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Environmental Management Accounting and Accountability for Circular Eco-Innovation Projects

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Abstract: Investments in circular eco-innovation projects require rigorous measurement and management accounting to assess environmental performance and enable circular economy reporting. Using a double-focused theoretical framework, a methodology is proposed to classify five circular eco-innovation projects in Spanish manufacturing companies. Projects are assessed at implementation under the prism of the resource-based view theory and over time to examine their disclosure in the stakeholder's theoretical framework. The findings show that companies consistently report sustainability issues and circular economy principles. Specific project information is disseminated punctually, but declines significantly over time, revealing different levels of accountability throughout the lifecycle of circular eco-innovation investments. This study advances circular accounting and the eco-innovation literature by equipping practitioners with tools to compare heterogeneous projects, even during budgeting, and introducing a novel temporal perspective on circular reporting. Given the application of the European Union sustainability disclosure regulations, it also informs the debate on circular accounting and reporting. Policymakers seeking to enhance circular reporting should prioritize monitoring disclosure practices, especially for inter-company and collaborative investments. This paper first introduces the research context, followed by a description of the qualitative research methodology, the main findings, and the conclusions, where the study's contributions and limitations are discussed.

Keywords: eco-innovation projects; project management; sustainability accounting; accountability; circular accounting; reporting

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1. Introduction

In these first decades of the 21st century, some companies are immersed in intense processes of pro-environmental change, increasing investments in circular eco-innovation projects. Circular eco-innovation can arise from the strategic search for environmental improvements through innovation [1], and is aimed at closing material loops [2] for a circular economy (CE). Circular eco-innovation implies the implementation of innovative CE-related activities that contribute to increasing CE principles in processes and products [3], mainly for zero waste [4] and waste patents [5]. In addition, cost savings have been identified as one of the main criteria adopted in decision-making regarding investment in eco-innovation and an innovative CE [6]. Thus, the idea that cost savings and a reduction in environmental damage are not incompatible is generally accepted [7,8].

Nonetheless, the measurement and reporting of the environmental performance of these investments and their implications for environmental accounting remain understudied. Despite the growing academic interest in circular sustainability accounting [9,10], further research is needed on environmental management accounting (EMA) procedures and the specific disclosure of innovation investments [5]. However, conducting an in-depth analysis in this field is challenging, as EMA procedures are not widely adopted by companies and are even less common in the context of the CE.

Given these premises, this study approaches circular eco-innovation investments as projects that achieve measurable environmental improvements [11,12], specifically targeting CE goals and relative cost optimization within the framework of EMA processes [13]. In the literature, EMA is recognized as a strategic capability for eco-innovation, based on the resource-based view (RBV) theory, which asserts that competitive advantage stems not merely from possessing resources, but from how effectively they are utilized. This principle also applies to the CE when introduced by companies and organizations [14].

According to [15], capabilities emerge from unique combinations of organizational processes that integrate strategic knowledge, ultimately enhancing company performance [16]. Therefore, certain internal resources and EMA processes may play a crucial role in circular eco-innovation projects and innovative investments [5]. This reflection leads us to pose the first research question of this study: to define and measure the extent of EMA practices in circular eco-innovation projects (RQ1).

The study of investment projects for eco-innovation is not an unpublished area of study. Still, it remains a topic that has not been widely addressed in the literature, specifically regarding the CE [9], probably due to the investments' uniqueness and the difficulties associated with collecting specific data. The improvements linked to circular eco-innovation investments are often related to resource and raw material conservation and recycling, generating environmentally beneficial innovations. In these investment projects, EMA is therefore relevant for identifying and measuring costs, defining indicators for carbon accounting, environmental performance, and their related issues for decision-making [17].

In particular, investments in CE projects have been addressed by a few authors to date [18,19], for example, in the construction sector [20] or renewables within circular environments [21,22]. Notably, these projects require exhaustive environmental performance measurement and reporting within a CE framework. Few studies in the literature on EMA have explored the accounting processes applied to circular eco-innovation projects in detail to enhance the understanding of the relationship between EMA and project management within a CE framework. Thus, this study provides an integrated measurement of the environmental performance of these investment projects as a second research question (RQ2), as this remains an emerging area of study for CE projects [9].

Finally, the third research question of this study arises from the proven statement that environmental disclosure and environmental performance are positively associated with circular innovation management [23]. In the field of accounting, interest in the CE is recent, and case studies focused on the application of EMA to the CE are still scarce. Despite recent studies on CE-related material flow cost accounting (MFCA) in projects [6], there is a gap in the literature that this paper aims to address. An increasing number of studies focus on reporting on eco-innovation and the CE [24], especially at the sectoral level. The financial sector and other industries have been the focus of an increasing number of studies analyzing circular reporting practices [25–27], such as the waste sector [28].

Previous studies have approached companies' CE reporting practices within the frameworks of the Institutional Theory [29] and the Stakeholder Theory [27,30]. In particular, Freeman's Stakeholder Theory [31] has become an interesting approach in academic studies for sustainability reporting practices [32], with recent studies highlighting the key role of stakeholders in value creation and CE implementation [33,34]. However, specific reporting practices for circular eco-innovation projects have not been studied in depth. Thus, we specifically analyze project reporting by companies over time to provide a methodology for defining accountability in project reporting (RQ3).

This study contributes to knowledge in this field through an integrated qualitative methodology from the double-focused theoretical perspective of the RBV and Stakeholder Theory, applied to five circular eco-innovation projects carried out by Spanish companies from a temporal perspective unprecedented in reporting studies on the CE. To the best of our knowledge, the research questions posed in this study have not been analyzed in the environmental accounting literature, and this study initiates a specific debate among academics focused on circular project management accounting for the CE from an RBV perspective.

