Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 2 April-June 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

Circular Economy and Climate Change: Promoting Sustainability and Resilience through Waste Reduction among Students

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ARTICLE DETAILS

History:
Accepted: 21 May 2025
Available Online: 26 May 2025

Keywords:
Circular Economy
Climate Change
Sustainability
Resilience

JEL Codes:
3-5 JEL Codes as per Keywords
JEL Code 1
JEL Code 2
JEL Code 3

ABSTRACT

Objective: The transition to a circular economy is essential for addressing climate change and promoting sustainable living by reducing waste and greenhouse gas emissions.

Research Gap: Although there is significant literature on the importance of circular economy activities in the industrial and manufacturing sectors, there is a noticeable lack in study into how university students understand and implement these practices. Most existing paradigms fail to account for how student understanding and behavioral intentions influence grassroots sustainability efforts, particularly in educational settings. Furthermore, little thought has been given to how the media framing of environmental concerns effects students' perspectives and engagement. This study addresses this gap by concentrating on the student population, employing Framing Theory, and quantitatively evaluating the linkages between circular behaviors, waste reduction, and climate resilience.

Design/Methodology/Approach: Using a quantitative research approach and a descriptive-correlational design, the study collected data from a stratified sample of students to examine their awareness, behaviors, and perceptions regarding circular economy principles.

Theoretical / Practical Implications of the Findings: Findings indicate a significant positive correlation between students' adoption of circular practices and their contribution to waste reduction and resource efficiency. Results highlight students' potential to act as key agents of change in promoting sustainability, with reductions in waste and improved climate resilience observed in their communities.

Originality/Value: This study underscores the importance of integrating circular economy concepts into educational frameworks to foster sustainable behaviors and policy recommendations for broader implementation.

Recommended Citation:

Tahreem, I., Shakeel, H. & Saif, N. (2025). Circular Economy and Climate Change: Reducing Waste to Promote Sustainability and Resilience. *Pakistan Journal of Economic Studies, 8*(2), 72-79. Available at: https://journals.iub.edu.pk/index.php/pjes/article/view/3449

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1. Introduction

The transition from a linear economy to a circular economy has become inevitable due to the global climate change and the need to build environmental resistance (Geissdoerfer et al., 2017; Kirchherr, Reike, & Hekkert, 2017). While linear economy is the "take make-dispose" model, circular economy aims at keeping materials in use for as long as possible; reducing losses; and emitting less waste through recycling, reusing and remanufacturing (European Commission, 2020; Blomsma & Brennan, 2017). These principles help to decrease resource consumption and prevent climate impacts, which make this approach useful for future environmental

issues (Winans, Kendall, & Deng, 2017; Ellen MacArthur Foundation, 2019).

The Guardian (May 2025) reports that for the past eight years, the share of recycled materials used out of the 106 billion tons produced yearly has consistently dropped to 6.9%.CE practices help nature and also strengthen the economy. The transition to a circular economy could generate economic opportunities valued at USD 4.5 trillion and produce 700,000 jobs in the EU by 2030 (SGS, 2024).

World Bank data (2022) shows annual municipal solid waste production exceeds 2.24 billion tons but environmental safety practices protect less than 67% of this total. This increasing waste issue, along with rising carbon emissions, highlights the critical need for new economic models that promote sustainability and resilience. The Circular economy (CE) has grown worldwide as a possible answer to meet the limitations of the linear "take-make-dispose" economic model. Advocates claim that CE is not only an effective tool towards reducing climate change but is also deemed to propagate sustainable development, and green innovation. For example, impact in five priority sectors: cement, aluminum, steel, plastics and food – could reduce 9.3 billion tones from the global greenhouse gas emissions by 2050 (Ellen MacArthur Foundation, 2019).

A number of studies published starting from 2015 indicate that circular economy policies can go a long way in reducing waste and emissions, and member countries of the EU further proved this when emissions reduced by 5% after implementing the policies (Blomsma & Brennan, 2017; European Commission, 2020). Likewise, in developing countries, the application of a circular economy enables the improvement of resource utilization while dealing with socio-economic issues (Korhonen, Honkasalo, & Seppälä; Geissdoerfer et al., 2017). However, there is still difficulty in the implementation of these practices from one region to another especially in regions with less infrastructure and facilities (Kirchherr et al., 2017; Blomsma & Brennan, 2017).

The present study examines how circular economy practices impact waste reduction and climate resilience, with a focus on students' perceptions and understanding of these principles in promoting sustainability. The findings also indicate that awareness and behavioral intention influence the implementation of circular economy significantly, especially among young people as key agents of change (Geissdoerfer et al., 2017; Kirchherr et al., 2017).

