reviewed sources constituted the analytical unit.

Sources were selected purposively on the basis of their substantive relevance to the research question and objectives. In the first stage, Persian keywords and their English equivalents were determined for identifying relevant studies. The principal keywords included "circular accounting," "circular economy," "environmental accounting," "material flow cost accounting," "material flows," "dynamic capabilities," "sustainability accounting," "environmental reporting," "resource management," "product life cycle," and "drivers and barriers of the circular economy."

Following the initial search, the identified sources were screened on the basis of the relevance of their titles and abstracts to the research topic. In the next stage, the full texts of relevant sources were examined, and those containing material from which the concepts of interest could be extracted were included in the analytical process. Sources lacking sufficient substantive relevance to the topic, duplicate sources, sources that did not provide usable information regarding the components under investigation, or sources dealing only with peripheral issues related to the circular economy were excluded from the analysis.

The principal inclusion criteria for sources were as follows:

1. Direct or meaningful relevance to circular accounting, the circular economy, environmental accounting, material flows, or sustainability;
2. Availability of extractable content concerning components, capabilities, indicators, drivers, or barriers related to the research topic;
3. Scientific credibility and citability;
4. Availability of sufficient content for coding; and
5. Applicability of the source findings to answering the research question.

Sources that lacked sufficient relevance to the research problem, duplicate sources, and sources whose content did not allow the extraction of relevant meaning units were excluded from the final analysis.

The research data were collected through documentary and library-based methods. In this process, relevant scientific sources were first identified, and eligible sources were selected following an initial review. The full texts of the selected sources were then examined, and sections of each source containing concepts relevant to the research topic were extracted and recorded.

The extracted information included concepts related to circular accounting capabilities, flexibility, innovation and technology, organizational learning, interaction and accountability, material flow management, recycling and reuse, product life cycle, material flow traceability, resource optimization, policies and regulations, information technology infrastructure, culture and education, economic incentives, market pressure, and organizational and coordination barriers.

No primary data were collected through questionnaires, interviews, or field observations in this study. All data used during the component-identification stage were extracted from the content of the selected scientific sources.

The data were analyzed using conventional qualitative content analysis. The analytical process was conducted through several consecutive stages.

Stage 1: Determining the Research Question and Scope of Analysis

Initially, the primary research question and the conceptual scope of the study were determined. The main research question focused on identifying the components presented in scientific sources as elements, capabilities, requirements, drivers, or barriers related to circular accounting. At this stage, three preliminary domains were considered for organizing the findings: dynamic capabilities of circular accounting, material flows in the circular economy, and institutional–environmental drivers and barriers. These three domains were used only as an initial framework for organizing the data, while the final codes were derived from the content of the reviewed sources.

Stage 2: In-Depth Review of the Selected Sources

The full texts of the selected sources were carefully examined, and propositions and sections containing information relevant to the research question were identified. At this stage, efforts were made to identify not only explicit concepts but also implicit concepts related to organizational capabilities, resource management, technology, policymaking, and environmental requirements.

Stage 3: Identification of Meaning Units

Relevant sections of each source were converted into meaning units. Each meaning unit consisted of a concept, proposition, or set of related statements conveying a specific message concerning one of the components, capabilities, drivers, or barriers of circular accounting. These units constituted the basis for initial coding.

Stage 4: Initial Coding

A descriptive code corresponding to the content of each meaning unit was assigned. At this stage, coding was kept as close as possible to the actual content of the sources, and the imposition of concepts not supported by the source material was avoided. When different sources referred to a similar concept using different terminology, the codes were compared semantically.

Stage 5: Comparison and Integration of Similar Codes

After completion of the initial coding process, codes extracted from different sources were comparatively examined. Duplicate codes or codes with highly similar meanings were integrated into a common concept, whereas distinct codes representing meaningful conceptual differences were retained separately. For example, the concepts “ability to reconfigure the accounting system” and “flexibility in responding to environmental reporting requirements” were, following substantive comparison, categorized under the subcomponent “flexibility and reconfiguration.”

Stage 6: Formation of Subcomponents

Following comparison and refinement, the initial codes were organized into subcomponents based on conceptual commonality. At this stage, efforts were made to ensure that each subcomponent was internally homogeneous while remaining conceptually distinct from other subcomponents. This process resulted in the development of a set of subcomponents, including flexibility and reconfiguration; innovation and technology; learning and knowledge development; interaction and accountability; efficient material management and consumption; life cycle and environmental traceability; supply chain and resource optimization; policymakers and regulations; infrastructure and information technology; culture, education, and media; economic incentives and market pressure; and organizational and coordination barriers.

Stage 7: Formation of Main Categories

In the subsequent stage, the identified subcomponents were assigned to the main categories based on their theoretical and substantive relationships. Accordingly, three main categories were established: dynamic capabilities of circular accounting, material flows in the circular economy, and institutional–environmental drivers and barriers. This stage resulted in a hierarchical structure consisting of initial codes, subcomponents, and main categories.