In summary, our research aims to fill a gap from the RBV perspective in defining and measuring the extent of EMA practices in circular eco-innovation projects (RQ1) to provide an integrated measurement of the environmental performance of these projects (RQ2) and the related resources and capabilities applied by companies. In addition, we analyze project reporting by companies over time (RQ3) in order to advance knowledge in the conceptualization of the disclosure of investments in innovative projects for circular eco-innovation.

The rationale of this paper is as follows: after this introduction, where we introduce the research objectives, the qualitative research methodology used in the multiple-case-study analysis is described, followed by the main results. Finally, in the conclusion, the main contributions and limitations of this study are outlined.

2. Materials and Methods

Despite the growing number of studies focused on eco-innovation projects from an RBV perspective, we can confirm that there is minimal empirical evidence regarding this subject. In particular, when we delve deeper into specific innovative CE projects, the gap becomes even more evident. This is most likely due to the limited availability of data related to internal EMA processes, and the fact that information about long-term circular eco-innovation investments is usually not disclosed due to its confidential nature in companies. In addition, specific EMA CE-related practices introduced by companies are still in the early stages of development, given the difficulty of integrating the measurement of all the facets involved in circular eco-innovation investments.

Project management has been defined in this study as "the manner of implementation, of expertise, paraphernalia, knowledge and modus operandi to an extensive range of activities for the fulfillment of the prerequisites of the specific project" [35]. For the conceptualization of circular eco-innovation projects, we consider the "dynamic process through which a project idea, from its generation in a raw form, is amplified, crystallized, and connected with an organization's knowledge system to reflect in the form of a concrete and explicit concept" [36]. In particular, circular eco-innovation refers to those CE-related innovative projects that contribute to increasing the implementation of the CE through investments.

Whilst the results obtained through physical indicators, such as CO_2 emissions, can also be measured for CE projects [37], the interrelation between cost optimization in eco-innovation projects and its implications for material loop closure, waste recovery, and reduction within a CE framework can vary significantly from one company to another. Thus, we developed an integrated qualitative methodology based on five case studies that allow for an in-depth analysis of a large number of variables for each project described in Appendix A.

The analyzed circular eco-innovation projects carried out by the selected companies are described in Table 1, within the framework of a campaign promoting eco-innovation and circular innovation in the Region of Aragon (Spain) in 2016. The specific analysis of eco-innovation projects began after the end of the campaign by defining the methodology, encoding the information case by case, and transforming project results into pattern codes, and then into variables. The selected companies were required to submit a detailed report outlining the key characteristics of their chosen eco-innovation projects. This included information on investment, execution details, timeline, location, type and objectives of eco-innovation, emissions, resource and waste savings, processes, applicable products or services, and the value chain, in alignment with the tools proposed for sustainability principles [38]. Therefore, the five cases were selected to reflect different types of circular eco-innovation, all in the manufacturing sector, for comparability. The analysis of Sustainable Development Goals (SDGs) was excluded, given the incipient implementation of SDGs at the time of the initial disclosure of the selected projects.

Table 1. Brief description of the case studies (alphabetical order).

Firms (Available Data 2023)	Projects (Initially Disseminated in 2016)	Circular Eco-Innovation Goals	Project Results
BSH Electrodomésticos España, S.A.—www.bsh-group.com Manufacturing: Appliances Industry—4323 employees, 41 years old	Eco-design of a new clamping system for one of the main components of the company's washer models.	Reduction in the product's weight and the materials required for its construction.	74% reduction in the environmental impact of the part. Short-term project timeframe. Low project investment level.
STELLANTIS España, S.L.—www.stellantis.com Manufacturing: Automotive Industry—10,898 employees, 30 years old	Design and configuration of new main painting and car refinishing processes based upon eco-design principles.	Reduction in the amount of paint applied per unit, leading to decreased use of solvents and energy during the process. This also significantly reduced the waste generated by the process.	Reduction of 149,000 L of paint and solvents annually. Achieved energy savings of 4680 MWh/year in process consumption. Significant increase in the quality of the painting. Mid-term project timeframe. Low project investment level.
MAC PUAR, S.A.—www.mpascensores.com Manufacturing: Elevators Industry—603 employees, 55 years old	Using the Life Cycle Analysis (LCA) methodology for the eco-design of a new elevator model.	Reduction in the client's energy consumption during product use, alongside a reduction in raw materials used for manufacturing, resulting in a lighter product.	40% reduction in energy consumption during product use compared to previous models. 20% reduction in raw material usage during the product's manufacturing. Mid-term project timeframe. Low project investment level.
MONDO TUFTING, S.A.U.—www.mondoworldwide.com Manufacturing: Other—85 employees, 23 years old	Design of a product specifically intended for the retrieval and recycling of its own plastic products at the end of their usage phase.	Process improvements enabling a reduction in raw material usage through the recycling of the company's own products.	90% reduction in the environmental impact of the product's life cycle. Short-term project timeframe. Low project investment level.
Sociedad Anónima Industrias Celulosa Aragonesa—www.saica.com Manufacturing: Paper Industry—771 employees, 82 years old	Design and installation of a new plant for energy valuation of production waste.	Reduction in environmental impact in waste management through energy recovery from waste and renewable energy generation for the main plant's operations.	520,000 t/year of CO_2 reduction in the production process. Long-term project timeframe. High project investment level.

Public presentations of all projects described in this table are available on YouTube at https://www.youtube.com/Ecoaragon (Accessed on 1 February 2025). Short-term: less than 5 years; mid-term: 5–15 years; and long-term: more than 15 years. Total project investment as a proportion of the company's total assets—low: less than 2.31%; medium: 2.31–4.61; and high: more than 4.61%.

As a second methodological phase, the projects are analyzed over the years to assess to what extent circular eco-innovations continue to be disseminated and how their disclosure by companies has evolved. This second step was conducted in 2025 through an external content analysis of companies' sustainability reporting practices disseminated in 2024 and the specific information disclosed about the projects.

