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An Expert-Based Analysis of ESG Reporting in the context of the Circular Economy

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ABSTRACT:
Existing literature has highlighted how Environmental Social Governance (ESG) reporting enables companies to drive their Circular Economy (CE) practices. However, current approaches to ESG reporting do not specifically consider how company activities and decisions about CE contribute to sustainable development. Indeed, CE has a great potential to ensure that companies actively participate in the achievement of the United Nations 2030 Agenda Goals although a more effective way to link CE and sustainability reporting processes is necessary. The present paper recognizes the importance of developing a standardized approach that aligns ESG metrics with CE practices to enhance both transparency and accountability. To this end, taking into consideration the relevance of the GRI guidelines to make the ESG performance of companies more transparent, an expert-based analysis of the importance of GRI topics to capture the ability of CE practices to create circular value is proposed. Creating circular value through CE improves the company's profitability and resilience while reducing costs for customers, and benefits society and the environment. The use of the fuzzy AHP (F-AHP) method ensures that the relevance of the economic, environmental, and social performance is estimated to make ESG reporting more informative about the company's commitment to a restorative and regenerative business. The findings offer guidelines for using CE reporting information to compare the companies' contributions to SDGs.

Keywords: ESG reporting, GRI standards, Circular Economy (CE), Fuzzy Analytic Hierarchy Process (F-AHP), Sustainable Development Goals (SDGs), circular value.

1. Introduction

The United Nations' 2030 Agenda and the set of Sustainable Development Goals (SDGs) raise new challenges for companies that are asked to contribute to a transformative vision for economic, social, and environmental development (ElAlfy et al., 2020). Circular Economy (CE) has become an effective approach to reaching the requirements of SDGs (Ortiz-de-Montellano et al., 2023), allowing businesses to increase economic benefits while simultaneously considering the issues of resource scarcity and environmental impact (Genovese et al., 2017; Brogi & Menichini, 2024). CE is defined as a rethinking of traditional linear model "take-make-consume-dispose" (Geng & Doberstein, 2008; De Jesus et al., 2019) on the entire value chain (Centobelli et al., 2020) with the aim to reduce

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waste generation and energy consumption by continually reintroducing used resources into the economy (Andersen, 2007; Ghisellini et al., 2016; Reike et al., 2018).

The Ellen MacArthur Foundation, the main global advocate towards CE among leaders in business, government, and academia, clearly explains the potentialities linked to the adoption of CE initiatives (MacArthur et al., 2015). Companies, in particular, have the opportunity to create new business opportunities that are synergistic with sustainable development (Ly, 2021). Reconsidering business models towards a circular business model is the main way companies manage CE strategies to redefine how they create value through their products, services, and processes, while also enhancing resource efficiency across the entire supply chain (Lahti et al., 2018; Lüdeke-Freund et al., 2019; Hansen & Revellio, 2020; Opferkuch, 2023). Moreover, by adopting a circular business model, companies are capable of catching a circular value from a three-dimensional perspective, transcending the economic-environmental dimension of sustainability (Romero-Hernández & Romero, 2018) and enabling sustainable long-term benefits for people and society (Nußholz, 2017; Haines-Gadd & Charnley, 2019; De Angelis, 2022). The multidimensionality of value creation is aligned with what the Triple Bottom Line (TBL) model requires, which emphasizes the need to balance economic prosperity and environmental protection with social equity to face the most urgent sustainable challenges (Aranda-Usón et al., 2022; Tapaninaho & Heikkinen, 2022). From this perspective, companies are urged to identify and measure their Environmental, Social, and Governance (ESG) performance to determine which business practices are most effective at driving circularity in value creation (van Langen et al., 2023). At the same time, it is also important for companies to transparently communicate and disclose their CE strategies and outcomes to give evidence of the company's progress towards sustainable development (Opferkuch et al., 2021). In this context, ESG reporting serves as a tool through which companies can gain legitimacy to operate by providing their stakeholders with information about the effectiveness of CE initiatives (Patil et al., 2021).

As widely recognized, the transparency and comparability of CE disclosure are crucial factors that allow stakeholders to make more informed decisions and, in the case of investors, to offer financial support to those companies deemed more sustainable (Kandpal et al., 2024; Ramakrishna & Ramasubramanian, 2024). Accordingly, it is essential for companies to monitor and prevent greenwashing, the corporate phenomenon of overstating sustainability achievements and enhancing the company's reputational external image to hide inadequate performance (Braga et al., 2019).

To aid companies in developing reliable ESG reports that ensure transparency and comparability of economic, environmental, and social information, different studies underline the usefulness of standardized frameworks such as those provided by the Global Reporting Initiatives (GRI) (Kücükgül, 2020; Diwan & Amarayil Sreeraman, 2024). Indeed, despite the voluntary nature of the GRI standards, they are widely adopted for mandatory requirements (Folkens & Schneider, 2019). However, a clear set of indicators able not only to take into account the economic and environmental benefits of CE practices but also to catch the circular value related to the social dimension, has not yet been outlined (Padilla-Rivera et al., 2020; Opferkuch et al., 2021; van Langen et al., 2023). Indeed, despite the GRI guidelines being considered appropriate to help disclose the CE's company's initiatives, how the GRI Standard framework can be effectively employed to assess CE practices and performance as well as to communicate the circular value through reporting, has not yet been thoroughly explored (Janik et al., 2020; Gunarathne et al., 2021; Sanches et al., 2022).

In response to this research need, an Expert Based Analysis (EBA) is proposed in this paper with the aim to identify how the GRI Standard Topics can be used to catch the three dimensions of circular value generated by companies' CE practices. Therefore, various well-versed academic experts in the fields of Sustainability Assessment, Circular Economy, and Sustainability Reporting have been invited to share their expertise to reach the aim of the analysis. The Analytic Hierarchy Process (AHP) method has been adopted to handle the expert's judgments and rank the GRI Standard Topics according to their relevance in effectively accounting for the economic, environmental, and social circular value of CE practices. The fuzzy logic has been integrated into AHP to solve the ambiguity inherent in the subjective assessments made by experts during the evaluation process (Chowdhury & Paul, 2020). The choice to use fuzzy AHP is also related to the ability to verify the consistency of judgments, which makes this approach robust (Calabrese et al., 2019; Liu et al., 2020). The paper is structured as follows: after a literature review on the ESG reporting of CE practices, the fuzzy AHP Expert Based Analysis is detailed. Results and discussion with conclusions complete the paper.