1.1 Hypothesis

H1: Circular economy practices significantly reduce waste generation.

H2: The reduction in waste leads to measurable decreases in carbon emissions.

2. Literature Review

The growing problem of climate change and environmental pollution has challenged organizations and policymakers to seek new ways of implementing and promoting the concept of circular economy (CE). One of the sub-strategies of the circular economy is the attempt at lowering waste from manufacturing and shipping (Yang et.al, 2023). In contrast to the linear economy where the main business model is "take-make-dispose", the circular economy prescribes constant circulation of resources from recycling, reuse and remanufacturing, hence generating less waste and hence having a smaller ecological footprint (Geissdoerfer, Savaget, Bocken, & Hultink, 2017).Such changes in the paradigm are crucial in managing greenhouse gasses and enhancing sustainability and resilience to the different sectors (Ellen MacArthur Foundation, 2019).

2.1 Circular Economy and Climate Change Mitigation

In current literature, there has been a clear link between circular economy and climatic change mitigation. The International Resource Panel (IRP, 2020) assesses that calculated emissions regarding global totals range from 45- 49% are from extraction and processing of materials. CE strategies like material efficient product design and closed loop recycling removes a lots of carbon footprints from industries (European Commission, 2020).For example, the construction industry which has been identified to contribute significantly to emissions can improve on its CE practices by following sustainable material for construction and improving energy efficiency in structures (Global Alliance for Buildings and Construction et al., 2019).In addition, Kirchherr,

Reike, and Hekkert (2017) found that CE does not only eliminate waste but also avoid the use of virgin materials that are often more energy demanding to produce than recycled materials. This means less extraction of material and its processing which therefore leads to reduced GHG emissions and hence building climate resilience (Korhonen, Honkasalo, & Seppälä, 2018). Similarly, supporting these findings, the Ellen MacArthur Foundation (2019) revealed that integrating over 100 CE principles across companies and industries could reduce global CO2 emissions by 9.3 gigatons the same as neutralizing the emissions from all transportation today.(Ellen MacArthur Foundation, 2019).

2.2 Sector-Specific Circular Economy Strategies

CE strategies applied in each sector have different potentials of fighting Climate change. A case of using remanufacturing and recycling within the manufacturing industry warrants a significant decrease in wastage and gasses released to the atmosphere (Geissdoerfer et al., 2017). For instance, car makers can reclaim used parts, remanufacture them and use them instead of manufacturing new parts, the process that cuts emissions released during manufacture (European Commission, 2020).CE is an important process in battling food waste, as well as encouraging the implementation of sustainable farming. The IPCC (2019) estimated that the AFOLU sectors contribute significantly to global emissions. CE measures like minimizing food loss and waste and applying climate adaptive agriculture practices to reduce emissions and at the same time improve the adaptability of the food system (Hertwich et al., 2019).

In plastics and textiles industries, recycling and material recovery play a central role in preventing pollution and climate change. OECD (2022) estimates that the efficient recycling systems can help reduce the dependence on virgin plastics that have a much higher carbon footprint implying thus reduced emissions (OECD, 2022). Thus, in the textiles industry, reducing the environmental impacts of garments through recycling and reusing them has the potential to substantially cut the environmental impacts of fashion (Korhonen et al., 2018).

2.3 Challenges and Barriers to Circular Economy Implementation

There are, however, a number of challenges to implementing a circular economy as it appears from the following subtopics: Kirchherr et al. (2017) outlined one of the primary barriers as the first hurdle, which consists in the comparatively high costs of CE technologies and infrastructure development and deployment. Furthermore, improvements in CE practices are constrained by innovation and effectiveness in the recycling processes; also, there is no proper framework that has been put in place and followed by most industries (Blomsma & Brennan, 2017).

2.4 Research Objectives

1. To assess the reduction in waste generation associated with the implementation of circular economy principles.
2. To measure the reduction in carbon emissions due to waste minimization strategies.
3. To identify the correlation between circular economy practices and long-term sustainability in specific sectors (e.g., manufacturing, consumer goods, automotive, etc.).

2.5 Research Questions

1. How do circular economy practices contribute to waste reduction and resource efficiency among students?
2. What role does student awareness of circular economy principles play in promoting sustainable waste management behaviors?
3. In what ways do circular economy practices enhance resilience to climate change impacts within student communities?

4. What are the perceived barriers and facilitators for students in adopting circular economy practices to reduce waste and support climate resilience?