The methodology applied for accountability is based on a rubric divided into three items, each assessed using discrete variables on a scale from 0 to 5 points, with a maximum possible score of 15 (Appendix A). The scoring was carried out through manual analysis (Table 2).

Table 2. Summarized accountability analysis of project disclosure.

Disclosure of Circular Eco-Innovation Projects over Time					
Project	Eco-design of a new clamping system for one of the main components of the company's washer models.	Design and configuration of new main painting and car refinishing processes based upon eco-design principles.	Using the Life Cycle Analysis (LCA) methodology for the eco-design of a new elevator model.	Design of a product specifically intended for the retrieval and recycling of its own plastic products at the end of their usage phase.	Design and installation of a new plant for energy valuation of production waste.
Website	Website (3/5): It features dedicated sections on sustainability and innovation, along with basic information about their eco-innovation projects.	Website (4/5): It features a responsibility section and provides information on eco-innovation projects.	Website (1/5): Minimal or vague mention of sustainability goals, with no specific reference to circular eco-innovation.	Website (1/5): Minimal or vague mention of sustainability goals, with no specific reference to circular eco-innovation.	Website (4/5): It features dedicated sections on sustainability and innovation, along with details about their collaborations on eco-innovation projects.
Reports	Reports (3/5): Several public reports exist, including information on patents, but details on eco-innovation projects could be improved.	Reports (4/5): Several years of reports are available, allowing for measurable outcomes.	Reports (0/5): No sustainability or related reports available for assessment.	Reports (3/5): Several public reports exist, but details on eco-innovation projects could be improved.	Reports (3/5): Reports are only available until 2021, making it difficult to assess progress in the present.
Project disclo-sure	Project disclosure (0/5): No information about the 2016 project.	Project disclosure (5/5): Comprehensive and well-maintained documentation of the 2016 project is accessible.	Project disclosure (0/5): No information about the 2016 project.	Project disclosure (0/5): No information about the 2016 project.	Project disclosure (2/5): Some basic information is available, but it lacks substance.
Total score:	6	13	1	4	9

This selection of case studies represents a significant contribution to the micro-area of literature on circular eco-innovation, as companies provided a large volume of information regarding their investments during the public campaign, which was collected through various means, such as specific investment project sheets and detailed videos showcasing the results of the selected projects. In particular, investments, costs, and detailed environmental improvements can be thoroughly described, along with the main EMA practices related to the projects. Likewise, this selection of case studies leaves no doubt about the circular eco-innovative nature of the projects, owing to the public dissemination process and the participation of many experts in the selection of companies' projects.

3. Results

This study was performed in close collaboration with eco-innovation actors and several managers of the analyzed companies. In particular, this collaboration highlighted entrepreneurs' need for a simple method allowing them to conduct an accounting analysis of certain aspects of the projects and obtain environmental information that is easily comprehensible and useful for company accountants (RQ1).

Throughout the research and analysis of the EMA process related to circular eco-innovation, no evidence was found to confirm the relevance of accountants' participation in these investment projects. Nevertheless, there was evidence of a specific internal collaborative process that included the accounting department in decision-making regarding circular eco-innovation investments on occasions where gathering information for the cost calculation for each project was necessary.

This initial result is consistent with the data gathered from the survey for the qualitative measurement of accounting behaviors in relation to environmental aspects in eco-innovative organizations. Table 3 presents a summary of the analysis results (In this analysis, for confidentiality reasons, the companies are numbered in the same order as in Tables 4 and 5, but their numbering differs from the list provided in Tables 1 and 2, which contains the case studies and the analysis of projects' accountability.) for the three dichotomous variables (questions from 1 to 3) and the two variables used to measure accountants' perceptions (questions 4 and 5, measured using a Likert scale ranging from 0 to 10) (A score of 0 indicates that the respondent (i.e., the company personnel in charge of environmental affairs) completely disagrees with the statement, whereas a score of 10 indicates complete agreement with the statement.) regarding the relevance of environmental issues and their participation in eco-innovation processes.

Table 3. Results obtained regarding the participation of accounting departments in environmental matters of the studied companies.

	Project 1	**Project 2**	**Project 3**	**Project 4**	**Project 5**
Expenses to reduce emissions are separately recorded as specific costs	YES (1)	YES (1)	YES (1)	NO (0)	NO (0)
Provisions and contingencies related to environmental expenditures are recorded	YES (1)	NO (0)	NO (0)	YES (1)	NO (0)
These items (expenses, provisions . . .) are detailed in reports	NO (0)	YES (1)	YES (1)	NO (0)	YES (1)
Accountants actively participate in environmental decisions and eco-innovation	1	3	5	10	4
Accountants consider it necessary to differentiate accounting for environmental issues and expenses	3	4	4	6	1
Max 23 TOT.	6.00 26%	9.00 39%	11.00 48%	17.00 74%	6.00 26%

It is observed that, with the exception of one company, where EMA is of interest to accountants and there is effective participation of this department in circular eco-innovation projects (74% of the available score), four of the five companies do not attain half of the available score. More specifically, reporting environmental issues is the most widespread activity, whereas in four of the companies analyzed, environment-related expenses are not differentiated at the accounting level, and the participation of accountants in decision-making concerning the company's environmental matters is not a priority (Table 3). Based on this analysis, to answer RQ1, we can confirm that EMA practices were initially considered to be of little relevance when projects started. This result is also corroborated by the semi-structured interviews conducted to explore the specific EMA resources and capabilities applied to the internal circular eco-innovation process. As a general result, accounting departments have marginal participation in circular eco-innovation investments, mainly contributing information regarding potential cost savings.

Table 4. Classification of the levels of environmental improvement related to the principal cost categories for circular eco-innovation investments (manufacturing phase).