2. ESG reporting of CE practices

In the last years, research on circular value creation has evolved to emphasize that value creation should enable environmental, social, and economic benefits and address the Triple Bottom Line goal of sustainability (Aranda-Usón et al., 2022; Tapaninaho & Heikkinen, 2022). Indeed, the transition to a CE allows companies to create new value that goes beyond just the economic-environmental dimension of sustainability, for instance, by maximizing the value of waste (Romero-Hernández & Romero, 2018). Recent literature highlighted the capability of CE to improve social well-being by creating value through circular strategies that extend the lifespan of resources within the system, thereby enabling sustainable long-term benefits for people (Nußholz, 2017; Haines-Gadd, & Charnley, 2019; De Angelis, 2022). Through CE initiatives, companies can play a pivotal role towards the economic, environmental, and social development challenges posed by CE-related SDGs (Schröder & Raes, 2021; Cudečka-Puriņa et al., 2022). To address the three dimensions of sustainability, Patil et al., 2021 focus on ESG reporting as a tool that serves to identify and understand how different business aspects have the potential to reach circular principles and overcome the limitations of the linear economy in practice. The authors assert that ESG reporting helps improve not only the environmental performance but also the company's social credibility with its stakeholders, ultimately leading to better governance by attracting institutional investors interested in sustainable businesses. A more transparent ESG reporting facilitates investors to make informed decisions in support of companies that adopt circular practices (Kandpal et al., 2024; Ramakrishna & Ramasubramanian, 2024), and also plays a crucial role in enabling companies to gain access to credit and public incentives, which are increasingly tied to sustainability and responsible business operations (Ferri et al., 2023). Sustainability reporting as "an organization's practice of reporting publicly on its economic, environmental, and/or social impacts, and hence its contributions – positive or negative – towards the goal of sustainable development" (GRI, 2016, p.3) appears to be essential to reduce information asymmetry between company and stakeholders (Calabrese et al., 2020). Accordingly, SDG requirements encourage companies to integrate information on sustainability practices into their reporting cycle (UN, 2015). Enhancing the transparency of how companies tackle sustainability is seen as a crucial step toward better CE practices (Bengtsson et al., 2018). As emerged in the study by Opferkuch et al., (2022), given the well-known recognized contribution of CE on numerous SDGs, a standardized approach to "little evidence exists on how companies may be operationalising CE within corporate reporting" (Opferkuch et al., 2022, p. 439), thus ensuring and effective monitoring of CE progress towards global goals of sustainability. Indeed, despite the rapidly expanding research on quantitative and qualitative methods for evaluating CE at both the corporate and product levels (Corona et al., 2019; Kristensen & Mosgaard, 2020), there is still no standardized approach for assessing the circular value of practices in the ESG context (Opferkuch et al., 2021; 2022). Prior studies highlight how companies of various sizes and from different sectors remain still unclear on how they integrate and communicate CE-related issues in their reporting practices, due to the lack of a standardized approach (Stewart & Niero, 2018; Donato et al., 2019; Fortunati et al., 2020; Marco-Fondevila et al., 2021). According to the review conducted by Opferkuch et al. (2021), "only a few of the revised reporting approaches explicitly mention CE, and the guidance given to companies is very general, inconsistent and places the responsibility of selecting performance assessment approaches on the companies" (Opferkuch et al., 2021, p. 4015).

Standardizing ESG reporting, including a clear definition of circular practices and how these create value, is crucial to ensure transparency, consistency, and compliance in disclosure: this entails the adoption of tools for measuring the circularity of businesses that includes a comprehensive list of indicators (van Langen et al., 2023). Furthermore, as various studies highlight, CE practices often emphasize economic systems and environmental benefits while only implicitly addressing social aspects (Geissdoerfer et al., 2017; Murray et al., 2017). Therefore, it is necessary to provide a clear set of indicators to assess how CE practices impact the social dimension of corporate sustainability (Padilla-Rivera et al., 2020; Opferkuch et al., 2021; Massari & Giannoccaro, 2023). To assess and report ESG performance, companies are currently adhering to established international standards and frameworks developed by various organizations (Patil et al., 2021; Diwan & Amarayil Sreeraman, 2024). Among them, the GRI guidelines are identified as the most popular and widely adopted reporting Standards (Costa et al., 2022; Opferkuch et al. 2021; 2022) since they take into consideration the TBL of sustainability (GRI, 2016; Kücükgül, 2020) by requiring companies to give evidence on their impacts and performance (economic, environmental, and social) as well as disclose their management approach and governance (Simmons et al., 2018). Moreover, different authors have recognized the potentialities of the GRI guidelines adoption to disclose the company's CE practices and strategies, even though no specific guidelines about their use in practice have been proposed (Janik et al., 2020; Gunarathne et al., 2021; Sanches et al., 2022). Considering the potentiality of CE in addressing the TBL of corporate sustainability performance (Elia et al., 2017; Opferkuch et al., 2021; Aranda-Usón et al., 2022) and in light of the acknowledged usefulness of GRI guidelines for sustainability reporting, an Expert Based

Analysis (EBA) is employed in this study to understand how the sustainability performance indicators proposed by the GRI Standards can be used for catching the circular value generated by the companies' CE practices. The EBA has already been adopted by previous studies to leverage the unique knowledge of experts belonging to specific fields of study, aiming to make informed decisions in identifying the most suitable solutions among a set of available alternatives (Narula et al., 2021; Pimsakul et al., 2021; Dano, 2022; Dano et al., 2023). Particularly, the proposed analysis is enhanced by integrating the Analytic Hierarchy Process (AHP) methodology, which facilitated a more structured approach to how involved experts provided their judgments (Ishizaka & Siraj, 2018), thereby mitigating the risk of inconsistency (Calabrese et al., 2019). In addition, the AHP is integrated into this analysis with fuzzy logic, which is recognized as a useful approach to address the inherent imprecision or vagueness in subjective evaluations (Raut et al., 2017; Chowdhury & Paul, 2020). More recently, the study by Sahoo & Goswami (2023) highlights the effectiveness of fuzzy logic in solving complex decision-making problems enhancing the accuracy and reliability of evaluations. Accordingly, leveraging the usefulness of the fuzzy AHP, it is possible to estimate the relevance of the economic, environmental, and social GRI indicators to make ESG reporting more informative about the company's commitment to adopting sustainable practices that favour circularity.

3. The Expert-Based Fuzzy-AHP Analysis

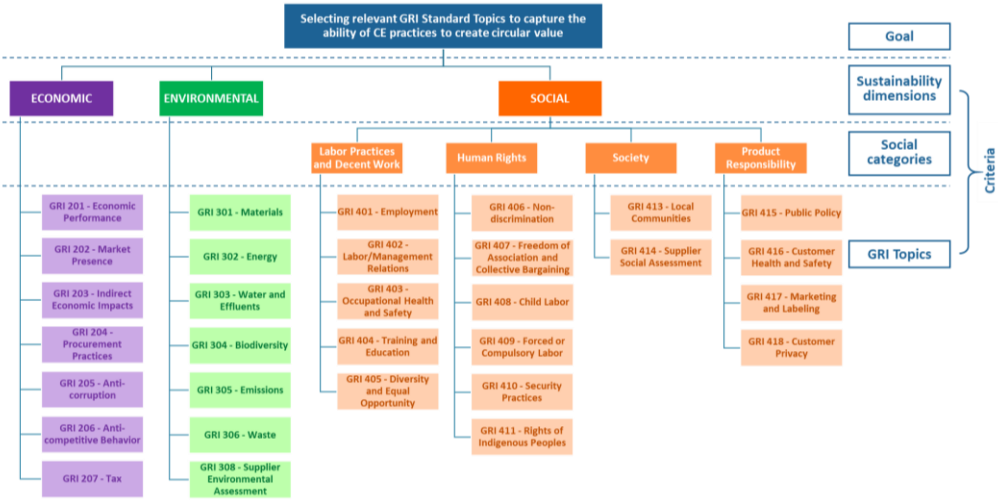
The present study employs the fuzzy AHP method as a structured approach to guide an EBA survey to evaluate the priority relevance of the GRI Standard Topics in capturing the ability of CE practices to create circular value. The use of AHP is well-suited to handle the judgments' allocation of different experts (Lawal et al., 2014) to arrive at solutions to complex decision-making problems (Saaty, 1980). The AHP problem is organized in a hierarchical form, with the overall goal at the top, above the lower levels of criteria and sub-criteria. The process allows for the inclusion of subjective opinions from surveys collected through questionnaires and reorganizing the information to effectively determine the weighting of the elements within the hierarchy, describing their importance in relation to the overall goal. The involved expert can progressively evaluate the relative importance of each criterion in pairwise comparisons for each level of the hierarchy. The pairwise evaluations are then organized into pairwise comparison matrices where each matrix collects the relative preferences of all elements compared to each other within the same level of the hierarchy (Saaty, 2001). The integration of fuzzy logic in the AHP method helps the evaluation process manage subjective preferences expressed in linguistic terms (Mosadeghi et al., 2015; Raut et al., 2017; Chowdhury & Paul, 2020). For these reasons, the fuzzy AHP method is among the most widely used multi-criteria decision-making (MCDM) methods in exploratory studies that propose an EBA in business, management, and accounting studies (Narula et al., 2021; Pimsakul et al., 2021; Mehta & Sharma, 2024).