Stage 8: Review of the Conceptual Structure

The structure resulting from the coding and categorization process was reviewed to identify and correct overlapping items, duplicate codes, categories lacking sufficient conceptual distinctiveness, and inappropriate conceptual relationships. At this stage, the relationships among the codes, subcomponents, and main categories were examined, and the final research structure was established. On the basis of this structure, a thematic network was also developed to visually represent the relationships between the main categories and their subcomponents.

Following the identification and classification of the components, the frequency of the extracted codes was used to determine the relative priority of the main categories. For this purpose, the number of codes assigned to each of the three main categories after the final coding and integration process was calculated, and the share of each category in the total number of extracted codes was determined.

In this study, frequency-based prioritization means that the greater the number of codes through which a concept was represented in the selected sources, the greater its presence and prominence in the reviewed literature. Therefore, this indicator reflects conceptual prominence in the examined sources and should not be interpreted as representing the definitive importance or causal weight of the components within organizations.

Using this method, “institutional–environmental drivers and barriers” were represented by 29 codes and accounted for 45.2% of the total, “dynamic capabilities of circular accounting” were represented by 22 codes and accounted for 34.3%, and “material flows in the circular economy” were represented by 13 codes and accounted for 20.3%.

Several mechanisms were employed during the analytical process to enhance the credibility of the findings. First, the codes were extracted directly from the content of the sources, and the relationship between each code and its corresponding meaning unit was maintained. Second, codes extracted from different sources were comparatively examined to identify duplicate or synonymous concepts and prevent the creation of parallel codes. Third, the final categories and subcomponents were reviewed in terms of internal coherence and conceptual distinctiveness. Fourth, the findings derived from coding were compared with the theoretical foundations and previous studies to assess the conceptual consistency of the identified categories.

Furthermore, the use of diverse domestic and international sources and the continuous comparison of extracted concepts throughout the analytical process were intended to increase data richness and reduce the dependence of the final structure on a single source or a limited group of studies. Accordingly, the credibility of the results was considered not merely in terms of code frequency but also on the basis of substantive relevance, conceptual coherence, traceability of codes to their original sources, and comparative analysis of the findings.

The research implementation process can be represented as an eight-stage sequence comprising:

- Determining the research question and scope of analysis;
- Identifying sources;
- Screening and selecting sources;
- Extracting meaning units;
- Initial coding;

- Comparing and integrating codes;
- Forming subcomponents and main categories; and
- Reviewing and prioritizing the categories based on code frequency.

The output of this process was a systematic set of codes, subcomponents, and main categories associated with circular accounting, which are presented in the research tables and formed the basis for constructing the thematic network and presenting the conceptual structure of the study.

3. Findings and Results

In this section, all identified codes were classified into categories containing conceptually similar items based on their underlying meanings. Table 1 presents the research codes and components using a comparative approach.

Table 1. Codes and Categories of the Research Components: Stage 1

Main Component	Measure/Indicator	Sources
Dynamic capabilities of circular accounting	Ability to reconfigure the accounting system in accordance with circularity requirements	Asan et al. (2023); Scarpellini et al. (2020); Shahdkar et al. (2022)
Dynamic capabilities of circular accounting	Flexibility in responding to environmental requirements in reporting	Nakhai et al. (2012); Scarpellini et al. (2020); Rahman Khan et al. (2020)
Dynamic capabilities of circular accounting	Innovation in environmental reporting tools and methods	Eichad and Zengerli (2023); Afra (2024); Di Vaio et al. (2023)
Dynamic capabilities of circular accounting	Organizational learning in sustainability accounting	Coppola et al. (2023); Shahdkar et al. (2022); Rahman Khan et al. (2020)
Dynamic capabilities of circular accounting	Capability to absorb emerging environmental accounting technologies	Fabian Jess et al. (2021); Shahdkar et al. (2022); Eichad and Zengerli (2023)
Dynamic capabilities of circular accounting	Capacity for interaction and collaboration between accounting and environmental units	Scarpellini et al. (2020); Maghsoudi and Rahimian (2023); Shahdkar et al. (2022)
Dynamic capabilities of circular accounting	Forecasting and analysis of environmental risks in financial reporting	Afra (2024); Rahman Khan et al. (2020); Coppola et al. (2023)
Dynamic capabilities of circular accounting	Capacity to develop analytical models for material flows	Asan et al. (2023); Fabian Jess et al. (2021); Kargar et al. (2023)
Dynamic capabilities of circular accounting	Integration of financial data with product life-cycle information	Di Vaio et al. (2023); Afra (2024); Shahdkar et al. (2022)
Dynamic capabilities of circular accounting	Corporate accountability based on environmental data	Scarpellini et al. (2020); Di Vaio et al. (2023); Nakhai et al. (2012)
Dynamic capabilities of circular accounting	Continuous measurement and monitoring of corporate circularity performance	Coppola et al. (2023); Shahdkar et al. (2022); Pahlavani et al. (2018)
Dynamic capabilities of circular accounting	Transparent accountability to stakeholders regarding environmental and financial performance	Di Vaio et al. (2023); Fabian Jess et al. (2021); Shahdkar et al. (2022)
Material flows in the circular economy	Raw material recycling rate	Hosseinpour et al. (2024); Di Vaio et al. (2023); Coppola et al. (2023)
Material flows in the circular economy	Degree of reduction in waste generation within the production unit	Hosseinpour et al. (2024); Rahman Khan et al. (2020); Shahdkar et al. (2022)
Material flows in the circular economy	Material reuse rate	Afra (2024); Di Vaio et al. (2023); Asan et al. (2023)
Material flows in the circular economy	Product life cycle and environmental footprint analysis	Fabian Jess et al. (2021); Afra (2024); Di Vaio et al. (2023)
Material flows in the circular economy	Resource optimization in the supply chain	Eichad and Zengerli (2023); Coppola et al. (2023); Shahdkar et al. (2022)
Material flows in the circular economy	Primary resource consumption intensity index	Hosseinpour et al. (2024); Asan et al. (2023); Maghsoudi and Rahimian (2023)
Material flows in the circular economy	Capability to control organizational material inputs and outputs	Kargar et al. (2023); Coppola et al. (2023); Di Vaio et al. (2023)
Material flows in the circular economy	Use of technology to trace material flows	Fabian Jess et al. (2021); Rahman Khan et al. (2020); Asan et al. (2023)