		L.(1) LOW (1 Point)	Coef. L.(1)	L.(2) MEDIUM (2 Points)	Coef. L.(2)	L.(3) HIGH (3 Points)	Coef. L.(3)
Project 1)	Materials savings (−56% paints and solvents)					3	1
	Resources savings (−26% electricity)					3	0.6
Project 2)	Raw material completely substituted with recycled materials and −10% materials savings					3	1
	Resources savings (−10% electricity)	1	0.2				
Project 3)	Raw materials savings (−47% metal)					3	1
	Resources savings (−5% electricity)	1	0.2				
Project 4)	Raw materials savings (valorization of waste 40%)					3	1
	Resources savings (−30% electricity)			2	0.8		
Project 5)	Raw materials savings (−20% metal)			2	0.6		
	No resources savings (−0% electricity)	1	0.2				

Table 5. Classification of the levels of environmental improvement related to the use phase or the end of product life for each project.

		L.(4) "Genuine" (4 Points)	Coef. L. (4)
Project 1	Improved recycling at the end of product life	4	0.1
Project 2	Improved recycling at the end of product life	4	1
Project 3	Improved recycling at the end of product life	4	0.8
Project 4	Improved recycling at the end of product life	4	0.1
Project 5	Energy savings during the use phase	4	1

Next, each selected project was analyzed to determine the most relevant cost items for circular eco-innovation and related environmental improvements (RQ2). The principal data obtained for the five case studies are summarized in Table 4, where environmental improvements obtained through circular eco-innovation projects are analyzed. These improvements are classified according to different intensity levels based on the emissions savings produced, which correspond to the cost categories optimized through the investments. In most cases, these categories involve savings in terms of raw materials, waste, and energy sources.

In summary, for each project, the first column summarizes the cost savings associated with innovative investments, and each type of cost saving is assigned the corresponding level of environmental improvement, ranging from "low intensity" to "high intensity". These levels allow us to understand the correlation between the degree of environmental improvement and project profitability (RQ2). Finally, a fourth level of environmental improvement is added and defined as "genuine", as these improvements occur during the products' usage phase or at the end of its lifecycle. Instead of being linked to company cost optimization, this level of improvement is achieved through efforts to enhance product recyclability for CE adoption or through environmental benefits for users due to eco-innovation, even if this does not result in cost reductions for the company.

As observed in Table 4, the majority of projects achieve medium or high-level environmental improvements (based on an estimate of CO_2-equivalent emissions savings) through the cost optimization inherent to investment, with the majority of improvements being linked to reductions in raw materials and waste classified as high-intensity. The observations related to the use phase or the end of product life are summarized in Table 5.

Due to the diversity of the circular eco-innovations analyzed, scores on a scale of one to four were assigned based on the level of environmental improvement. These scores were adjusted using a coefficient, which indicates the intensity of savings achieved in both raw materials and resources, thereby contributing to waste reduction. This is presented in Tables 5 and 6, where the potential savings levels and assigned coefficients are classified. In the case of the fourth level (four points), the coefficient is estimated based on potential savings achieved during the product's usage or end-of-life phases, in terms of emissions, energy consumption, or recyclability improvements.

Table 6. Adjusting coefficients for each environmental improvement level in energy savings and raw materials savings.

Environmental coefficient	0%	From 1% to 10%	From 11% to 20%	From 21% to 30%	From 31% to 40%	More than 40%
Energy savings	0	0.2	0.4	0.6	0.8	1
Environmental coefficient	0%	From 1% to 5%	From 6% to 10%	From 11% to 20%	From 21% to 30%	More than 30%
Raw materials savings	0	0.2	0.4	0.6	0.8	1

In Table 6, we describe in detail the coefficients used to adjust the energy savings and raw materials savings obtained at each stage of the eco-innovation projects and the adjusting coefficients assigned.

The simplification method adopted for the integrated measurement allows us to analyze EMA internal processes in the case studies, applied to systems for managing and optimizing environmental costs. This methodology can be applied during the budget phase of investments and in reporting activities. Thus, by applying the integrated measurement, accountants are provided with easily usable information to estimate key environmental performance metrics and the related cost optimization for circular eco-innovation investments, which can be classified into different intensity levels.

This simplified classification and measurement method also allows us to compare different eco-innovation projects based on data regarding cost savings that correlate with reductions in the company's environmental impact. The relationship between cost savings and associated positive environmental effects does not necessarily require continuous interaction between the accounting and environmental departments throughout the project's duration, which simplifies its application.

To address the third research question, an analysis of project reporting practices over time was conducted using an external content analysis applied to selected circular eco-innovation initiatives (RQ3). The findings, summarized in Table 2, reveal significant discrepancies in how companies maintain and communicate their eco-innovation initiatives over time. Some demonstrated a well-documented and transparent approach, particularly in maintaining comprehensive and well-structured documentation of past projects. Others provided moderate levels of information, with structured sustainability sections and publicly available reports. However, the limited accessibility of past project details suggests that while sustainability efforts are communicated, long-term project tracking remains inconsistent. At the lower end of the spectrum, certain cases showed minimal engagement in publicly documenting sustainability and circular eco-innovation efforts.

4. Discussion

4.1. Discussion in the Framework of the RBV

Through the five case studies from which data were gathered, we can begin to formulate an initial conceptualization of a scarcely explored area, for which no broader consensus has yet been reached in the literature regarding specific EMA resources and capabilities for circular eco-innovation projects. Although, in a seminal study [39] demonstrated the influence of dynamic accounting on the CE, in this study, only certain resources related to EMA can be outlined that enhance the management of investment projects and make measurement practices and specific project reporting more comprehensive and sustainable over time. To date, these questions have received little attention in the literature regarding the analysis of specific projects.