3.1 The hierarchical structure for the GRI Standard Framework

The GRI guidelines offer a structured framework of sustainability aspects and indicators that can be effectively represented by AHP hierarchies (Ziout et al., 2013; Calabrese et al., 2016). Accordingly, the problem is structured in a multi-level hierarchy

(Figure 1) which allows taking into account the three dimensions of sustainability derived by the GRI Standards as decisional criteria: "Economic, Environmental, and Social". Particularly, the social dimension in the hierarchical structure presents a further level of sub-criteria corresponding to the GRI "Social sub-categories" prescribed by the "G4" version of the GRI guidelines (GRI, 2013). The categorization of GRI Social Topics has been introduced in the proposed study to reduce the likelihood of inconsistency in the comparative judgments, given the large number of Topics belonging to the aforementioned social dimension. The GRI Topics are thus integrated into the fuzzy AHP method in terms of lowest-level decisional criteria for each sustainability dimension (see Figure 1), enabling the identification of those most relevant for capturing the ability of CE initiatives to create circular value, which constitutes the overall Goal of the proposed AHP problem.

Figure 1: The hierarchical structure of GRI Topics for each economic, environmental, and social dimension.



3.2 Data collection and analysis

The proposed method requires the involvement of academic experts. They were selected considering their educational background (PhD and master's degree in economics or engineering), professional experience/scientific publications in the fields of corporate sustainability, sustainability assessment and CE innovative technologies, as to ensure experts' knowledge and understanding of how the multifaceted nature of CE practices and performance can be captured by GRI Topics. This is an essential requirement for the present study to ensure that the validity and reliability of the responses do not depend on the number of participants (Saaty & Özdemir, 2014). Accordingly, ten (n=10) academic experts have been involved. Therefore, an AHP-based survey has been developed and a questionnaire has been employed for the collection of the primary data from all the involved experts. An introductory section was attached to provide the instructions and information to minimize the occurrence of inconsistent or biased responses. Then, the questionnaire was structured into different sections according to the hierarchical structure in Figure 1 allowing the respondents to compare the relative importance of each element against the others of the same level, to determine which of them accounts better for the circular value resulting from the adoption of CE practices. Particularly, the questions are close-ended, requiring responses using linguistic terms: “equally”, “weakly more”, “moderately more”, “strongly more”, or “extremely more important”. The linguistic responses are thus converted into Triangular Fuzzy Numbers (TFNs) using the conversion on a nine-point scale illustrated in Table 1 (Chang, 1996; Lee, 2010), and organized in pair-wise fuzzy comparison matrices where the generic element $\tilde{a}_{ij}(l_{ij}, m_{ij}, u_{ij})$ representing the relative importance for the items *i* with respect to *j*.

Table 1: The adopted conversion scale for linguistic judgments (Chang, 1996; Lee, 2010).

Linguistic variables	**Triangular fuzzy conversation scale**	**Triangular fuzzy reciprocal scale**
Equally important	(1, 1, 1)	(1, 1, 1)
Weakly more important	(1, 3/2, 2)	(1/2, 2/3, 1)
Moderately more important	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Strongly more important	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Extremely more important	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

Since the pairwise fuzzy comparison matrices are square and symmetrical, the operational laws of fuzzy numbers (Wang & Elhag, 2007) allow re-organizing them considering the corresponding reciprocal values where $\tilde{a}_{ij} = \frac{1}{\tilde{a}_{ji}}$ (Sevkli et al., 2012). Moreover, $\tilde{a}_{ij} = 1$ is adopted for the diagonal member of the matrices.

The fuzzy AHP method proposed by Calabrese et al. (2019) is then applied to each comparison matrix. According to this, the matrices are thus tested for consistency and the results show that it is verified for all the matrices, obtaining an acceptable value of consistency according to the threshold specified in the literature (Forman, 1990; Liu et al., 2020). A set of eight fuzzy comparison matrices is obtained for each involved expert. The judgments provided by all the experts about the pairwise comparisons of elements within each level of the hierarchical structure are then synthesized using the geometric mean method, recognized as the most effective for handling AHP characteristic evaluations (Abba et al., 2013).

Table 2 shows the synthesized pairwise fuzzy comparison matrix of the GRI Topics belonging to the Social sub-category “Product Responsibility”.

Table 2: Synthesized pair-wise fuzzy judgments for “Product Responsibility”.

	GRI 415 Public Policy			GRI 416 Customer Health and Safety			GRI 417 Marketing and Labeling			GRI 418 Customer Privacy		
	l	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*
GRI 415 - Public Policy	1.0	1.0	1.0	0.7	0.8	1.0	0.7	0.9	1.1	0.9	1.1	1.2
GRI 416 - Customer Health and Safety	1.0	1.2	1.5	1.0	1.0	1.0	1.1	1.3	1.6	1.4	1.6	1.8
GRI 417 - Marketing and Labeling	0.9	1.1	1.4	0.6	0.8	0.9	1.0	1.0	1.0	0.9	1.2	1.6
GRI 418 - Customer Privacy	0.8	0.9	1.1	0.5	0.6	0.7	0.6	0.8	1.1	1.0	1.0	1.0

The method proceeds to determine the local priority weight of each criterion, sub-criterion and sub-sub-criterion that composes the hierarchical structure (Figure 1), using the row sum RSi and the normalized row sum Si for each of the obtained synthesized fuzzy matrices.

As an example, Table 3 summarizes the row sums (*RSi*) and normalized row sums (*Si*) for the matrix shown in Table 2. Finally, the crisp weights are obtained by applying the centroid defuzzification method (Yager, 1981) through the conversion formula for TFNs (Wang & Elhag, 2007). Thus, via normalization, the local crisp weight obtained is: $w_{ssc} = (0.23, 0.32, 0.25, 0.20)$.

