International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Interdisciplinary Perspectives on the Circular Economy: An Empirical Evidence

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Abstract:
The circular economy is a transformational concept that demands interdisciplinary collaboration for effective sustainable resource management, moving beyond previous siloed systems. The study reveals significant variations in circular economy awareness and adoption across disciplines, with engineering and environmental sciences showing higher engagement compared to management and social sciences. Interdisciplinary collaboration emerges as a critical enabler, yet barriers such as siloed knowledge structures and communication gaps persist, underscoring the need for integrated training programs. These insights contribute to a unified framework for fostering cross-disciplinary synergies in the execution of the circular economy. Through a survey of professionals, professors, and students across sectors, the study examines interdisciplinary viewpoints on the circular economy. Using descriptive statistics and inferential tests, it examines the understanding of circular economy principles, perceived advantages and limitations, and existing activities. The study aims to identify knowledge-practice discrepancies, determine the facilitators and barriers of interdisciplinary collaboration, and furnish policymakers and educators with insights to enhance circular economy activities.

Keywords: Circular economy, interdisciplinary, barriers, policymakers, level of significance.

1. Introduction

A novel concept, the circular economy (CE) seeks to address resource depletion, waste management, and climate change by transforming the production, consumption, and disposal processes. It focuses on eliminating waste and pollution to ensure that products and materials are continually used, and revitalising natural systems to reduce greenhouse gas emissions, conserve resources, and encourage economic growth. Its core principles focus on eliminating waste through thoughtful design, maximising the use of products via sharing or refurbishment, and restoring natural systems. This approach can yield significant economic and environmental advantages. Key implementation strategies include regulatory drives, such as extended producer responsibility, and practical tools, like the Ellen MacArthur Foundation's butterfly diagram. Successful examples from companies like Patagonia, the World Economic Forum, the International Financial Cooperation and IKEA highlight their Circular Economy and sustainability efforts.

Key interdisciplinary theories of the circular economy blend ecological, economic, and social principles to advocate for closed-loop systems. Core theories include industrial ecology, which promotes waste-to-input processes and industrial symbiosis; Cradle to Cradle design, emphasising regenerative materials; and biomimicry, focusing on zero-waste systems inspired by nature. Foundational frameworks like performance economy and closed-loop economy prioritise service-based models and minimal environmental impact through redesigned product lifecycles. Related concepts, such as the blue economy

and waste hierarchy, enhance value generation from waste and establish accountability for product lifecycles, facilitating transdisciplinary applications across various fields.

The circular economy suggests a change from the linear "take-make-dispose" model to sustainable methods, emphasising resource efficiency and waste minimisation. Using actual survey data, the paper "Exploring Interdisciplinary Perspectives on the Circular Economy: A Survey-Based Study" examines diverse perspectives and contributions from many industries. It highlights the importance of interdisciplinary collaboration to address challenging issues, incorporating viewpoints from the social sciences, engineering, and business.

There are still gaps in cross-disciplinary alignment and stakeholder awareness despite the growing post-2015 EU Circular Economy Action Plan. The survey attempts to evaluate awareness, prioritise collaboration, and build frameworks for effective integration through rigorous statistical analysis. Ultimately, data will inform policies and practices that support sustainable methods linked with global sustainability goals.

2. Literature Review

Ghisellini et al. (2016) published an extensive review of Circular Economy (CE), examining its origins, principles, advantages, and implementation at various levels globally. Kirchherr et al. (2017) revealed that the circular economy is often regarded as involving reduce, reuse, and recycle operations, but it also requires a structural shift that is often missed. Murrey et al. (2017) furnished a revised definition of the Circular Economy as “an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximise ecosystem functioning and human well-being”.

Laso et al. (2018) found a two-step eco-efficiency methodology by combining Life Cycle Assessment (LCA) and Life Cycle Costing (LCC). A cradle-to-gate assessment evaluated three origins of anchovy species, revealing that circular economy applications enhanced both environmental and economic benefits. The proposed method aids decision-making in the anchovy canning sector. Liakos et al. (2019) revealed that global governing authorities highlight Circular Economy (CE) principles, and corporations are becoming increasingly aware of them. Their analysis demonstrated that the environmental effect pillar of CE is better developed compared to the economic benefits and resource scarcity pillars, which remain predominantly in a research phase.

Lazaridou et al. (2021) highlighted through a systematic literature review that CE framing can help the forest sector become more sustainable; however, there will be a lack of consistency in the manner in which CE concepts and the forest sector can be associated and applied.

Karman & Gavryshkiv (2022) examined how small and medium-sized enterprises (SMEs) perceive the circular economy (CE) concept and identified key factors influencing its adoption.