In response to RQ1, we observe that EMA can serve as a useful foundation for classifying circular eco-innovation project results and the internal processes necessary to implement these projects to achieve environmental goals. In recent years, a greater degree of environmental consciousness raising has encouraged organizations to use EMA, highlighting its relevance for the CE and circular eco-innovation investments [23]. When EMA is applied, it is carried out through companies' management systems or parallel internal accounting processes, rather than through ordinary standards, which would facilitate its study. On the other hand, accounting studies conducted from an RBV perspective mainly focus on the application of management accounting and its relation to the management of strategic assets and companies' financial performance [40–43]. Unlike other studies, in this study, we perform a specific analysis to define the resources applied to eco-innovation and the environmental accounting capability of companies investing in circular eco-innovation.

This research enhances the knowledge on internal accounting resources that could be applied to simultaneously achieve cost optimization and environmental improvements in circular eco-innovation projects. Furthermore, this cost optimization could be obtained at the maximum level and intensity of environmental performance that these projects are capable of producing. Thus, the limited scope of collaboration between the accounting department and other departments usually involved in circular eco-innovation project management is highlighted.

The results obtained from the analysis of the management process of the circular eco-innovation projects analyzed (RQ2) provide a classification of the principal cost categories optimized in the projects, in addition to their environmental impacts, which are primarily linked to reductions in raw materials and energy sources. Likewise, through the proposed classification, we can differentiate the improvements generated by eco-innovative projects, which we define as "genuinely environmental" within the EMA framework, since they materialize in the product's usage phase without reducing costs for the company.

In general terms, the measurement of the environmental results of eco-innovation projects is retrospective in nature [44], as it describes savings obtained once investments have been implemented. In this regard, the measurement scale proposed by [45] is considerably broadened, as it is obtained by evaluating each item's relevance in relation to environmental improvements and considering a series of criteria applied to eco-innovation projects in manufacturing companies.

Based on the information obtained, the R&D and innovation departments, the environmental department, and, where applicable, the manufacturing department, are typically involved in the different phases of defining and implementing eco-innovation. In decision-making regarding investment, the finance department and company management play a predominant role, consistent with the results obtained by [6] for MFCA processes.

4.2. Main Implications for Reporting Circular Eco-Innovations

The commitment to inform and involve stakeholders is crucial [46]. Thus, the third objective of this paper is to contribute to a line of inquiry by expanding the knowledge on reporting practices for circular eco-innovation investment projects in the framework of the Stakeholder Theory. A key result obtained from the accountability analysis is the lack of publicly available information on past circular eco-innovation projects, as only one of the five case studies provided consistent long-term access to records. While some basic references were found, most companies failed to ensure historical transparency. This gap in accessibility suggests that sustainability communication efforts often prioritize current and future commitments rather than maintaining long-term accountability for investment projects.

These case studies highlight the importance of sustainability communication in establishing best practices to enhance stakeholder expectations [47] and commitment [48]. However, disclosure should be improved to better reflect the specific outcomes of projects over time. Ref. [23] argues that circular eco-innovation presents significant challenges in stakeholder management for environmental disclosure. However, based on the analyzed case studies, we cannot confirm that the reporting practices for the five projects effectively target a broader spectrum of stakeholders. Thus, progress remains to be made in analyzing stakeholder impacts for specific projects and in analyzing to what extent their collaborative behaviors may influence the implementation of the CE [49]. The results obtained in this study do not allow us to delve deeper into these arguments. Still, we can highlight the predisposition of the analyzed entities to reporting on their specific circular eco-innovation investments in detail; therefore, also increasing the information reported about the CE in the short and medium term, according to other authors [6,23].

Furthermore, we would like to emphasize that accountants lack specific EMA-related information that links principal cost items that they calculate and manage to the environmental repercussions of these savings and project management. This undoubtedly limits accountants' awareness of environmental issues, participation in the circular eco-innovation process, and their role in reporting these issues. However, given the complexity of circular eco-innovation, accountants could be regarded as a unique and inimitable company resource that could positively influence the outcomes of eco-innovation projects, provided that they are actively integrated into these processes from their inception, including providing information as part of voluntary reporting schemes.

5. Conclusions

This in-depth analysis of five circular manufacturing eco-innovation projects over time highlights the potential of specific EMA resources and their role in facilitating innovative investments. A key finding of this study is the integrated measurement methodology used to assess circular eco-innovation project outcomes. This methodology enables accounting practitioners to classify and compare environmental performance and cost optimization across projects. Moreover, it allows for the evaluation of heterogeneous circular eco-innovation projects, even during the budgeting phase, making it a valuable tool for both accounting practitioners and academics.

From a double-focused theoretical perspective, these results contribute to the ongoing academic debate regarding circular accounting and reporting specifically for investment projects. Given the conceptual application of EMA to circular environments, these factors are also relevant in decision-making for project management to integrate the accounting process of circular eco-innovation projects as new specific capabilities to be developed. Furthermore, practitioners and companies may adapt and improve their metrics for project indicators, shifting from complying and benchmarking to truly addressing their stakeholders' needs and priorities in reporting projects' impacts.

These results indicate a growing tendency to involve a wider range of resources and functional areas within organizations in eco-innovation investments. Additionally, there is an increasing depth of analysis and a broader array of information available regarding the accounting management of these projects. The findings also suggest that reporting on past projects is becoming more structured and transparent as the quality of corporate websites and available reports improves. Companies with strong sustainability reporting practices tend to maintain more comprehensive records of past circular eco-innovation initiatives, whereas those with limited disclosure lack historical transparency.

The novel approach adopted to examine circular eco-innovation reporting over time in this study may assist policymakers and government authorities in refining regulations to establish transparent monitoring mechanisms for the impact of specific investment projects. Notably, this research provides a targeted approach to enhancing accountability policies that support project disclosure, rather than prioritizing corporate reporting standards. However, given the limited scope of these five case studies, this trend cannot be definitively confirmed.

Future research should expand on this topic by analyzing a broader range of circular eco-innovation projects. Additionally, as this study focuses on Spain, its findings may not be generalizable to countries outside the EU with different sustainability disclosure standards. Nevertheless, the methodology applied in these case studies could be adapted for use in other European regions, particularly for manufacturing companies, with minimal adjustments to account for variations in time and regulatory frameworks.