Table 3: Row sums (*RSi*) and normalized row sums (*Si*) for GRI Standard Topics of "Product Responsibility".

		l	*m*	*u*		*l*	*m*	*u*
GRI 415 - Public Policy	$\widetilde{RS}_1$	3.32	3.77	4.32	$\widetilde{S}_1$	0.185	0.230	0.283
GRI 416 - Customer Health and Safety	$\widetilde{RS}_2$	4.44	5.19	5.96	$\widetilde{S}_2$	0.254	0.316	0.377
GRI 417 - Marketing and Labeling	$\widetilde{RS}_3$	3.48	4.08	4.83	$\widetilde{S}_3$	0.197	0.248	0.309
GRI 418 - Customer Privacy	$\widetilde{RS}_4$	3.03	3.38	3.86	$\widetilde{S}_4$	0.167	0.206	0.256

To rank GRI Topics-criteria, the method prescribes calculating their global weights by multiplying each lower criterion's local weights with the upper criteria's corresponding local weights in the hierarchical structure. In particular, in the proposed analysis, the global weights of the sub-criteria belonging to the "Economic" and "Environmental" criteria are determined by multiplying their local weights with those of the corresponding upper criteria.

Instead, considering the sub-categorization of the social dimension, the related local weights of these sub-sub-criteria are firstly multiplied for the corresponding local weights of sub-criteria and then for the local weight of the "Social" criterion. For instance, the global priority weight of the sub-sub-criterion "GRI 416 - Customer Health and Safety" (2.4%) is calculated by multiplying its local weight (31.3%) by the local weight of sub-criterion "Product responsibility" (23.4%) and by the local weight of criterion "Social" (32.8%).

As a result, the obtained global priority weights allow the ranking of the GRI Topics in terms of their priority relevance to capture the circular value of CE practices.

4. Results and Discussion

The following section presents the overall results of the EBA conducted in this study. Table 4 shows the local weights for each criterion, sub-criterion and sub-sub-criterion, together with the global priority weights of the GRI Topics-criteria and the related final ranking.

The analysis shows that the "Environmental" dimension of sustainability is the most relevant in catching the circular value created by CE practices (39.7%) followed by the "Social" dimension (32.8%) and the "Economic" one (27.5%) (Figure 2).

Table 4. Overall results of the study.

CRITERIA	w_c			SUB-CRITERIA	w_{sc}	Global priority Weights ($W_{sc}= w_c*w_{sc}$)	RANKING %	
Economic	*0.275*			GRI 201 - Economic Performance	*0.173*	*0.0477*	4.77	**6**
				GRI 202 - Market Presence	*0.139*	*0.0381*	3.81	**13**
				GRI 203 - Indirect Economic Impacts	*0.149*	*0.0411*	4.11	**10**
				GRI 204 - Procurement Practices	*0.128*	*0.0353*	3.53	**16**
				GRI 205 - Anti-corruption	*0.135*	*0.0371*	3.71	**14**
				GRI 206 - Anti-competitive Behaviour	*0.141*	*0.0388*	3.88	**12**
				GRI 207 - Tax	*0.134*	*0.0370*	3.70	**15**
Environmental	*0.397*			GRI 301 - Materials	*0.168*	*0.0668*	6.68	**2**
				GRI 302 - Energy	*0.143*	*0.0565*	5.65	**4**
				GRI 303 - Water and Effluents	*0.116*	*0.0460*	4.60	**7**
				GRI 304 - Biodiversity	*0.109*	*0.0430*	4.30	**8**
				GRI 305 - Emissions	*0.170*	*0.0675*	6.75	**1**
				GRI 306 - Waste	*0.168*	*0.0666*	6.66	**3**
				GRI 308 - Supplier Environm. Assessment	*0.126*	*0.0499*	4.99	**5**
		SUB-CRITERIA	w_{sc}	**SUB-SUB-CRITERIA**		($W_{ssc}=w_c*w_{sc}*w_{ssc}$)		
Social	*0.328*	Labor Practices	*0.234*	GRI 401 - Employment	*0.223*	*0.0171*	1.71	**22**
				GRI 402 - Labor/Management Relations	*0.158*	*0.0122*	1.22	**30**
				GRI 403 - Occupational Health and Safety	*0.257*	*0.0197*	1.97	**19**
				GRI 404 - Training and Education	*0.196*	*0.0151*	1.51	**26**
				GRI 405 - Diversity and Equal Opportunity	*0.165*	*0.0127*	1.27	**29**
		Human Rights	*0.279*	GRI 406 - Non-discrimination	*0.155*	*0.0142*	1.42	**27**
				GRI 407 - Freedom of Ass. and Coll. Bargaining	*0.130*	*0.0119*	1.19	**31**
				GRI 408 - Child Labor	*0.219*	*0.0201*	2.01	**18**
				GRI 409 - Forced or Compulsory Labor	*0.183*	*0.0168*	1.68	**23**
				GRI 410 - Security Practices	*0.167*	*0.0154*	1.54	**25**
				GRI 411 - Rights of Indigenous Peoples	*0.145*	*0.0133*	1.33	**28**
		Society	*0.252*	GRI 413 - Local Communities	*0.485*	*0.0402*	4.02	**11**
				GRI 414 - Supplier Social Assessment	*0.515*	*0.0427*	4.27	**9**
		Product Responsibility	*0.234*	GRI 415 - Public Policy	*0.230*	*0.0177*	1.77	**21**
				GRI 416 - Customer Health and Safety	*0.313*	*0.0241*	2.41	**17**
				GRI 417 - Marketing and Labeling	*0.249*	*0.0192*	1.92	**20**
				GRI 418 - Customer Privacy	*0.207*	*0.0160*	1.60	**24**

These findings align with the extensive body of studies that have found greater relevance and applicability in environmental indicators to reflect the benefits derived from the adoption of a circular model (Geissdoerfer et al., 2017; Murray et al., 2017; Romero-Hernández & Romero, 2018; van Langen et al., 2023). Nonetheless, since CE has also been recognized as capable of providing long-term benefits for people (Nußholz, 2017; Haines-Gadd & Charnley, 2019; De Angelis, 2022), this study aims to respond to the need to provide indicators to assess the influence of CE practices on society (Opferkuch et al., 2021; Massari & Giannoccaro, 2023), by taking into consideration the Social Topics provided by the GRI guidelines. According to this, considering only the social dimension of sustainability, "Human Rights" is the subcategory with the highest local weight (27.9%), while "Labor Practices" and "Product Responsibility" are the subcategories with the lowest local weight, both with the same relevance (23.4%) (Figure 3).

Figure 2. Relevance of GRI sustainability performance dimensions (Sustainability dimensions level of the fuzzy AHP hierarchical structure).