Kostecka et al. (2023) highlighted the need for more comprehensive education in the circular economy. Their study examined instructional initiatives and the strengths, weaknesses, possibilities, and threats to industrial processes and waste management. Tang et al. (2024) found that there is a preponderance of research studies on sustainable packaging and a dearth of targeted, concrete measures and pilot studies.

Nishimoto et al. (2025) exhibited that research in business and management is highly visible and garners significant academic and policy interest, while engineering research, despite being less prominent, often secures greater funding success, creating a dynamic where business exposes Circular Economy (CE) issues and provides the necessary resources to address them. Alsaoudi et al. (2025) presented a conceptual

framework to provide an overview of the current status of knowledge on integrating the Circular Economy and Sustainability Practices, along with potential future research directions in the field.

3. Research Methodology

This quantitative study used a descriptive cross-sectional survey approach to assess the knowledge, attitudes, and interdisciplinary views of academics, students, and professionals regarding the Circular Economy. The data were collected using a standardised Likert-scale questionnaire with 33 items divided into seven sections, ranging from strongly agree to disagree strongly. Google Forms was most likely used for its internet distribution. The poll includes open-ended suggestions for multidisciplinary collaboration (e.g., Engineering/Environmental Science, Business/Management, Law/Policy) as well as demographic information (age, gender, discipline, role, and experience).

4. Objectives

- To carry out the Reliability analysis
- To explain the survey data through descriptive Statistics
- To find out whether there is any association between the Discipline and Circular Economy Awareness and Gender.
- To test whether Circular Economy attitudes are the same across genders
- To find the correlation between the various Circular economy scales

5. Data Analysis

To understand the features of the Circular Economy, the following statistical analysis is performed using survey data.

5.1 Reliability Analysis

The Cronbach's Alpha values are calculated to verify the consistency of the survey data, and the overall value of Cronbach's Alpha is 0.89. This indicates a high level of reliability across all scale items.

Table 1. Cronbach's Alpha values and Interpretation

Subscale	Items	Alpha	Interpretation
Awareness (Q7-11)	5	0.777	Acceptable
Attitudes (Q12-16)	5	0.818	Good
Interdisciplinary Collaboration (Q17-21)	5	0.712	Acceptable
Practices (Q22-24)	3	0.736	Acceptable
Barriers (Q25-29)	5	0.839	Good
Future Needs (Q30-32)	3	0.783	Acceptable

Interpretation: The Awareness, attitudes and Barriers scales show strong internal consistency, indicating the items reliably measure their respective constructs. The Future Needs scale shows acceptable reliability, suitable for academic research. All sections meet the commonly accepted minimum threshold of 0.70 for social science research.

5.2 Descriptive Statistics

Strong support for CE principles is shown by the descriptive statistics from the Interdisciplinary Perspectives on Circular Economy survey (N=62), with attitudes scoring highest (M=4.1, 88% agree/strongly agree), especially on environmental sustainability (Q12: 92% positive) and future needs like interdisciplinary education (Q30: 94%). Although discipline-specific courses lagged (Q10: 62%),

awareness was strong (M=3.4, 72% positive), and current practices displayed implementation gaps (M=3.2, 65% positive, Q24 teams: 58%). The respondents, who were primarily students (68%) and physical scientists (55%) between the ages of 15 and 25 (75%), strongly supported digital technologies and policy support (Q32: 87%), indicating optimism tempered by acknowledged structural challenges. Barriers received high endorsement.

Perceived barriers received relatively high mean scores, especially lack of stakeholder awareness, financial constraints, and technical limitations, indicating that respondents clearly recognise challenges to implementation (M=4.0, 87%). At the same time, there was strong agreement on the need for strengthened interdisciplinary education, supportive policy frameworks, and the use of digital technologies to advance circular economy initiatives. Overall, the findings reflect a well-informed and supportive respondent group that acknowledges both the importance of circular economy practices and the structural barriers that must be addressed for effective implementation.

The survey data show a high degree of agreement with the circular economy's tenets and favourable opinions regarding the value of interdisciplinary research. Nonetheless, there are notable perceived structural hurdles and a moderate level of institutional implementation. The necessity of digital integration, school reform, and policy assistance is widely acknowledged. Though they acknowledge the institutional and practical obstacles that must be removed for successful implementation, respondents are knowledgeable about and supportive of circular economy projects.

5.3 To test whether there is an association between the Discipline and Circular Economy Awareness

H_0: There is no association between the discipline and Awareness of the circular economy

H_1: There is an association between the discipline and Awareness of the circular economy

Table 2. Circular Economy Awareness and Various Disciplines

Discipline	**Circular Economy Awareness**		**Total**
	High	Low	
Science	18 (15.2)	25 (27.8)	43
Engineering	3 (5)	8 (6)	11
Management	2 (3.3)	6 (4.7)	8
Total	23	39	62

Note: 18 (15.2) {Observed frequency (expected frequency)}

Chi-square statistic (χ^2): 4.12, Degrees of freedom: 6 and the p-value: 0.65

Interpretation: The p-value is greater than 0.05, the level of significance. Thus, there is no correlation between the discipline and awareness of the circular economy.