There are several potential improvements that could be proposed for future studies on this subject, particularly regarding the number of case studies, the size and characteristics of the companies, the nature of their eco-innovation projects, and the geographic region analyzed. The limited sample size means that the generalization of the trend has to be considered with caution, because companies with strong sustainability reporting maintain better records of circular investments. However, the limited dataset prevents a definitive conclusion. More quantitative analysis across a larger dataset could strengthen claims made on this topic. Thus, the associated extensions of this study include the analysis of a large number of cases with a greater range of variables over a longer period, particularly concerning intrinsic relationships with stakeholders and the dissemination of the SDGs in projects. In addition, potential benchmarking analysis against industry-wide EMA and CE reporting standards (e.g., GRI, and EU Taxonomy) would improve cross-company comparisons to promote EMA practices as a future line of research.

Despite their limitations, the results obtained can help practitioners to become more aware of accounting processes and their influence on environmental performance, to increase the commitment of accounting departments to corporate environmental performance. The lack of partnerships for implementing CE practices could be analyzed in future lines of inquiry, particularly in relation to the sector-specific, inter-company disclosure of circular practices both within and beyond company boundaries.

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Abbreviations

The following abbreviations are used in this manuscript:

CE	Circular economy
EMA	Environmental management accounting
RBV	Resource-based view
MFCA	Material flow cost accounting
SDGs	Sustainable Development Goals
CO_2	Carbon dioxide
LCA	Life Cycle Analysis
R&D	Research and Development
EU	European Union
GRI	Global reporting initiative

Appendix A

Table A1. List of variables for analyzing accounting processes and accountability of circular eco-innovation projects.

Variables inherent to the accounting process	
Continuous	Investment related to the eco-innovation project (euros)
Continuous	Project execution period (months)
Discrete	Eco-innovation place of implementation
Discrete	Type of eco-innovation
Discrete	Investment project's principal objective
Continuous	Emissions savings (%)
Continuous	Raw materials savings (%)
Continuous	Energy sources savings (%)
Continuous	Waste reduction (%)
Continuous	Improvement in environmental impact in the product's usage phase (%)
Variables inherent to the accounting process	
Dichotomic	Expenses to reduce emissions are separately recorded as specific costs
Dichotomic	Provisions and contingencies related to environmental expenditures are recorded
Dichotomic	These items (expenses, provisions ...) are detailed in reports
Likert 0–10	Accountants actively participate in environmental decisions and eco-innovation
Likert 0–10	Accountants consider it necessary to differentiate accounting for environmental issues and expenses
Variables inherent to the accountability of circular eco-innovation projects	
Likert 0–5	Assessment of information regarding circular eco-innovation projects specifically on the company's official website: 0—No information about sustainability or circular innovation is available. 1—Minimal or vague mention of sustainability goals, with no specific reference to circular eco-innovation. 2—Sustainability is addressed, and there is some reference to circular economy concepts, but these are brief or lack depth. 3—Circular eco-innovation projects are explicitly mentioned with basic details (e.g., project names and/or short descriptions). 4—Circular eco-innovation projects are detailed, with moderate insights such as goals, timelines, or partners. 5—Comprehensive information, including detailed project descriptions, measurable impacts, and ongoing updates.

Table A1. *Cont.*

Likert 0–5	Assessment of information regarding circular eco-innovation projects specifically in the company's sustainability and/or related reports over multiple years: 0—No sustainability and/or related reports available for assessment. 1—General sustainability topics are mentioned in reports, but circular economy or eco-innovation is absent. 2—Circular economy and eco-innovation are briefly addressed in reports, but coverage is inconsistent or lacks specifics. 3—Circular eco-innovation is consistently mentioned in reports, with some project details provided. 4—Detailed information on circular eco-innovation projects is provided for multiple years, showing progress and measurable outcomes. 5—Reports provide extensive, transparent, and evolving documentation of circular eco-innovation, including challenges, solutions, and long-term impacts.
Likert 0–5	Verification of whether detailed information about the 2016 circular eco-innovation project remains accessible on the company's official website in 2025: 0—No information about the 2016 circular eco-innovation project is available in 2025. 1—The project is mentioned on the website, but with minimal or no details (e.g., just the name or a passing reference). 2—Some basic information is available about the 2016 project, such as an archived summary, but it lacks substance. 3—Moderate details about the 2016 project are accessible, such as objectives, partners, or brief outcomes. 4—Detailed information about the 2016 project remains accessible, including measurable outcomes, milestones, and any follow-up actions. 5—Comprehensive and well-maintained documentation of the 2016 project is accessible, reflecting transparency, lessons learned, and its long-term impacts.