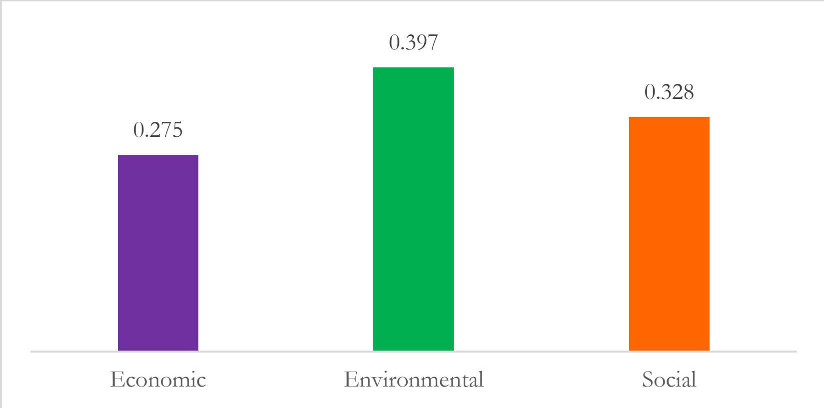
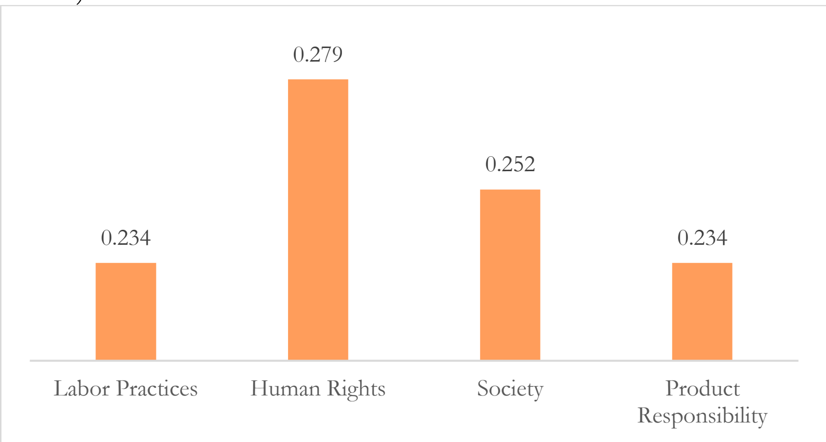


Figure 3. Relevance of GRI Social sub-categories (Social categories level of the fuzzy AHP hierarchical structure).



Particularly, as shown in Table 4, "GRI 413 - Local Communities" and "GRI 414 - Supplier Social Assessment" (of the "Society" sub-category) are the GRI Topics with the highest global weights (respectively 4.02% and 4.27%) within the entire considered "Social" category. Indeed, following prior authors, the active engagement of local communities is recognized as crucial for disseminating awareness of the circular value CE initiatives can generate (Padilla-Rivera et al., 2020; Schröder et al., 2020). Moreover, results are aligned with the recognized importance of maximizing the benefits of circularity throughout the life cycle of products, by ensuring sustainable and responsible supplier practices (Centobelli et al., 2021). Finally, considering the overall ranking of GRI Topics, "GRI-305 - Emissions" (6.75%), is the most important GRI Topic for capturing the ability of CE practices to create circular value. Indeed, CE practices such as reuse, recycling, and material regeneration are widely acknowledged as essential for minimizing environmental impact through optimized resource use (Cantzler et al., 2020; Hailemariam & Erdiaw-Kwasie, 2023; Brogi & Menichini, 2024). This implies the adoption of innovative technologies that bring long-term economic benefits by reducing energy usage costs (Stavropoulos et al., 2021). Furthermore, the reduction of emissions through CE practices contributes to improving quality of life, providing direct benefits to public health and enhancing overall societal well-being (MacArthur et al., 2015; Giannetti et al., 2023). Monitoring "GRI-305 – Emissions" enables companies to measure the circular value they create, disclosing their progress toward environmental, economic, and social sustainability.

5. Conclusions

By rethinking their business model using the integration of the CE principles, companies can leverage the potentiality of CE practices to identify alternative strategies to simultaneously meet new business opportunities with global sustainability challenges (Genovese et al., 2017; Ly, 2021). This entails circular value creation that goes beyond the economic and environmental dimension of sustainability (Romero-Hernández & Romero, 2018) to enable long-term benefits also for social well-being (Nußholz, 2017; Haines-Gadd & Charnley, 2019; De Angelis, 2022). The present paper embraces what emerged from previous studies that highlight the multidimensionality of circular value following the TBL model of sustainability performance (Padilla-Rivera et al., 2020; Aranda-Usón et al., 2022; Tapaninaho & Heikkinen 2022). Particularly, this study aims to address the emerging need for practical and standardized approaches to evaluate how CE practices generate circular value considering the obtained overall economic, environmental and social benefits (Opferkuch et al., 2021; 2022; van Langen et al., 2023). Given the well-established suitability of GRI guidelines in promoting transparency and accountability of ESG reporting (Kücükgül, 2020; Opferkuch et al. 2021; 2022; Diwan & Amarayil Sreeraman, 2024), EBA has been conducted in the proposed paper to discern and identify the most relevant GRI Topics, for capturing how CE initiatives generate circular value. By leveraging the expertise of different academic well-versed experts, a Fuzzy AHP has been adopted to guide the analysis and rank the economic, environmental and social GRI Topics. The employing of the AHP method has allowed to organize the problem in a multi-level hierarchy, to take into account the multidimensional nature of sustainability and the overall circular value of CE practice. The integration of Fuzzy logic into the AHP method has enabled more efficiency in the handling of the evaluation process supporting the vagueness related to the linguistic terms of the judgments (Raut et al., 2017; Chowdhury & Paul, 2020). The obtained results highlight consistency with various previous studies concerning the evaluation of the economic, environmental, and social impacts of CE companies' practices through sustainability reporting (e.g., Nußholz, 2017; Haines-Gadd & Charnley, 2019; De Angelis, 2022), thus validating the effectiveness of the analysis. The proposed analysis meets the demand for greater clarity and comparability of reporting information about the company's adoption of CE practices to promote sustainable development (Patil et al., 2021; Kandpal et al., 2024; Ramakrishna & Ramasubramanian, 2024).

We think that our method and findings could be helpful in guiding corporate reporting of CE, in line with the challenges that emerged by "the guidance for companies is vague, inconsistent and places the responsibility for the selection of CE-specific assessment approaches on the companies" (Opferkuch et al., 2021, p. 4027)". First, our approach provides companies with a standard reference to understand the multidimensional nature of circular value (economic, environmental, and social) they generate through CE practices and consequently guides them towards adequate CE reporting based on the most relevant GRI topics to capture the value of their CE practices. Therefore, the proposed GRI Standards-based approach can be useful for benchmarking company CE reported performance. By using the standardized framework of GRI, companies can measure their CE performance on economic, environmental, and social issues, accurately (Gunarathne et al., 2021; Opferkuch et al., 2021). GRI Standards are widely recognized as the most used reference framework for sustainability reporting which can be applied regardless of company's sector and size (Halkos & Nomikos, 2021). Furthermore, the GRI standard has proved helpful for companies to exploit sustainability reporting for substantive aims rather than merely as a tool for enhancing their public image (Ruiz-Blanco et al., 2022). Particularly, by focusing on the most relevant GRI Topics to capture circular value, the reporting of CE practices can enhance its communication effectiveness to stakeholders. Indeed, the proposed method and findings help identify those standardized GRI topics that better explain the circular value generated by CE practices, thus ensuring a standardized performance monitoring approach as well as allowing comparability among companies operating in different contexts. Enhanced monitoring and comparability of reported data are valuable for improving accountability to stakeholders and reducing the risk of greenwashing (Yu et al., 2020).