Material flows in the circular economy	Material productivity ratio in the production process	Afra (2024); Eichad and Zengerli (2023); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Government support for circular economy policies	Shahdkar et al. (2022); Hosseinpour et al. (2024); Di Vaio et al. (2023)
Institutional–environmental drivers and barriers	Availability of technological infrastructure	Coppola et al. (2023); Rahman Khan et al. (2020); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Public culture supporting recycling	Maghsoudi and Rahimian (2023); Hosseinpour et al. (2024); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Laws and regulations encouraging the circular economy	Shahdkar et al. (2022); Di Vaio et al. (2023); Rahman Khan et al. (2020)
Institutional–environmental drivers and barriers	Organizational and public education concerning circularity	Hosseinpour et al. (2024); Afra (2024); Scarpellini et al. (2020)
Institutional–environmental drivers and barriers	Economic incentives for circular accounting	Di Vaio et al. (2023); Eichad and Zengerli (2023); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Market and competitive pressure to adopt the circular model	Rahman Khan et al. (2020); Kargar et al. (2023); Scarpellini et al. (2020)
Institutional–environmental drivers and barriers	Information technology readiness to support circular economy reporting	Fabian Jess et al. (2021); Shahdkar et al. (2022); Asan et al. (2023)
Institutional–environmental drivers and barriers	Resistance to change among middle managers	Nakhai et al. (2012); Rahman Khan et al. (2020); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Lack of standardized circular economy reporting systems	Afra (2024); Di Vaio et al. (2023); Asan et al. (2023)
Institutional–environmental drivers and barriers	Weak stakeholder alignment across the supply chain	Eichad and Zengerli (2023); Coppola et al. (2023); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Level of sustainable development in domestic industries	Hosseinpour et al. (2024); Coppola et al. (2023); Maghsoudi and Rahimian (2023)
Institutional–environmental drivers and barriers	Role of the media in promoting the circular economy	Hosseinpour et al. (2024); Di Vaio et al. (2023); Shahdkar et al. (2022)
Institutional–environmental drivers and barriers	Participation of NGOs and non-state actors	Shahdkar et al. (2022); Rahman Khan et al. (2020); Scarpellini et al. (2020)

Subsequently, through the integration of the indicators, the following new codes were extracted.

Table 2. Codes and Categories Using a Comparative Approach: Stage 2

Main Component	Subcomponent	Indicators
Dynamic capabilities of circular accounting	Flexibility and reconfiguration	Ability to reconfigure the accounting system in accordance with circularity requirements; flexibility in responding to environmental requirements in reporting
Dynamic capabilities of circular accounting	Innovation and technology	Innovation in environmental reporting tools and methods; capability to absorb emerging environmental accounting technologies
Dynamic capabilities of circular accounting	Learning and knowledge development	Organizational learning in sustainability accounting; capacity to develop analytical models for material flows
Dynamic capabilities of circular accounting	Interaction and accountability	Capacity for interaction and collaboration between accounting and environmental units; forecasting and analysis of environmental risks in financial reporting; integration of financial data with product life-cycle information; corporate accountability based on environmental data; continuous measurement and monitoring of corporate circularity performance; transparent accountability to stakeholders regarding environmental and financial performance
Material flows in the circular economy	Efficient material management and consumption	Raw material recycling rate; degree of reduction in waste generation within the production unit; material productivity ratio in the production process
Material flows in the circular economy	Life cycle and environmental traceability	Material reuse rate; product life cycle and environmental footprint analysis; use of technology to trace material flows

