

Barriers to Circular Economy: Comparative Analysis of Brazil, Asia, and the EU.

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Abstract. The transition from a linear to a circular economy has gained prominence as a response to growing resource pressures and environmental degradation. However, implementation remains uneven across regions due to multiple and interconnected barriers. This study aims to analyze and compare the barriers to circular economy implementation in three distinct regional contexts: the European Union, Asia (with emphasis on China and Taiwan), and Brazil. The research employs a qualitative comparative design based on secondary data, including peer reviewed literature, systematic reviews, and bibliometric analyses. Barriers are categorized into four dimensions: economic, institutional, technological, and social. The findings reveal that while economic constraints such as high upfront costs and price disparities are persistent across all regions, the predominant type of barrier varies according to levels of economic development and institutional capacity. In the European Union, barriers are largely cultural and regulatory, related to implementation complexity and consumer behavior. In Asia, technological and infrastructural gaps are more pronounced, limiting scalability in a rapidly industrializing manufacturing hub. In Brazil, structural and institutional weaknesses prevail, including policy fragmentation, lack of standardized indicators, and high informality in key sectors such as textiles. The analysis also highlights that no single barrier operates in isolation; these constraints interact in mutually reinforcing ways. The study concludes that effective implementation depends on context sensitive strategies tailored to each region's development stage.

Keywords. Circular economy, barriers, European Union, Asia, Brazil, comparative analysis, economic development, institutional capacity, sustainability.

1. Introduction

Growing pressure on natural resources, environmental degradation, and waste generation has intensified the search for alternative models of economic development. In this context, the circular economy has emerged as a promising framework aimed at reconciling economic growth with environmental sustainability by promoting resource efficiency and closing material loops across production and consumption systems [1]. Over the past decade, the concept has gained significant traction among policymakers, businesses, and academia, becoming a central component of sustainability strategies worldwide [2].

Despite its increasing relevance, the transition from a linear to a circular economic model remains complex and uneven. The circular economy is constrained not only by conceptual and physical limitations but also by a wide range of barriers that hinder its practical implementation [3,4]. Economic,

institutional, technological, and social barriers often interact in ways that reinforce existing linear systems, resulting in limited and fragmented adoption of circular practices [4,5].

The nature and intensity of these barriers vary across regions, reflecting differences in economic development, institutional capacity, industrial structure, and cultural dynamics. While some regions benefit from advanced regulatory frameworks and technological capabilities, others face structural constraints that limit the scalability of circular initiatives. This highlights that the transition to a circular economy varies significantly across regions.

This study analyzes and compares the barriers to the circular economy in three regions: the European Union, Asia, and Brazil, selected for their contrasting economic structures, policy frameworks, and stages of development. By examining both shared challenges and region-specific constraints, the paper contributes to a more nuanced understanding of how

barriers to circularity emerge and interact. Ultimately, it argues that the effectiveness of circular economy strategies depends not only on technological and economic factors, but also on broader institutional and structural conditions.

2. Methodology

This study employs a qualitative comparative research design to analyze barriers to the circular economy across three regions: the European Union, Asia, and Brazil. The approach examines how different economic structures and institutional contexts shape the nature and intensity of these barriers.

The approach relies primarily on secondary data sources, including peer-reviewed academic literature, systematic reviews, bibliometric analyses, and empirical region-specific studies [5,6]. The selected literature prioritizes publications from the last five years (2021–2024), complemented by seminal theoretical works from 2017–2018 to establish conceptual foundations. This combination allows for both a broad theoretical understanding of circular economy barriers and a contextualized analysis of how these barriers manifest in different regions.

Barriers are categorized into four dimensions (economic, institutional, technological, and social) based on established frameworks [4,7]. This classification enables systematic cross case comparison and helps identify common patterns and regional differences.

The research focuses on three regions with distinct characteristics. The European Union is analyzed as a case of advanced institutional development and strong regulatory frameworks [8]. Asia, with emphasis on China and Taiwan, represents a dynamic and heterogeneous context characterized by rapid industrialization and technological development [9,10]. The focus on China and Taiwan is deliberate, as Asia encompasses highly diverse economies. India and Southeast Asia face barriers more similar to Brazil, while China and Taiwan represent advanced cases of circular economy policy in a rapidly industrializing manufacturing context. Brazil is examined as an emerging economy, where structural and institutional constraints play a central role in shaping the transition to circularity, particularly within the textile and fashion sector [11,12].