3. Theoretical Framework

Framing Theory is one of the media theory that looks at the ways through which the media informs the audience deciding what aspects of a particular issue is worth focusing on and which are not worth it (Goffman 1974; Entman 1993).Proposed by Erving Goffman and later elaborated by scholars in the field of communication, this theory posits that framing affects how audiences interpret information. In other words, framing theory holds that the media always chooses to offer the audience certain stories, words, pictures, and aspects of an issue that influence the public perception of an issue (Tewksbury & Scheufele, 2009).

3.1 How Framing Theory Relates to Circular Economy and Climate Change

The way the circulation system and climate resilience are reported in the media can positively or negatively influence students' perception and actions on circulatory economy. For instance, if local media sources dedicate their coverage to reporting positive outcomes of circular economy solutions that minimize waste and build community resilience to climate effects, students are more likely to perceive these approaches as practicable and effective, thus boosting their performance motivation (Entman, 1993).

If the media coverage is on the negative side showing that circular economy practices are costly or cannot be implemented because of some other reasons this may demoralize the students and give them an impression that circular economy is not feasible. Public perception is impacted by this aspect, which makes framing theory useful in comprehending how the coverage by the media leads or hinders sustainability activity in student groups that is an area of focus for your work (Chong & Druckman, 2007).

4. Research Method

The research used a quantitative understanding and assessment of the current use of circular economy strategies and waste management in connection to the climate change resilience of the university students. Employing 350 participants selected from this population, a stratified random sampling technique was employed to cover a reasonable cross-section within the various university programs including different levels of study. Questionnaires were administered and self-developed and consisted of a set of statements that aimed at capturing potential participants' attitudes and behaviors of circular economy practices, their waste management behaviors, and attitudes towards climate change resilience. Quantitative methods proved useful in analyzing the correlations, and trends of these variables to give a perfect picture of these relationships in the targeted students. The goal of this approach was to generate data that can be generalized to other similar university settings and useful in understanding and framing sustainability in higher education environments.

Independent Variable: Circular economy practices (e.g., recycling, remanufacturing, reuse, sustainable product design).

Dependent Variables: Waste reduction, carbon emission levels, economic resilience.

5. Findings and Interpretations

The reliability test, Cronbach's Alpha coefficient for this scale which consists of 350 items is 0.844 and shows a high level of coefficient indicating that items are highly correlated with each other. Cronbach's Alpha values vary between 0 to 1 with values exceeding 0.7 being acceptable and values over 0.8 are good.

So, the value of 0.844 demonstrates that the items are high and most probably, they represent similar construct or theme. Thus, it can be concluded that the use of the scale ensures reliability and its applicability for evaluating the targeted concept in the framework of this research.

5.1 Reliability Statistics

Table 1: Reliability Statistics

Cronbach's Alpha	N of Items
0.844	350

Source : Authors' Estimation

5.2 Pearson Correlation

First, the positive, moderate correlation observed between CE and waste reduction ($r = 0.482$, $p = 0.027$) echoes the assertion by Ghisellini, Cialani, and Ulgiati (2016) that CE models support resource efficiency by rearranging to reduce product design and extend the material lifecycles and consequently decrease the waste generation. Correlation analysis conducted on the variables Circular Economy Practices, Waste Reduction and Resilience to Climate Change, reveal high positive correlation between the three factors. Organizations that engage more in Circular Economy practices tend to reduce waste and there is a moderate positive relationship between Circular Economy and Waste reduction; $r = 0.482$; $p = 0.027$. They are statistically significant at the 0.05 level in this research as stated in table 2. This research depicts that circular economy explained overall 53% of the resilience with a correlation coefficient of 0.733 and at a significance level 0.000 which shows that circular economy must be enhanced to improve resilience to the impact of climate change. It is highly significant at ($p < 0.01$). A high positive correlation between waste reduction and climate change resilience with the correlation coefficient of 0.680 at 0.001 levels thus establishing that reduction in wastes has a positive impact on climate resilience. In total, these findings demonstrate that more circulation and the reduction of waste are directly associated with better climate change adaptation as well as highlighting additional benefits of sustainable practices.