Material flows in the circular economy	Supply chain and resource optimization	Resource optimization in the supply chain; primary resource consumption intensity index; capability to control organizational material inputs and outputs
Institutional–environmental drivers and barriers	Policymakers and regulations	Government support for circular economy policies; laws and regulations encouraging the circular economy
Institutional–environmental drivers and barriers	Infrastructure and information technology	Availability of technological infrastructure; information technology readiness to support circular economy reporting
Institutional–environmental drivers and barriers	Culture, education, and media	Public culture supporting recycling; organizational and public education concerning circularity; role of the media in promoting the circular economy
Institutional–environmental drivers and barriers	Economic incentives and market pressure	Economic incentives for circular accounting; market and competitive pressure to adopt the circular model
Institutional–environmental drivers and barriers	Organizational and coordination barriers	Resistance to change among middle managers; lack of standardized circular economy reporting systems; weak stakeholder alignment across the supply chain; participation of NGOs and non-state actors; level of sustainable development in domestic industries

The configuration of the main and secondary thematic network is presented below.

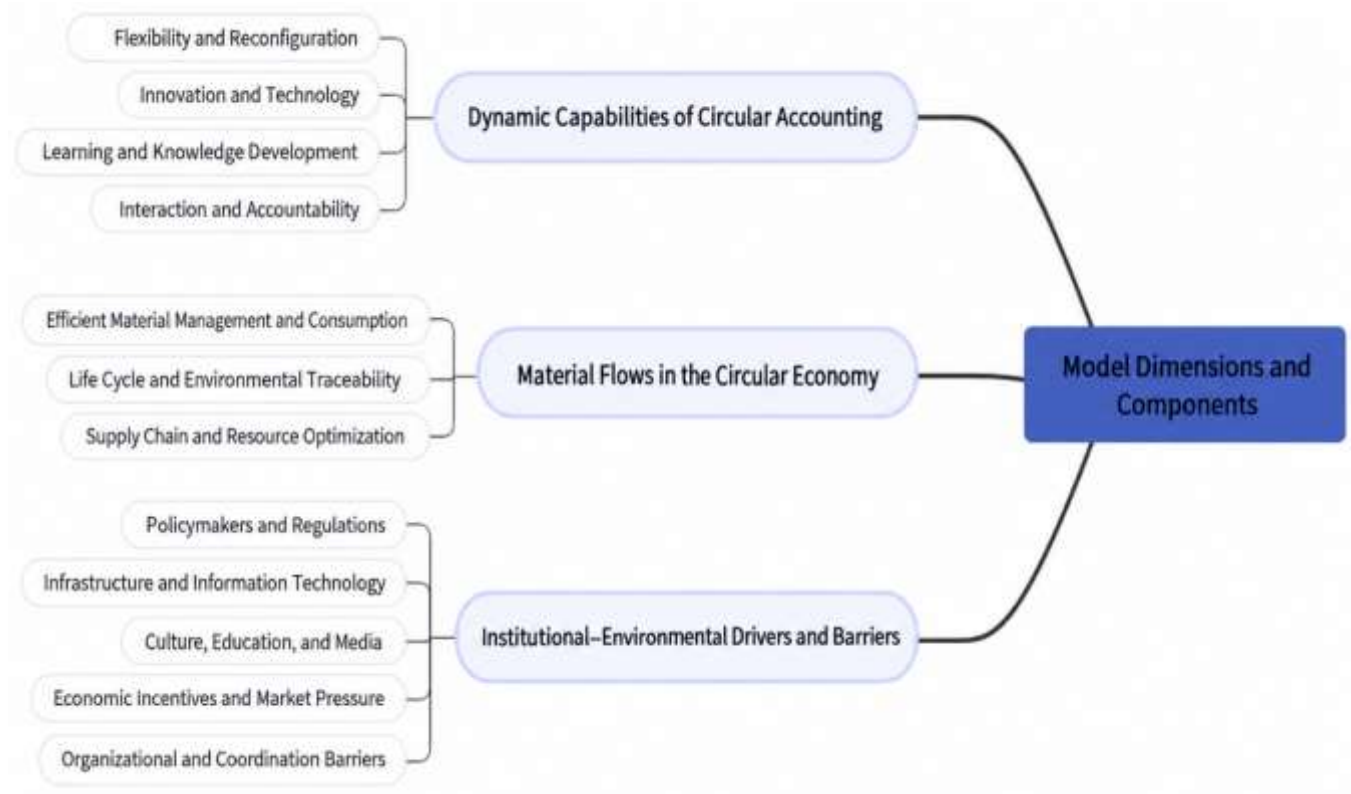


Figure 1. Thematic Network of the Research

The analytical results indicated that the identified concepts could be prioritized on the basis of their relative prominence. The prioritization criterion in this study was the frequency of codes associated with each concept. The findings showed that institutional–environmental drivers and barriers had the highest frequency, whereas material flows in the circular economy had the lowest frequency among the extracted concepts.