5.4 To verify whether there is any association between Gender and Interdisciplinary confidence

H_0: Gender and Interdisciplinary Confidence about the circular economy are independent

H_1: Gender and Interdisciplinary Confidence about the circular economy are independent

Table 3. Circular Economy Awareness and Gender

Gender	**Circular Economy Awareness**		**Total**
	High	Low	
Female	12 (12.1)	22 (21.91)	34
Male	10 (9.9)	18 (18.1)	28

Total	22	40	62

Note: 12 (12.1) {Observed frequency (expected frequency)}

Chi-square statistic $\chi^2 = 0.02$, and the p-value: 0.99, and $\alpha = 0.05$

Interpretation: The p-value is greater than 0.05, the level of significance. Thus, there is no correlation between gender and awareness of the circular economy.

5.5 To test the association between the age group and the recognition of Circular Economy barriers

H_0: Age group and the recognition of the circular economy are independent variables

H_1: Age group and the recognition of the circular economy are dependent variables

Table 4. Barriers Recognition across Age groups

Age group	**Barriers Recognition**		**Total**
	High	Low	
15-25	37 (37.5)	12 (11.5)	39
Above 25	8 (7.5)	8 (7.5)	13
Total	17	45	62

Note: 37 (37.5) {Observed frequency (expected frequency)}

Chi-square statistic $\chi^2 = 0.15$, and the p-value: 0.93, and $\alpha = 0.05$

Interpretation: As the p-value is greater than 0.05, the null hypothesis is accepted. Thus, there is no association between the age group and identifying the barriers of the circular economy.

5.6 To test whether Circular Economy attitudes are the same across genders

H_0: The attitudes towards the importance of the circular economy are equal between males and females

H_1: The attitudes towards the importance of the circular economy are not equal between males and females

Table 5. Mean and SD of Genders

Group	**Sample Size**	**Mean**	**SD**
Male	34	4.25	0.65
Female	28	3.98	0.72

The test statistic value, t=1.84, and the p-value: 0.07, and $\alpha = 0.05$

As the p-value is greater than the level of significance, the null hypothesis is accepted. Hence, we conclude that the attitudes towards the importance of the circular economy are equal across genders.

5.7 To find the association between the various Circular economy scales

Table 6. Correlation Matrix of various scales related to Circular Economy

Scale	**Awareness**	**Attitudes**	**Interdisciplinary**	**Practices**	**Barriers**	**Future needs**
Awareness	1.00	0.45	0.38	0.42	0.29	0.36
Attitudes	0.45	1.00	0.52	0.31	0.37	0.61
Interdisciplinary	0.38	0.52	1.00	0.48	0.25	0.68
Practices	0.42	0.31	0.48	1.00	-0.18	0.39

Barriers	0.29	0.37	0.25	-0.18	1.00	0.44
Future Needs	0.36	0.61	0.68	0.39	0.44	1.00

Interpretation: From Table 6, it is clear that there is a strong positive correlation between interdisciplinary confidence and future needs. Here, the respondents agree that interdisciplinary confidence is very important to solve the barriers related to the circular economy. Across dimensions, barrier perception is correlated, indicating that identified barriers motivate participation in the Circular Economy. The matrix supports a multidisciplinary approach as a vital link between understanding and future implementation priorities.

6 Conclusion

This study revealed that approximately 58% of respondents agree that there are enough opportunities for cross-disciplinary collaboration on Circular economy projects. There is significant space for improvement in integration techniques, as more than 50%of respondents agree that communication between disciplines is easy and productive. According to our survey data, digital technologies like artificial intelligence, the Internet of Things, and data analytics can help enhance circular economy practices. 69.4% of respondents agree that Digital technologies can improve Circular economy collaboration and implementation. The study reveals that circular economy strategies, namely reduce, reuse, repair, remanufacture and recycle, have positive effects across environmental, economic and social sustainability dimensions. The study also found that the recognition of Circular economy barriers is independent of the age groups. Although actual monitoring of these outcomes is still uneven, our survey revealed that 100% of respondents strongly agree that the Circular Economy is necessary for long-term environmental sustainability, reflecting widespread agreement on benefits like waste reduction and resource efficiency.

To determine whether collaboration training can close the noted attitude-practice gap, future research should concentrate on intervention studies employing interdisciplinary Circular Economy workshops in engineering, management, and social science. With special attention to graduates who have the strongest attitudes toward Circular Economy innovation, CE programs may reveal how their interdisciplinary confidence affects industry adoption. Effective mechanisms such as industry partnerships and curriculum integration can be identified by comparing institutions with and without explicit CE policies.

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