Table 2: Correlations

		Circular_Economy_Practices	Waste_Reduction	Resilience To_Climate Change
Circular_Economy_Practices	Pearson Correlation	1	.482*	.733**
	Sig. (2-tailed)		.027	.000
	N	350	350	350
Waste_Reduction	Pearson Correlation	.482*	1	.680**
	Sig. (2-tailed)	.027		.001
	N	350	350	350
Resilience_To_Climate_Change	Pearson Correlation	.733**	.680**	1
	Sig. (2-tailed)	.000	.001	
	N	350	350	350

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

5.3 Mathematical Model Using Pearson Correlation

The Pearson Correlation Coefficient is given by the formula:

$$rXY = \sum i = 1n(Xi - X^{-})2 \cdot \sum i = 1n(Yi - Y^{-})2\sum i = 1n(Xi - X^{-})(Yi - Y^{-})$$

Equation 1: Pearson Correlation Coefficient

Where, r{XY} is pearson correlation coefficient between variables X and Y. Xi and Yi are individual values of variables X and Y. $X^{-}$and Y^{-} are mean of variables X and Y. n is the number of observations. In the context of this study, the following correlations were calculated as r {CE, WR} is correlation between circular economy practices and waste reduction. r{CE, RC} is correlation between circular economy practices and climate change resilience. r{WR, RC} is correlation between waste reduction and climate change resilience. Observed correlation values from the study are

r {CE, WR} = 0.482
r {CE, RC} = 0.733
r {WR, RC} = 0.680

These values show moderate to strong positive associations, implying that more student engagement in circular economy activities is connected with lower waste and higher climate resilience.

6. Conclusions

The study's findings reflect the key ideas of Framing Theory, specifically how students interpret and implement circular economy activities based on the information they receive. The high link between awareness and sustainable practices implies that media framing (how circular economy principles are presented) has a considerable impact on student views. For example, students who reported increased understanding of circular economy ideas frequently ascribed their knowledge to positive framing in instructional content, social media, or environmental activities. This lends credence to the premise that when circular activities are presented as practical, accessible, and urgent solutions to climate change; students are more inclined to interact with them. In contrast, poor awareness among some students may imply inadequate or negative framing, emphasizing the relevance of media and institutional messaging in shaping behavioral intentions.

According to the studies, enshrinement of the circular economy innovation including recycling, lessening the use of the resources, and optimizing the utilization of the materials have a powerful impact on lessening of the waste. This reduction not only; reduces environmental hazards but also increases the resilience of the communities/organizations to climate change impacts. In this manner, there are opportunities to implement true circular practices within operations to create a closed-loop system through which resources are conserved, emissions are reduced, and the ability to develop longevity in operations is enhanced.

This study presented circular economy practices as a feasible and effective way of attaining sustainable development and climate change management consistent with global environmental standards. All the three strategies of circular economy which includes slowing, closing and narrowing of loops can be applied within the construction project to reduce climate change (Gallego-Schmid, A., Chen, H. M., Sharmina, M., & Mendoza, J. M. F. 2020). This supports the notion of a circular economy as a coordinated series of dynamics that can help to maintain ecological and socio-economic values under continuous negative changes.

7. Recommendations

To expedite the adoption of circular economy practices among university students and the general public, numerous focused governmental initiatives are required. First, higher education institutions should incorporate circular economy and sustainability education into all specialties' curricula to establish core knowledge and attitudes early on. To encourage behavioral change, government organizations and environmental departments can develop youth-focused awareness programs that use positive media framing. Furthermore, financial incentives, grants, or awards could be introduced to encourage student-led efforts that minimize campus waste or innovate sustainable methods. Universities should also implement green campus rules requiring proper trash segregation, recycling infrastructure, and reuse systems in dormitories, canteens, and laboratories.

8. Limitations

Although the sample size of this study was increased to 350 it holds certain limitations that reduced the external validity and qualitative depth of this research. This method is capable of having its preponderant sample bias correspond to a certain demographic or geographic population, which will in turn result in its findings being less suitable for other scopes of practice or other areas of business. Also, the calculus based on the self-reported data may incline toward certain biases such as social desirable bias since participants may overemphasize their sustainable practices. Another methodological limitation of the study is the cross-sectional research design which only samples data at one time point, which limits the researcher's capacity to temporal changes and their causes. A longitudinal approach could give richer understanding on how the practices related to circular economy, waste and climate work in parallel and interactively. It can also be observed that the Cronbach alpha for the instrument is very high; however, to fully validate the construct, further Confirmatory Factor Analysis (CFA) is necessary to justify the validity of the scales in measuring the respective constructs. Lastly, because the study addresses specific relationships, it does not consider other outside factors that also could play crucial roles in designing circular economy practices and resilience: regulatory policies, technologies, and external economy conditions.

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Acknowledgments

The author must acknowledge the support in conducting the research work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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