With the introduction of the United Nations' Agenda 2030, the demand for improved reporting transparency by companies has become increasingly crucial for their transition towards sustainable development (Schröder & Raes, 2021). The obtained results offer practical guidance also to plan initiatives useful to achieve CE-related SDGs. Indeed, the specific document "Linking the SDGs and the GRI Standards" provided by GRI enables mapping the disclosures in the GRI Standards against each of the 17 SDGs, making it easier for organizations to measure, track, and communicate progress on the Global Goals (GRI, 2022). For example, the SDGs linked to the "GRI-305 – Emissions" are SDG 3, 12, 13, 14, and 15. By monitoring how CE initiatives benefit people and the planet, managers can gain a clearer understanding of the extent to which the company is contributing to the SDGs. This allows for more efficient planning of resources and investment optimization towards the company's priority SDGs (Verboven & Vanherck, 2016; Smith et al., 2022), as well as engaging the audience, building trust and credibility with stakeholders by improving SDG reporting effectiveness (Olofsson & Mark-Herbert, 2020). In future studies, the proposed approach can be extended to validate this proposal in a case study and to obtain empirical evidence on how it can be used for SDG monitoring and strategic resource planning. According to Fisher et al. 's definition of an "expert stakeholder" as who has gained "domain specific expertise through their profession" (Fisher et al., 2014, p. 333), future studies could involve industrial experts with extensive experience or expertise of CE practice to ensure that a common language for reporting circular value being tested and validated across different contexts. By means of longitudinal and multiple case study analysis, the reporting framework could be used as a reference framework to compare companies' performance belonging to different contexts. Multiple, longitudinal and cross-sectional case study analysis would be useful to understand how the integration of CE practices into ESG reporting, as well as stakeholder engagement initiatives, impact the effectiveness of sustainability business practices. With this regard, the selected relevant GRI topics could be used as an ESG reference framework to compare CE companies' performance over time and belonging to different operative contexts. Deductive content analysis applied to ESG reports as well as qualitative analysis such as semi-structured interviews involving qualified industrial experts could help design the research.

References

Abba, A. H., Noor, Z. Z., Yusuf, R. O., Din, M. F. M., & Hassan, M. A. A. (2013). Assessing environmental impacts of municipal solid waste of Johor by analytical hierarchy process. *Resources, Conservation and Recycling*, *73*, 188-196.

Andersen, M. S. (2007). An introductory note on the environmental economics of the circular economy. *Sustainability science*, *2*(1), 133-140.

Aranda-Usón, A., Moneva, J. M., & Scarpellini, S. (2022). 'Circular sustainability accounting'in businesses for a circular economy: a framework of analysis. *European Journal of Social Impact and Circular Economy*, *3*(3), 1-10.

Bengtsson, M., Alfredsson, E., Cohen, M., Lorek, S., & Schroeder, P. (2018). Transforming systems of consumption and production for achieving the sustainable development goals: Moving beyond efficiency. *Sustainability science*, *13*, 1533-1547.

Braga, S., Martínez, M. P., Correa, C. M., Moura-Leite, R. C., & Da Silva, D. (2019). Greenwashing effect, attitudes, and beliefs in green consumption. *RAUSP Management Journal, 54*(2), 226-241.

Brogi, S., & Menichini, T. (2024). The pathway towards circular economy: Measuring circular advantage of eco-innovations. *Business Strategy and the Environment*, *33*(4), 3005-3038.

Calabrese, A., Costa, R., Levialdi Ghiron, N., & Menichini, T. (2019). Integrating sustainability into strategic decision-making: A fuzzy AHP method for the selection of relevant sustainability issues. *Technological Forecasting and Social Change*, *139*, 155-168.

Calabrese, A., Costa, R., Levialdi, N., & Menichini, T. (2016). A fuzzy analytic hierarchy process method to support materiality assessment in sustainability reporting. *Journal of Cleaner Production*, *121*, 248-264.

Calabrese, A., Costa, R., Levialdi, N., Menichini, T., & Villazon Montalvan, R. A. (2020). Does more mean better? Exploring the relationship between report completeness and environmental sustainability. *Sustainability*, *12*(24), 10635.

Cantzler, J., Creutzig, F., Ayargarnchanakul, E., Javaid, A., Wong, L., & Haas, W. (2020). Saving resources and the climate? A systematic review of the circular economy and its mitigation potential. *Environmental Research Letters*, *15*(12), 123001.

Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., & Urbinati, A. (2020). Designing business models in circular economy: A systematic literature review and research agenda. *Business Strategy and the Environment*, *29*(4), 1734-1749.

Centobelli, P., Cerchione, R., Esposito, E., & Passaro, R. (2021). Determinants of the transition towards circular economy in SMEs: A sustainable supply chain management perspective. *International Journal of Production Economics*, *242*, 108297.

Chang, D. Y. (1996). Applications of the extent analysis method on fuzzy AHP. *European journal of operational research*, *95*(3), 649-655.

Chowdhury, P., & Paul, S. K. (2020). Applications of MCDM methods in research on corporate sustainability: A systematic literature review. Management of Environmental Quality: An International Journal, 31(2), 385-405.

Corona, B., Shen, L., Reike, D., Carreón, J. R., & Worrell, E. (2019). Towards sustainable development through the circular economy—A review and critical assessment on current circularity metrics. *Resources, Conservation and Recycling*, *151*, 104498.

Costa, R., Menichini, T., & Salierno, G. (2022). Do SDGs really matter for business? Using GRI sustainability reporting to answer the question. *European Journal of Sustainable Development*, *11*(1), 113-113.

Cudečka-Puriņa, N., Atstāja, D., Koval, V., Purviņš, M., Nesenenko, P., & Tkach, O. (2022). Achievement of sustainable development goals through the implementation of circular economy and developing regional cooperation. *Energies*, *15*(11), 4072.

Dano, U. L. (2022). An AHP-based assessment of flood triggering factors to enhance resiliency in Dammam, Saudi Arabia. *GeoJournal*, *87*(3), 1945-1960.

Dano, U. L., Abubakar, I. R., AlShihri, F. S., Ahmed, S. M., Alrawaf, T. I., & Alshammari, M. S. (2023). A multi-criteria assessment of climate change impacts on urban sustainability in Dammam Metropolitan Area, Saudi Arabia. *Ain Shams Engineering Journal*, *14*(9), 102062.

De Angelis, R. (2022). Circular economy business models: A repertoire of theoretical relationships and a research agenda. *Circular economy and sustainability*, *2*(2), 433-446.

De Jesus, A., Antunes, P., Santos, R., & Mendonça, S. (2019). Eco-innovation pathways to a circular economy: Envisioning priorities through a Delphi approach. *Journal of Cleaner Production*, *228*, 1494-1513.

Diwan, H., & Amarayil Sreeraman, B. (2024). From financial reporting to ESG reporting: a bibliometric analysis of the evolution in corporate sustainability disclosures. *Environment, development and sustainability*, *26*(6), 13769-13805.

Donato, C., Amatulli, C., & De Angelis, M. (2019). Responsible luxury development: A study on luxury companies' CSR, circular economy, and entrepreneurship. *Sustainable Luxury: Cases on Circular Economy and Entrepreneurship*, 21-38.

ElAlfy, A., Palaschuk, N., El-Bassiouny, D., Wilson, J., & Weber, O. (2020). Scoping the evolution of corporate social responsibility (CSR) research in the sustainable development goals (SDGs) era. *Sustainability*, *12*(14), 5544.

Elia, V., Gnoni, M. G., & Tornese, F. (2017). Measuring circular economy strategies through index methods: A critical analysis. *Journal of cleaner production*, *142*, 2741-2751.