Table 3. Prioritization of the Concepts

Concept	Frequency	Frequency Percentage
Dynamic capabilities of circular accounting	22	34.3%
Material flows in the circular economy	13	20.3%
Institutional–environmental drivers and barriers	29	45.2%

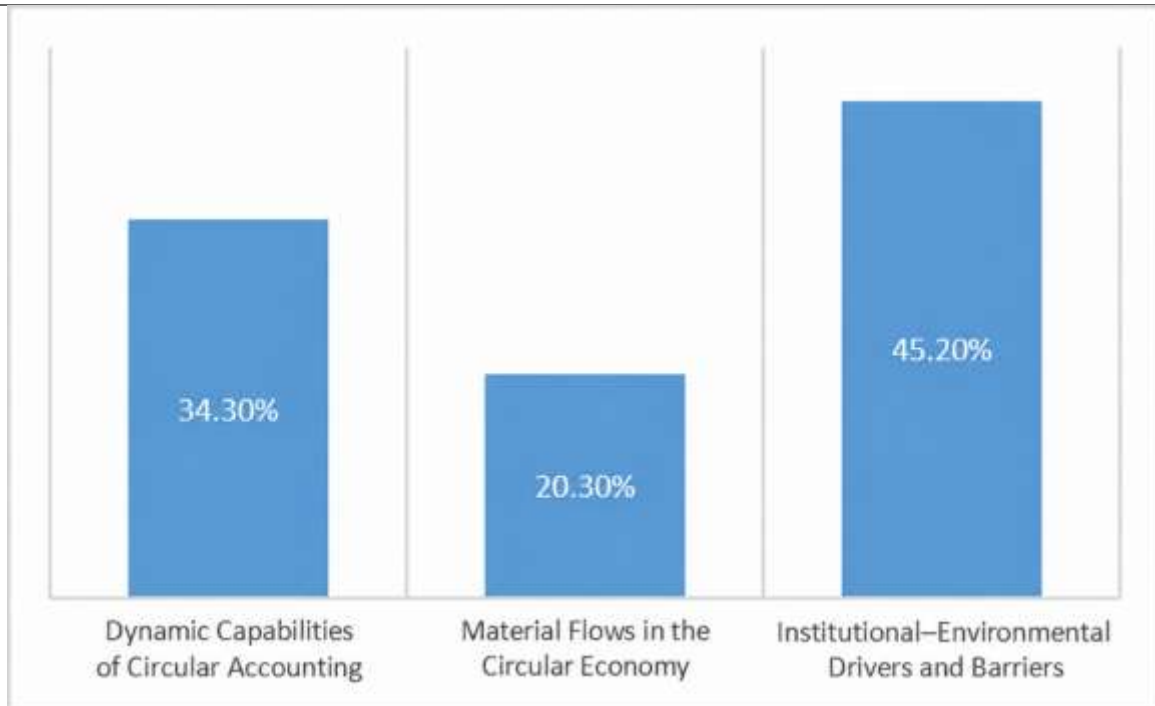


Figure 2. Prioritization of the Concepts

4. Discussion and Conclusion

The present study aimed to identify, categorize, integrate, and prioritize the components of circular accounting through a systematic qualitative content analysis of the relevant literature. The findings resulted in three main categories: dynamic capabilities of circular accounting, material flows in the circular economy, and institutional–environmental drivers and barriers. These categories were further divided into 12 subcomponents, including flexibility and reconfiguration; innovation and technology; learning and knowledge development; interaction and accountability; efficient material management and consumption; life cycle and environmental traceability; supply chain and resource optimization; policymakers and regulations; infrastructure and information technology; culture, education, and media; economic incentives and market pressure; and organizational and coordination barriers. The frequency-based prioritization showed that institutional–environmental drivers and barriers had the highest share, with 29 codes and 45.2% of the total, followed by the dynamic capabilities of circular accounting, with 22 codes and 34.3%, and material flows in the circular economy, with 13 codes and 20.3%. These findings indicate that circular accounting is not merely an accounting technique concerned with tracing materials or measuring waste; rather, it is a multidimensional organizational and institutional system that requires the simultaneous development of internal capabilities, material-flow information, technological infrastructure, regulatory support, and stakeholder coordination.