References

1. Doran, J.; Ryan, G. Eco-Innovation—Does Additional Engagement Lead to Additional Rewards? *Int. J. Soc. Econ.* **2014**, *41*, 1110–1130. [CrossRef]
2. Suchek, N.; Fernandes, C.I.; Kraus, S.; Filser, M.; Sjögrén, H. Innovation and the Circular Economy: A Systematic Literature Review. *Bus. Strategy Environ.* **2021**, *30*, 3686–3702. [CrossRef]
3. Demirel, P.; Danisman, G.O. Eco-Innovation and Firm Growth in the Circular Economy: Evidence from European Small- and Medium-Sized Enterprises. *Bus. Strategy Environ.* **2019**, *28*, 1608–1618. [CrossRef]
4. de Jesus, A.; Antunes, P.; Santos, R.; Mendonça, S. Eco-Innovation in the Transition to a Circular Economy: An Analytical Literature Review. *J. Clean. Prod.* **2018**, *172*, 2999–3018. [CrossRef]
5. Portillo-Tarragona, P.; Scarpellini, S.; Marín-Vinuesa, L.M. 'Circular Patents' and Dynamic Capabilities: New Insights for Patenting in a Circular Economy. *Technol. Anal. Strateg. Manag.* **2024**, *36*, 1571–1586. [CrossRef]
6. Aranda-Usón, A.; Scarpellini, S.; Moneva, J.M. Dynamic Capabilities for a "Circular Accounting" and Material Flows in a Circular Economy. *Resour. Conserv. Recycl.* **2024**, *209*, 107756. [CrossRef]
7. Triguero, A.; Moreno-Mondéjar, L.; Davia, M.A. Drivers of Different Types of Eco-Innovation in European SMEs. *Ecol. Econ.* **2013**, *92*, 25–33. [CrossRef]
8. Shuaib, M.; Seevers, D.; Zhang, X.; Badurdeen, F.; Rouch, K.E.; Jawahir, I.S. Product Sustainability Index (ProdSI): A Metrics-Based Framework to Evaluate the Total Life Cycle Sustainability of Manufactured Products. *J. Ind. Ecol.* **2014**, *18*, 491–507. [CrossRef]
9. Etxeberria, I.Á.; Llena-Macarulla, F.; Portillo-Tarragona, P. Editorial Letter. Sustainability Accounting, Accountability and Disclosure in a Circular Economy. *Rev. Contab.-Span. Account. Rev.* **2023**, *26*, 3–6. [CrossRef]
10. Arjaliès, D.L.; Rodrigue, M.; Romi, A.M. "Come Play with Us!" A Grassroots Research Agenda for Accounting and the Circular Economy. *Account. Forum* **2023**, *47*, 497–524. [CrossRef]
11. Ekins, P. Eco-Innovation for Environmental Sustainability: Concepts, Progress and Policies. *Int. Econ. Econ. Policy* **2010**, *7*, 267–290. [CrossRef]
12. Alam, S.; Atif, M.; Chien-Chi, C.; Soytaş, U. Does Corporate R&D Investment Affect Firm Environmental Performance? Evidence from G-6 Countries. *Energy Econ.* **2019**, *78*, 401–411. [CrossRef]
13. Aureli, S.; Foschi, E.; Paletta, A. Management Accounting for a Circular Economy: Current Limits and Avenue for a Dialogic Approach. *Account. Audit. Account. J.* **2023**. [CrossRef]
14. Gallardo-Vázquez, D.; Scarpellini, S.; Aranda-Usón, A.; Fernández-Bandera, C. How Does the Circular Economy Achieve Social Change? Assessment in Terms of Sustainable Development Goals. *Humanit. Soc. Sci. Commun.* **2024**, *11*, 692. [CrossRef]
15. Penrose, E.T. *The Theory of the Growth of the Firm*, 4th ed.; OUP Oxford, Ed.; Oxford University Press: New York, NY, USA, 1959; ISBN 0199573840.