Through this comparative approach, the study seeks to identify common patterns and region-specific differences in barriers to circular economy implementation. The objective is to provide a nuanced understanding of how contextual factors influence the transition process and to highlight the importance of tailored strategies according to different levels of economic development and institutional capacity.

However, this study presents some methodological

limitations. A significant portion of the selected literature focuses on specific sectors, particularly the textile and fashion industry and waste management systems [6,11]. While these sectors are highly relevant, this concentration may limit the generalizability of the findings. Circular economy practices in the service sector remain underrepresented, resulting in less emphasis on service-based models and potentially overlooking dynamics related to non-material value creation. As a result, the analysis may reflect a bias toward product-based and industrial perspectives of the circular economy.

3. Circular Economy: concept and limitations

3.1 Definition of Circular Economy

The Circular Economy (CE) is a regenerative economic system designed to replace the traditional “end-of-life” model with strategies such as reducing, reusing, recycling and recovering materials throughout the entire supply chain [1]. Scientifically, it is described as a system that maximizes the service produced from the linear flow of matter and energy by utilizing cyclical flows, renewable energy, and cascading energy use [3]. The concept applies at three levels: micro, as products and company-consumer relations, meso, as eco-industrial parks and regional networks, and macro, including cities, nations, and the global economy [1]. Its primary aim is to achieve sustainable development, balancing environmental quality, economic prosperity and social equity for current and future generations [13].

3.2 Limitations of the concept

However, despite its theoretical appeal, CE has critical limitations that must be addressed to achieve global sustainability. According to the second law of thermodynamics (entropy), 100% recycling is impossible. Cyclical processes will always consume energy and generate their own waste and side-products [3], which in fact complicates the explanation of CE as a complete functional system.

A second limitation concerns infrastructure and culture. Existing linear infrastructures and cultural routines create a “lock-in” effect [3]. This lock-in prevents superior circular innovations from penetrating the market. The problem is deeper: it involves governance, policy coordination, and material flow management. Moreover, “waste” is a social construct, so its meaning varies across cultures and over time [3]. This makes universal policies or statistics for material recovery difficult to establish.

Beyond these conceptual limitations, the transition to a Circular Economy faces multiple interconnected barriers that hinder its effective implementation across different sectors. These barriers can be broadly categorized into economic, institutional, technological, and social dimensions [4,5,7].

3.3 Barriers to implementation

Economic barriers are among the most significant obstacles to the circular transition [4,5]. Circular products often carry a “green premium” due to production inefficiencies and limited economies of scale, which discourages adoption [5]. At the same time, linear systems remain economically advantageous as they do not fully internalize environmental externalities, keeping conventional products artificially cheap [4]. Small and medium enterprises also face high upfront costs and uncertain returns, which further discourages investment in circular business models [5].

Institutional barriers also play a key role. Regulatory frameworks are often fragmented, slow to implement, and poorly aligned with business realities [4]. In addition, comprehensive measures addressing entire product life cycles remain limited [8]. Complex legal procedures, such as restrictions on cross-border waste movement, further hinder circular practices. The absence of financial incentives and subsidies also reduces firms’ willingness to transition [4,8].

Technological barriers are closely linked to the lack of knowledge, expertise, and infrastructure [7]. Many firms lack the technical capabilities to redesign products or manage material flows effectively [5]. A significant gap remains between awareness and practical implementation [2]. High technology costs, inadequate recycling and reverse logistics infrastructure, and limited knowledge sharing between firms further constrain progress [4,5,7].

Social barriers include behavioral and cultural factors [4,5]. The “intention–action gap” highlights how consumers express concern for sustainability but fail to change purchasing behavior, often due to higher prices and negative perceptions of recycled products [4,5]. Organizational resistance to change is also significant, as business leaders tend to prefer linear models due to uncertainty and fear of failure [4,7].