Ferri, S., Tron, A., Colantoni, F., & Savio, R. (2023). Sustainability disclosure and IPO performance: Exploring the impact of ESG reporting. *Sustainability*, *15*(6), 5144.

Fischer, A. R., Wentholt, M. T., Rowe, G., & Frewer, L. J. (2014). Expert involvement in policy development: A systematic review of current practice. *Science and Public Policy*, *41*(3), 332-343.

Folkens, L., & Schneider, P. (2019). Social responsibility and sustainability: How companies and organizations understand their sustainability reporting obligations. *Social responsibility and sustainability: How businesses and organizations can operate in a sustainable and socially responsible way,* 159-188.

Forman, E.H., 1990. Random indices for incomplete pairwise comparison matrices. *Eur. J. Oper. Res. 48 (1)*, 153–155.

Fortunati, S., Martiniello, L., & Morea, D. (2020). The strategic role of the corporate social responsibility and circular economy in the cosmetic industry. *Sustainability*, *12*(12), 5120.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. *Journal of cleaner production*, *143*, 757-768.

Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving'leapfrog development'. *The International Journal of Sustainable Development & World Ecology*, *15*(3), 231-239.

Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. *Omega*, *66*, 344-357.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner production*, *114*, 11-32.

Giannetti, B. F., Lopez, F. J. D., Liu, G., Agostinho, F., Sevegnani, F., & Almeida, C. M. (2023). A resilient and sustainable world: Contributions from cleaner production, circular economy, eco-innovation, responsible consumption, and cleaner waste systems. *Journal of cleaner production*, *384*, 135465.

Global Reporting Initiative (2013). Pedoman Pelaporan Keberlanjutan. Amsterdam, The Netherlands, Europe: Global Reporting Initiative. Retrieved from G4-Sustainability-Reporting-Guidelines-Implementation-Manual-GRI-2013.pdf (respect.international) (accessed June 2024).

Global Reporting Initiative. (2016). 101: Foundation. *Amsterdam: Global Reporting Initiative*. Retrieved from https://globalreporting.org (accessed June 2024).

Global Reporting Initiative (2022). Linking the SDGs and GRI. Retrieved from https://www.globalreporting.org/search/?query=Linking+the+SDGs+and+the+GRI+Standards (accessed June 2024).

Gunarathne, N., Wijayasundara, M., Senaratne, S., Kanchana, P. K., & Cooray, T. (2021). Uncovering corporate disclosure for a circular economy: An analysis of sustainability and integrated reporting by Sri Lankan companies. *Sustainable Production and Consumption*, *27*, 787-801.

Hailemariam, A., & Erdiaw-Kwasie, M. O. (2023). Towards a circular economy: Implications for emission reduction and environmental sustainability. *Business Strategy and the Environment*, *32*(4), 1951-1965.

Haines-Gadd, M., & Charnley, F. (2019). Creating a taxonomy of value for a circular economy. In *Sustainable Design and Manufacturing 2019: Proceedings of the 6th International Conference on Sustainable Design and Manufacturing (KES-SDM 19)* (pp. 241-261). Springer Singapore.

Halkos, G., & Nomikos, S. (2021). Corporate social responsibility: Trends in global reporting initiative standards. *Economic Analysis and Policy, 69*, 106-117.

Hansen, E. G., & Revellio, F. (2020). Circular value creation architectures: Make, ally, buy, or laissez-faire. *Journal of Industrial Ecology*, *24*(6), 1250-1273.

Ishizaka, A., & Siraj, S. (2018). Are multi-criteria decision-making tools useful? An experimental comparative study of three methods. *European Journal of Operational Research*, *264*(2), 462-471.

Janik, A., Ryszko, A., & Szafraniec, M. (2020). Greenhouse gases and circular economy issues in sustainability reports from the energy sector in the European Union. *Energies*, *13*(22), 5993.

Kandpal, V., Jaswal, A., Santibanez Gonzalez, E. D., & Agarwal, N. (2024). Sustainable Energy Transition, Circular Economy, and ESG Practices. In *Sustainable Energy Transition: Circular Economy and Sustainable Financing for Environmental, Social and Governance (ESG) Practices* (pp. 1-51). Cham: Springer Nature Switzerland.

Kristensen, H. S., & Mosgaard, M. A. (2020). A review of micro level indicators for a circular economy–moving away from the three dimensions of sustainability?. *Journal of Cleaner Production*, *243*, 118531.

Kücükgül, E. (2020). Corporate Sustainability and Reporting Frameworks: A Methodology forAligning Various Guides on Sustainable Development Goals.

Lahti, T., Wincent, J., & Parida, V. (2018). A definition and theoretical review of the circular economy, value creation, and sustainable business models: where are we now and where should research move in the future?. *Sustainability*, *10*(8), 2799.

Lawal, D. U., Matori, A. N., Yusof, K. W., Hashim, A. M., Aminu, M., Sabri, S., ... & Mokhtar, M. R. M. (2014). Flood susceptibility modeling: a geo-spatial technology multi-criteria decision analysis approach. *Research Journal of Applied Sciences, Engineering and Technology*, *7*(22), 4638-4644.

Lee, S. H. (2010). Using fuzzy AHP to develop intellectual capital evaluation model for assessing their performance contribution in a university. *Expert systems with applications*, *37*(7), 4941-4947.

Liu, Y., Eckert, C. M., & Earl, C. (2020). A review of fuzzy AHP methods for decision-making with subjective judgements. *Expert systems with applications*, 161, 113738.

Lüdeke-Freund, F., Gold, S., & Bocken, N. M. (2019). A review and typology of circular economy business model patterns. *Journal of industrial ecology*, *23*(1), 36-61.

Ly, B. (2021). Competitive advantage and internationalization of a circular economy model in apparel multinationals. *Cogent Business & Management*, *8*(1), 1944012.

MacArthur, E., Zumwinkel, K., & Stuchtey, M. R. (2015). Growth within: a circular economy vision for a competitive Europe. *Ellen MacArthur Foundation*, *100*.

Marco-Fondevila, M., Llena-Macarulla, F., Callao-Gastón, S., & Jarne-Jarne, J. I. (2021). Are circular economy policies actually reaching organizations? Evidence from the largest Spanish companies. *Journal of Cleaner Production*, *285*, 124858.

Massari, G. F., & Giannoccaro, I. (2023). Adopting GRI Standards for the Circular Economy strategies disclosure: the case of Italy. *Sustainability Accounting, Management and Policy Journal*, (ahead-of-print).

Mehta, K., & Sharma, R. (2024). Unraveling Quantum Complexity: A Fuzzy AHP Approach to Understanding Software Industry Challenges. *Deep Learning Tools for Predicting Stock Market Movements*, 39-60.

Mosadeghi, R., Warnken, J., Tomlinson, R., & Mirfenderesk, H. (2015). Comparison of Fuzzy-AHP and AHP in a spatial multi-criteria decision making model for urban land-use planning. *Computers, Environment and Urban Systems*, *49*, 54-65.

Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: an interdisciplinary exploration of the concept and application in a global context. *Journal of business ethics*, *140*, 369-380.

Narula, S., Puppala, H., Kumar, A., Frederico, G. F., Dwivedy, M., Prakash, S., & Talwar, V. (2021). Applicability of industry 4.0 technologies in the adoption of global reporting initiative standards for achieving sustainability. *Journal of Cleaner Production*, *305*, 127141.