16. Ketata, I.; Sofka, W.; Grimpe, C. The Role of Internal Capabilities and Firms' Environment for Sustainable Innovation: Evidence for Germany. *RD Manag.* **2015**, *45*, 60–75. [CrossRef]
17. Schaltegger, S.; Csutora, M. Carbon Accounting for Sustainability and Management. Status Quo and Challenges. *J. Clean. Prod.* **2012**, *36*, 1–16. [CrossRef]
18. Gonçalves, B.d.S.M.; Carvalho, F.L.d.; Fiorini, P.d.C. Circular Economy and Financial Aspects: A Systematic Review of the Literature. *Sustainability* **2022**, *14*, 3023. [CrossRef]
19. Dewick, P.; Bengtsson, M.; Cohen, M.J.; Sarkis, J.; Schröder, P. Circular Economy Finance: Clear Winner or Risky Proposition? *J. Ind. Ecol.* **2020**, *24*, 1192–1200. [CrossRef]
20. Wuni, I.Y. A Systematic Review of the Critical Success Factors for Implementing Circular Economy in Construction Projects. *Sustain. Dev.* **2023**, *31*, 1195–1213. [CrossRef]
21. Dar, A.A.; Hameed, J.; Huo, C.; Sarfraz, M.; Albasher, G.; Wang, C.; Nawaz, A. Recent Optimization and Panelizing Measures for Green Energy Projects; Insights into CO2 Emission Influencing to Circular Economy. *Fuel* **2022**, *314*, 123094. [CrossRef]
22. Romero-Castro, N.; Ángeles López-Cabarcos, M.; Miramontes-Viña, V.; Ribeiro-Soriano, D. Sustainable Energy Transition and Circular Economy: The Heterogeneity of Potential Investors in Rural Community Renewable Energy Projects. *Environ. Dev. Sustain.* **2023**, *1*, 1–26. [CrossRef]
23. Valero-Gil, J.; Scarpellini, S. Management of Patented 'Circular Innovation' in View of the Circular Economy. *RD Manag.* **2024**, *54*, 1016–1039. [CrossRef]
24. Marco-Fondevila, M.; Llena-Macarulla, F.; Callao-Gastón, S.; Jarne-Jarne, J.I. Are Circular Economy Policies Actually Reaching Organizations? Evidence from the Largest Spanish Companies. *J. Clean. Prod.* **2021**, *285*, 124858. [CrossRef]
25. Stewart, R.; Niero, M. Circular Economy in Corporate Sustainability Strategies: A Review of Corporate Sustainability Reports in the Fast-Moving Consumer Goods Sector. *Bus. Strategy Environ.* **2018**, *27*, 1005–1022. [CrossRef]
26. Esposito, B.; Raimo, N.; Malandrino, O.; Vitolla, F. Circular Economy Disclosure and Integrated Reporting: The Role of Corporate Governance Mechanisms. *Bus. Strategy Environ.* **2023**, *32*, 5403–5419. [CrossRef]
27. Vitolla, F.; L'Abate, V.; Petruzzella, F.; Raimo, N.; Salvi, A. Circular Economy Disclosure in Sustainability Reporting: The Effect of Firm Characteristics. *Sustainability* **2023**, *15*, 2200. [CrossRef]
28. Di Vaio, A.; Hasan, S.; Palladino, R.; Hassan, R. The Transition towards Circular Economy and Waste within Accounting and Accountability Models: A Systematic Literature Review and Conceptual Framework. *Environ. Dev. Sustain.* **2023**, *25*, 734–810. [CrossRef]
29. Roberts, L.; Georgiou, N.; Hassan, A.M. Investigating Biodiversity and Circular Economy Disclosure Practices: Insights from Global Firms. *Corp. Soc. Responsib. Environ. Manag.* **2023**, *30*, 1053–1069. [CrossRef]
30. Gallardo-Vazquez, D.; Scarpellini, S.; Aranda-Usón, A.; Kuba-Khoury, V. Social and Circular Economy: Measurement and Reporting for Sustainability Management in Nonprofit Entities. *UCJC Bus. Soc. Rev.* **2024**, *21*, 18–59. [CrossRef]
31. Freeman, R.E. *Strategic Management: A Stakeholder Approach*; Pitman: Marshfield, MA, USA, 1984; ISBN 0273019139.
32. Diwan, H.; Amarayil Sreeraman, B. From Financial Reporting to ESG Reporting: A Bibliometric Analysis of the Evolution in Corporate Sustainability Disclosures. *Environ. Dev. Sustain.* **2024**, *26*, 13769–13805. [CrossRef]
33. Kujala, J.; Heikkinen, A.; Blomberg, A. *Stakeholder Engagement in a Sustainable Circular Economy: Theoretical and Practical Perspectives*; Springer International Publishing: Cham, Switzerland, 2023; ISBN 9783031319372.
34. Adebayo, Y.A.; Ikevuje, A.H.; Kwakye, J.M.; Esiri, A.E. Driving Circular Economy in Project Management: Effective Stakeholder Management for Sustainable Outcome. *GSC Adv. Res. Rev.* **2024**, *20*, 235–245. [CrossRef]
35. Qureshi, T.M.; Warraich, A.S.; Hijazi, S.T. Significance of Project Management Performance Assessment (PMPA) Model. *Int. J. Proj. Manag.* **2009**, *27*, 378–388. [CrossRef]
36. Akbar, H.; Mandurah, S. Project-Conceptualisation in Technological Innovations: A Knowledge-Based Perspective. *Int. J. Proj. Manag.* **2014**, *32*, 759–772. [CrossRef]
37. Jesse, F.F.; Antonini, C.; Luque-Vilchez, M. A Circularity Accounting Network: CO_2 Measurement along Supply Chains Using Machine Learning. *Rev. Contab.-Span. Account. Rev.* **2023**, *26*, 21–33. [CrossRef]
38. Muñoz-Torres, M.J.; Fernández-Izquierdo, M.Á.; Rivera-Lirio, J.M.; Ferrero-Ferrero, I.; Escrig-Olmedo, E.; Gisbert-Navarro, J.V.; Marullo, M.C. An Assessment Tool to Integrate Sustainability Principles into the Global Supply Chain. *Sustainability* **2018**, *10*, 535. [CrossRef]
39. Scarpellini, S.; Valero-Gil, J.; Moneva, J.M.; Andreaus, M. Environmental Management Capabilities for a "Circular Eco-Innovation". *Bus. Strategy Environ.* **2020**, *29*, 1850–1864. [CrossRef]
40. Howorth, C.; Westhead, P. The Focus of Working Capital Management in the UK Small Firms. *Manag. Account. Res.* **2003**, *14*, 94–111. [CrossRef]
41. Henri, J.-F. Management Control Systems and Strategy: A Resource-Based Perspective. *Account. Organ. Soc.* **2006**, *31*, 529–558. [CrossRef]

42. Widener, S.K. Associations between Strategic Resource Importance and Performance Measure Use: The Impact on Firm Performance. *Manag. Account. Res.* **2006**, *17*, 433–457. [CrossRef]
43. Toms, S. View of the Firm Value, Profit and Risk: Accounting and the Resource-Based View of the Firm. *Account. Audit. Account. J.* **2010**, *23*, 647–670. [CrossRef]
44. Bocken, N.M.P.; Allwood, J.M.; Willey, A.R.; King, J.M.H. Development of a Tool for Rapidly Assessing the Implementation Difficulty and Emissions Benefits of Innovations. *Technovation* **2012**, *32*, 19–31. [CrossRef]
45. Calik, E.; Bardudeen, F. A Measurement Scale to Evaluate Sustainable Innovation Performance in Manufacturing Organizations. *Procedia CIRP* **2016**, *40*, 449–454. [CrossRef]
46. Torelli, R.; Balluchi, F.; Lazzini, A. Greenwashing and Environmental Communication: Effects on Stakeholders' Perceptions. *Bus. Strategy Environ.* **2020**, *29*, 407–421. [CrossRef]
47. Torelli, R. "What I Say Is Not Necessarily What I Do": A Critical Conceptual Analysis of the (Missing) Link between Corporate Sustainability Reporting and Social Impact. In *Ethical Economy*; Kacanski, S., Kabderian Dreyer, J., Sund, K.J., Eds.; Springer Science and Business Media B.V.: Cham, Switzerland, 2023; Volume 64, pp. 27–36. [CrossRef]
48. Rivera, J.M.; Muñoz, M.J.; Moneva, J.M. Revisiting the Relationship Between Corporate Stakeholder Commitment and Social and Financial Performance. *Sustain. Dev.* **2017**, *25*, 482–494. [CrossRef]
49. Galarza-María, J.; Díaz de Junguitu, A.; Labaien, I. Social Dimension of the Circular Economy: Impact Categories through Fuzzy Delphi Method. *Sustain. Dev.* **2024**, *32*, 4726–4737. [CrossRef]