Despite the persistence of these barriers, several countries and regions have increasingly incorporated circular economy principles into their policy agendas and development strategies. However, the ways in which these barriers emerge and interact vary significantly according to economic structures, institutional frameworks, and cultural contexts. In this regard, the European Union, Asia, and Brazil represent particularly relevant cases, given their distinct levels of economic development, regulatory environments, and approaches to sustainability. These differences provide a valuable basis for examining how multiple and interdependent barriers to the circular economy manifest across diverse settings and influence the pace and direction of the transition.

4. Barriers to the circular economy: regional perspectives

4.1 The European Union

The circular economy has become a central pillar of the European Union’s sustainability and industrial strategy over the past decade [8]. The EU has actively promoted circularity as a pathway to resource efficiency, environmental sustainability, and long-term economic competitiveness. Despite this strong institutional commitment, the practical implementation of circular economy principles across the EU remains uneven and relatively limited. Instead, circular economy initiatives are often concentrated in specific sectors, regions, or among firms already engaged in sustainability-oriented activities [4]. This gap between policy ambition and real-world adoption highlights the structural challenges involved in transitioning from a linear to a circular system.

Within this context, several key barriers help explain the slow progress of the circular economy in the European Union. Among these, cultural barriers emerge as the most pressing challenges [4]. In particular, lack of consumer interest and awareness emerges as the most critical obstacle. Although sustainability is increasingly discussed, consumers often prefer new products over used or remanufactured ones, and their preferences change too quickly to support durable product models [4]. Circular economy adoption is also further constrained by a hesitant company culture, in which the concept remains confined to CSR departments rather than core business functions, and by the inertia of linear systems, as supply chains continue to operate under deeply embedded linear structures [4]. These dynamics suggest that the circular economy remains, to a large extent, a niche concept rather than a dominant paradigm within European markets.

In addition, market barriers play a crucial role and often drive cultural hesitation. One of the most important barriers is the low price of virgin materials, which makes circular alternatives less competitive [4]. Primary materials (like fossil-fuel-based plastics) are frequently cheaper than recycled or bio-based alternatives, making circular products uncompetitive [5]. There are also high upfront investment costs. The transition requires significant capital for “learning curves,” which leads many companies to adopt a “wait and see” approach and discourages firms from adopting new business models [4]. These economic constraints reinforce existing linear systems and reduce incentives for innovation.

While economic factors dominate, regulatory barriers, although less prominent, also contribute to the complexity of implementation [4]. Certain laws and regulations may inadvertently restrict circular practices, for example by limiting the use or cross-border movement of secondary materials. At the same time, policy frameworks are not always sufficiently aligned to support the systemic changes required for circularity [8].

Finally, contrary to earlier assumptions,

technological barriers are not the primary constraint in the EU context. Available evidence indicates that the necessary technologies largely exist [4]. The main challenges lie instead in economic structures, institutional arrangements, and behavioral factors.

Overall, the barriers to the circular economy in the European Union do not operate in isolation, but rather interact in complex and mutually reinforcing ways [4]. Implementation costs, for instance, are closely linked to hesitant firm behavior and uncertainty. Supply chain coordination challenges reflect both structural dependence on linear systems and limited collaboration among actors. At the same time, difficulties related to industrial adaptation are not primarily technological, but stem from the need to transform existing business models within an economic environment that still favors linear production. These dynamics illustrate that economic, organizational, and structural barriers are deeply intertwined, collectively slowing down the transition and reinforcing the persistence of the linear system.

4.2 Asia

As a global manufacturing hub, the region faces significant pressures related to intensive resource use, large-scale waste generation, and environmental degradation, making the adoption of circular practices particularly relevant. Within this context, several Asian economies have begun to incorporate circular economy principles into national and sectoral strategies, although progress remains heterogeneous across countries [9].

China is one of the most advanced cases, having integrated the circular economy into its national development agenda, particularly through the Fourteenth Five Year Plan [9]. Initiatives include resource recycling systems, waste free cities, and digital sharing platforms. In contrast, Taiwan shows strong sectoral performance, especially in textiles, with high recycling rates and technological capabilities [10].