The identification of dynamic capabilities of circular accounting as one of the three principal categories confirms that circular accounting should be understood as an adaptive rather than static accounting architecture. The subcomponents of flexibility and reconfiguration, innovation and technology, learning and knowledge

development, and interaction and accountability all indicate that organizations must continuously adjust their accounting systems in response to evolving circular economy requirements. This finding is strongly aligned with the dynamic capabilities perspective, which emphasizes the ability of organizations to sense environmental changes, seize emerging opportunities, and transform or reconfigure their resources and routines. Scarpellini et al. showed that dynamic capabilities and environmental accounting are closely connected in organizations attempting to transition toward circular economy practices and that firms require flexible information systems capable of supporting such transitions [11]. Similarly, Nakhaei et al. highlighted the importance of dynamic capabilities in environmental accounting for the circular economy, emphasizing that firms must be able to adapt accounting processes to changing environmental and sustainability demands [12]. Therefore, the present findings support the view that circular accounting cannot develop effectively within rigid accounting structures.

The subcomponent of flexibility and reconfiguration reflects the capacity of accounting systems to modify measurement procedures, reporting practices, and information flows in accordance with circularity requirements. This result is also consistent with studies showing that circular economy adoption is often gradual and requires progressive organizational adaptation. Aranda-Usón et al. found that businesses tend to adopt circular economy practices incrementally and that organizational readiness, cleaner production practices, and resource-related capabilities play an important role in this progression [16]. Eechoud and Ganzaroli similarly demonstrated that dynamic capabilities are critical for digital circular business model innovation because organizations must reconfigure their structures and routines in response to new technological and circular opportunities [13]. In this sense, accounting flexibility is not merely a technical characteristic; it represents an organizational capacity to translate changing circular strategies into new measurement and reporting practices.

The identification of innovation and technology as another subcomponent of dynamic capabilities further confirms the growing importance of digital transformation in circular accounting. Circular systems depend on increasingly complex data concerning material movements, life cycles, recycling rates, environmental impacts, and resource efficiency. Technologies such as digital tracking systems, artificial intelligence, and integrated databases can support the collection and analysis of such information. Jesse et al. proposed a circularity accounting model for carbon dioxide based on artificial neural networks, demonstrating the potential of advanced analytical tools in environmental measurement [10]. Marín-Vinuesa et al. also emphasized the importance of organizational capabilities for generating waste-related patents and technological innovation in the circular economy [14]. These findings support the present result that innovation and technology are not peripheral to circular accounting but constitute one of its core capability domains.

The learning and knowledge development subcomponent also emerged prominently in the findings. This suggests that circular accounting requires the creation, absorption, and diffusion of new knowledge across accounting, environmental management, operations, and supply-chain functions. The circular economy introduces concepts and metrics that are often unfamiliar to traditional accounting departments, such as material productivity, resource intensity, environmental footprints, product life-cycle information, and non-product outputs. The need for learning is therefore structural rather than temporary. Cainelli et al. showed that resource-efficient eco-innovations are associated with organizational learning and innovation capabilities among European firms [15]. Moreover, research on circular business models indicates that knowledge-based capabilities are central to the redesign of organizational processes and value creation systems [18, 19]. The present findings therefore reinforce the need to treat organizational learning as a formal component of circular accounting capability.

The interaction and accountability subcomponent, which included cross-functional collaboration, environmental risk analysis, integration of financial and product life-cycle data, environmental accountability, continuous monitoring of circular performance, and transparent stakeholder reporting, represents one of the most comprehensive dimensions identified in the analysis. This finding is particularly consistent with the broader accounting and accountability literature on circular economy transitions. Di Vaio et al. showed that accounting and accountability models play multiple roles in circular economy and waste transitions, including measurement, control, reporting, stakeholder communication, and decision support [26]. Arjaliès et al. likewise argued that accounting research should move beyond narrow measurement questions and examine how accounting participates in governing, enabling, and scrutinizing the circular economy [4]. Etxeberría et al. similarly emphasized sustainability accounting, accountability, and disclosure as central concerns in the circular economy [3]. The present findings extend this argument by showing that interaction and accountability are embedded within the internal dynamic capabilities required for circular accounting.

The second principal category, material flows in the circular economy, comprised efficient material management and consumption, life cycle and environmental traceability, and supply chain and resource optimization. Although this category had the lowest frequency among the three main categories, with 13 codes and 20.3% of the total, its conceptual role is fundamental because material circulation constitutes the operational core of the circular economy. Circularity ultimately depends on reducing virgin resource consumption, minimizing waste, extending product and material life cycles, increasing reuse and recycling, and improving the efficiency of material inputs and outputs. The lower code frequency should therefore not be interpreted as indicating low substantive importance; rather, it suggests that the reviewed literature gave greater attention to the institutional and capability-related conditions surrounding material-flow management.