Nußholz, J. L. (2017). Circular business models: Defining a concept and framing an emerging research field. *Sustainability*, *9*(10), 1810.

Olofsson, L., & Mark-Herbert, C. (2020). Creating shared values by integrating un sustainable development goals in corporate communication—the case of apparel retail. *Sustainability*, *12*(21), 8806.

Opferkuch, K., Caeiro, S., Salomone, R., & Ramos, T. B. (2021). Circular economy in corporate sustainability reporting: A review of organisational approaches. *Business Strategy and the Environment*, *30*(8), 4015-4036.

Opferkuch, K., Caeiro, S., Salomone, R., & Ramos, T. B. (2022). Circular economy disclosure in corporate sustainability reports: The case of European companies in sustainability rankings. *Sustainable Production and Consumption*, *32*, 436-456.

Opferkuch, K., Walker, A. M., Roos Lindgreen, E., Caeiro, S., Salomone, R., & Ramos, T. B. (2023). Towards a framework for corporate disclosure of circular economy: Company perspectives and recommendations. *Corporate Social Responsibility and Environmental Management*, *30*(5), 2457-2474.

Ortiz-de-Montellano, C. G. S., Samani, P., & van der Meer, Y. (2023). How can the circular economy support the advancement of the Sustainable Development Goals (SDGs)? A comprehensive analysis. *Sustainable Production and Consumption*, *40*, 352-362.

Padilla-Rivera, A., Russo-Garrido, S., & Merveille, N. (2020). Addressing the social aspects of a circular economy: A systematic literature review. *Sustainability*, *12*(19), 7912.

Patil, R. A., Ghisellini, P., & Ramakrishna, S. (2021). Towards sustainable business strategies for a circular economy: environmental, social and governance (ESG) performance and evaluation. *An introduction to circular economy*, 527-554.

Pimsakul, S., Samaranayake, P., & Laosirihongthong, T. (2021). Prioritizing enabling factors of IoT adoption for sustainability in supply chain management. Sustainability, 13(22), 12890.

Ramakrishna, S., & Ramasubramanian, B. (2024). ESG and Circular Economy. In *Handbook of Materials Circular Economy* (pp. 227-253). Singapore: Springer Nature Singapore.

Raut, R., Cheikhrouhou, N., & Kharat, M. (2017). Sustainability in the banking industry: A strategic multi-criterion analysis. *Business strategy and the environment*, *26*(4), 550-568.

Reike, D., Vermeulen, W. J., & Witjes, S. (2018). The circular economy: new or refurbished as CE 3.0?—exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. *Resources, conservation and recycling*, *135*, 246-264.

Romero-Hernández, O., & Romero, S. (2018). Maximizing the value of waste: From waste management to the circular economy. *Thunderbird International Business Review*, *60*(5), 757-764.

Ruiz-Blanco, S., Romero, S., & Fernandez-Feijoo, B. (2022). Green, blue or black, but washing–What company characteristics determine greenwashing?. *Environment, Development and Sustainability, 24*(3), 4024-4045.

Saaty, T. L. (1980). The analytic hierarchy process (AHP). *The Journal of the Operational Research Society*, *41*(11), 1073-1076.

Saaty, T. L. (2001). *Fundamentals of decision making and priority theory with the analytic hierarchy process* (Vol. 6). RWS publications.

Saaty, T. L., & Özdemir, M. S. (2014). How many judges should there be in a group?. *Annals of Data Science*, *1*, 359-368.

Sahoo, S. K., & Goswami, S. S. (2023). A comprehensive review of multiple criteria decision-making (MCDM) Methods: advancements, applications, and future directions. *Decision Making Advances, 1*(1), 25-48.

Sanches, J. R., Trevisan, A. H., Seles, B. M. R. P., Castro, C. G., Piao, R. S., Rozenfeld, H., & Mascarenhas, J. (2022). Sustainable circular economy strategies: an analysis of Brazilian corporate sustainability reporting. *Sustainability*, *14*(10), 5808.

Sathyan, R., Parthiban, P., Dhanalakshmi, R., & Sachin, M. S. (2023). An integrated Fuzzy MCDM approach for modelling and prioritising the enablers of responsiveness in automotive supply chain using Fuzzy DEMATEL, Fuzzy AHP and Fuzzy TOPSIS. *Soft Computing, 27*(1), 257-277

Schröder, P., & Raes, J. (2021). Financing an inclusive circular economy. *De-Risking Investments for Circular Business Models and the SDGs. Chatham House*, *7*.

Schröder, P., Lemille, A., & Desmond, P. (2020). Making the circular economy work for human development. *Resources, Conservation and Recycling*, *156*, 104686.

Sevkli, M., Oztekin, A., Uysal, O., Torlak, G., Turkyilmaz, A., & Delen, D. (2012). Development of a fuzzy ANP based SWOT analysis for the airline industry in Turkey. *Expert systems with Applications*, *39*(1), 14-24.

Simmons Jr, J. M., Crittenden, V. L., & Schlegelmilch, B. B. (2018). The global reporting initiative: do application levels matter?. *Social Responsibility Journal*, *14*(3), 527-541.

Smith, H., Discetti, R., Bellucci, M., & Acuti, D. (2022). SMEs engagement with the Sustainable Development Goals: A power perspective. *Journal of business research*, *149*, 112-122.

Stavropoulos, P., Papacharalampopoulos, A., Tzimanis, K., Petrides, D., & Chryssolouris, G. (2021). On the relationship between circular and innovation approach to economy. *Sustainability*, *13*(21), 11829.

Stewart, R., & Niero, M. (2018). Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector. *Business Strategy and the Environment*, *27*(7), 1005-1022.

Tapaninaho, R., & Heikkinen, A. (2022). Value creation in circular economy business for sustainability: A stakeholder relationship perspective. *Business Strategy and the Environment*, *31*(6), 2728-2740.

United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development A/RES/70/1. Resolution adopted by the General Assembly on 25 September 2015, (p. 35). Paris.

van Langen, S. K., Patil, R. A., & Ramakrishna, S. (2023). Insights from ESG Evaluation for Circularity Assessment. In *Circularity Assessment: Macro to Nano: Accountability Towards Sustainability* (pp. 15-34). Singapore: Springer Nature Singapore.

Verboven, H., & Vanherck, L. (2016). Sustainability management of SMEs and the UN sustainable development goals. *uwf UmweltWirtschaftsForum*, *24*(2-3), 165-178.

Wang, Y. M., & Elhag, T. M. (2007). A fuzzy group decision making approach for bridge risk assessment. *Computers & Industrial Engineering*, *53*(1), 137-148.

Yager, R. R. (1981). A procedure for ordering fuzzy subsets of the unit interval. *Information sciences*, *24*(2), 143-161.

Yu, E. P. Y., Van Luu, B., & Chen, C. H. (2020). Greenwashing in environmental, social and governance disclosures. *Research in International Business and Finance, 52*, 101192

Ziout, A., Azab, A., Altarazi, S., & ElMaraghy, W. H. (2013). Multi-criteria decision support for sustainability assessment of manufacturing system reuse. *CIRP Journal of Manufacturing Science and Technology*, *6*(1), 59-69.