The subcomponent of efficient material management and consumption is strongly supported by the literature on MFCA. Nishitani et al. demonstrated that MFCA can improve understanding of the relationship among material flows, environmental performance, and economic performance, thereby supporting circular economy implementation [5]. Walz and Guenther similarly showed that MFCA can influence organizational decision-making by making material losses and their financial consequences more visible [6]. In sector-specific applications, Amicarelli et al. applied MFCA to measure food loss and waste costs in the Italian potato chip industry, illustrating the value of accounting for inefficient material consumption [7]. Bux and Amicarelli also emphasized the usefulness of MFCA for environmental entrepreneurship in the meat sector, particularly for identifying resource inefficiencies and cost-saving opportunities [8]. These studies align closely with the present finding that recycling rates, waste reduction, and material productivity are key indicators of circular accounting.

The life cycle and environmental traceability subcomponent reflects the need to move beyond point-in-time accounting toward information systems that trace materials and environmental consequences across the entire product life cycle. This includes material reuse, environmental footprint analysis, and the use of technology to trace material flows. Chaurasiya et al. demonstrated the importance of life-cycle assessment for identifying environmental hotspots and evaluating circular pathways in seaweed-based biorefineries [9]. Such evidence confirms that circular accounting must increasingly integrate life-cycle and environmental information rather than focusing only on conventional financial periods. The finding also corresponds with Kirchherr et al.'s conceptualization of the circular economy as a system concerned with resource-value retention across multiple stages of use and recovery [2] and with Reike et al.'s emphasis on value retention options as a defining feature of circularity [1].

Supply chain and resource optimization formed the third material-flow subcomponent. The inclusion of primary resource consumption intensity, control over material inputs and outputs, and supply-chain optimization reflects the systemic nature of circular accounting. Circularity extends beyond the boundaries of a single firm and requires coordination across suppliers, producers, distributors, consumers, and recovery actors. The findings are consistent with Shahdkar et al., who emphasized the role of circular business models in reorganizing resource use and value creation across firms [18]. They are also aligned with research showing that the transition toward circular economy business models requires interorganizational coordination and changes in supply-chain relationships [19]. Therefore, circular accounting should be designed to capture interorganizational flows rather than limiting itself to internal cost centers or financial reporting boundaries.

The most prominent category in the present study was institutional–environmental drivers and barriers. This category accounted for 45.2% of the total extracted codes, indicating that the reviewed literature places strong emphasis on the external and contextual conditions shaping circular accounting adoption. The five subcomponents were policymakers and regulations, infrastructure and information technology, culture, education, and media, economic incentives and market pressure, and organizational and coordination barriers. The high frequency of this category suggests that circular accounting depends substantially on the environment in which organizations operate and cannot be successfully implemented through internal accounting reforms alone.

The importance of policymakers and regulations is consistent with the broader circular economy literature. Shahdkar et al. identified policy support and enabling institutional conditions among the important factors affecting circular economy implementation in SMEs [17]. Hosseinpour et al., in evaluating circular economy efficiency in municipal solid waste management in Persian Gulf countries, also showed that institutional and policy environments are central to the performance of circular systems [20]. Di Vaio et al. likewise emphasized the role of governance, accountability, and regulatory pressure in circular economy transitions [26]. Therefore, the prominence of policy and regulation in the present findings is theoretically and empirically justified.

The identification of infrastructure and information technology as a key subcomponent also reflects the increasing data intensity of circular accounting. Effective circular reporting requires the capacity to collect, integrate, trace, and analyze financial and nonfinancial information across organizational and supply-chain boundaries. Digital infrastructure facilitates material tracking, real-time monitoring, integration of life-cycle data, and the development of circular performance indicators. Eechoud and Ganzaroli highlighted the importance of digital capabilities in circular business model innovation [13], while Jesse et al. demonstrated the application of artificial intelligence to circularity-related carbon accounting [10]. The present results therefore confirm that technological readiness is one of the enabling conditions for circular accounting.

Culture, education, and media also emerged as a distinct subcomponent. This finding suggests that accounting changes cannot be separated from broader organizational and societal awareness of circularity. Employees, managers, consumers, and other stakeholders must understand circular economy principles if circular accounting information is to influence behavior. Maghsoudi and Rahimian emphasized the relationship between circular economy practices and consumer behavior [21]. Mohammadi et al. also showed, through network and thematic trend analysis, that circular economy research increasingly overlaps with entrepreneurship, innovation, and new forms of value creation, all of which depend on knowledge diffusion and cultural acceptance [24]. Thus, education and media are relevant not merely for awareness but also for creating the social legitimacy required for circular practices.

Economic incentives and market pressure were also identified as important drivers. Organizations are more likely to invest in circular accounting when environmental efficiency, regulatory compliance, market reputation, customer expectations, cost savings, or competitive advantage provide sufficient incentives. The literature on eco-innovation supports this conclusion, as resource-efficient innovations are often linked to both environmental objectives and economic benefits [15]. Similarly, circular entrepreneurship research indicates that market opportunities and business-model innovation can create incentives for firms to adopt circular practices [24]. Advanced decision-making frameworks for waste management also indicate that circular choices are increasingly evaluated through multiple economic, environmental, and operational criteria [22, 23]. Accordingly, the present findings suggest that circular accounting must be capable of demonstrating not only environmental outcomes but also economic value.

Finally, organizational and coordination barriers included resistance to change, lack of standardized circular economy reporting systems, weak stakeholder alignment, NGO participation, and the level of sustainable development in domestic industries. These factors illustrate that implementation barriers can arise both within organizations and across the broader ecosystem. The absence of standardized reporting systems can reduce comparability and make organizations uncertain about which indicators should be measured. Afraz noted the need for stronger integration between circular economy concepts and financial accounting practices [27]. Salari et al. similarly emphasized the need for an integrated circular accounting model in public finance, indicating that fragmented approaches may be insufficient for institutionalized implementation [25]. The present study therefore supports the development of more coherent conceptual and measurement frameworks for circular accounting.

The overall pattern of results shows that circular accounting should be viewed as a system of mutually reinforcing components. Material-flow indicators provide the informational substance of circularity; dynamic capabilities determine whether organizations can generate and use that information; and institutional-environmental factors determine whether circular accounting practices are supported, constrained, or institutionalized. In this sense, the three categories should not be treated as independent dimensions. Instead, effective circular accounting requires simultaneous development across all three. The finding that institutional-environmental factors had the highest frequency highlights the importance of context, while the substantial share of dynamic capabilities confirms that internal organizational readiness remains critical. Material-flow information, although less frequent, remains the operational basis on which circular performance is ultimately assessed.

An additional interpretive point concerns the distinction between circular economy research and other cyclical concepts in economics. Studies on monetary and fiscal policy cycles [28] and on financial and business cycles [29] address cyclical phenomena in a macroeconomic sense rather than circularity in resource systems. Their inclusion in the broader reviewed literature underscores the importance of conceptual clarity. In circular accounting, the relevant notion of “cycle” refers specifically to closed-loop resource use, material retention, recovery, reuse, and reintegration into production systems rather than recurrent macroeconomic fluctuations. This distinction is important for ensuring conceptual precision in future research.

The present study has several limitations. First, the findings were derived from documentary and literature-based data rather than from primary empirical data collected from firms, accountants, managers, policymakers, or other stakeholders. Therefore, although the extracted categories reflect recurring themes in the reviewed literature, they do not directly demonstrate how organizations currently operationalize circular accounting in practice. Second, the prioritization of the three main categories was based on code frequency, which reflects conceptual prominence in the reviewed sources rather than causal importance, practical effectiveness, or statistical weight.

Third, the quality and scope of the findings depend on the range of sources included in the review, and potentially relevant studies may have been omitted because of database coverage, language restrictions, publication accessibility, or differences in terminology. Fourth, the categorization process involved qualitative interpretation, and although conceptual comparisons and reviews were undertaken to improve consistency, some degree of researcher judgment is unavoidable. Finally, the study focused on constructing an integrated conceptual structure and did not empirically test the relationships among the identified components.

Future studies should empirically validate the proposed categories and subcomponents using quantitative and mixed-method designs. Researchers can develop a measurement instrument based on the 12 identified subcomponents and assess its content validity, construct validity, convergent validity, discriminant validity, and reliability. Structural equation modeling can then be used to test relationships among dynamic accounting capabilities, material-flow management, institutional–environmental conditions, and circular performance outcomes. Future research should also compare different industries because the importance of specific components may vary substantially across manufacturing, food, construction, energy, services, and public-sector organizations. Cross-country studies would be useful for examining how regulatory quality, technological infrastructure, and cultural conditions affect circular accounting adoption. Longitudinal studies could investigate how circular accounting capabilities evolve over time. In addition, future work should examine the role of digital technologies, artificial intelligence, blockchain, Internet of Things applications, and automated material tracking in improving the accuracy and timeliness of circular accounting information.

Managers and accounting professionals should approach circular accounting as an integrated management system rather than as an isolated environmental reporting activity. Organizations should first map their material inputs, outputs, losses, recycling flows, and reuse opportunities and then connect these physical flows with financial information. Accounting departments should collaborate closely with environmental, production, procurement, logistics, and information technology units to create integrated datasets. Firms should invest in digital infrastructure capable of tracing materials and linking life-cycle information with cost and performance data. Training programs should be designed to improve accountants' understanding of circular economy concepts and environmental measurement. Senior management should also reduce resistance to change by formally embedding circular accounting responsibilities into governance structures and performance evaluation systems. Policymakers and standard-setting bodies should support organizations by developing clearer reporting guidelines, common indicators, and incentives for adopting circular accounting practices. Finally, firms should use circular accounting information not only for external disclosure but also for operational decision-making, resource optimization, product design, supply-chain coordination, investment appraisal, and continuous improvement.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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