Implementation of circular economy practices across Asia remains uneven and constrained by multiple barriers [9]. Economic and financial barriers are significant. The transition requires substantial upfront investment in technology, infrastructure, and new processes, often without immediate financial returns [5]. Price disparities between conventional and sustainable products discourage adoption in price sensitive markets. Small and medium enterprises often struggle to access capital for circular innovation [5]. The transition also requires sustained long-term investment, with low short-term returns.

Cultural and social barriers also play a critical role [9]. Persistent lack of consumer awareness limits market demand, while negative perceptions of recycled materials reduce acceptance. Many firms resist change, maintaining traditional linear production models. Knowledge gaps, including lack of technical expertise and professional capacity,

further constrain implementation [9]. Addressing these gaps requires investment in human capital and professional training programs.

Technological and infrastructural barriers remain highly relevant [9]. Many regions have underdeveloped waste management systems with insufficient infrastructure for collection, sorting, and quality recycling. This is especially critical for plastics and electronic waste. Gaps in advanced processing technologies and difficulties in ensuring product quality limit scalability [6]. Overcoming these barriers requires investment in research and development, including collaborative R&D alliances [9]. Complex supply chains with limited coordination also complicate circular solutions.

Regulatory and institutional barriers contribute to the persistence of linear systems [9]. Although some countries have policy frameworks, enforcement mechanisms are often weak or inconsistent. In China, lax supervision and lack of accountability hamper implementation [9]. The absence of standardized criteria for recycled products creates market uncertainty, while bureaucratic burdens divert resources from innovation to compliance. In response, some countries, particularly China, have begun implementing national strategies to strengthen human resources, aligning educational curricula with market needs [9].

The transition to a circular economy in Asia, especially in China and Taiwan, highlights significant challenges in implementation, technology, and workforce skills [9,10]. China has strong policy direction but struggles to translate ambition into consistent implementation. Taiwan has advanced recycling systems but faces sector specific limitations [10]. Technological gaps and limitations in technical expertise hinder broader diffusion of circular practices. Addressing these constraints requires sustained investment in both technological innovation and human capital development over the long term [9].

4.3 Brazil

The circular economy in Brazil is an emerging and still underexplored field [1]. Both research and practical initiatives remain concentrated in specific sectors rather than broadly diffused across the economy. Among these, the textile and fashion (T&F) industry stands out due to Brazil's complete production chain, from fiber to final consumption, and its significant economic and social impact, affecting millions of people directly and indirectly [11,12].

Despite this potential, the transition toward circularity remains limited and constrained by structural barriers [11]. A key challenge is the dominance of the linear business model, particularly fast fashion, characterized by high production volumes, short product life cycles, and low durability. This model incentivizes rapid consumption and disposal, while remaining highly profitable, which

discourages firms from adopting circular alternatives [12].

Supply chain and technological limitations also pose substantial obstacles [11]. Industrial infrastructure is largely designed for large-scale linear production, making adaptation to circular processes difficult. In addition, fragmented and cost-driven supply chains show resistance to non-standard inputs and new production logics, limiting the scalability of circular initiatives, especially for small and medium-sized enterprises [11].

Social and labor challenges further complicate the transition [11]. A significant share of the workforce operates under informal conditions, hindering regulatory enforcement and reducing transparency. This informality is associated with risks such as labor exploitation and conditions analogous to modern slavery [11]. At the same time, skill gaps persist, particularly in areas related to circular design, sustainable production, and business model innovation.

From a market perspective, demand for circular products remains limited and unstable [11]. Although awareness of sustainability is increasing, this has not translated into consistent consumer behavior. Consequently, firms, especially those based on circular principles, struggle to balance environmental and social objectives with financial viability in a market dominated by linear competitors [12].

Institutional barriers further constrain the transition [11]. There is a lack of robust public policies, targeted incentives, and coordinated government support for circular economy adoption, particularly for SMEs [12]. In addition, the absence of standardized indicators makes it difficult to measure performance, assess impacts, and guide decision-making, limiting the scalability and long-term sustainability of circular initiatives [11].

In sum, Brazil's circular transition remains constrained by a lack of standardized indicators, weak value chain coordination, and insufficient institutional support [11]. Limited coordination among stakeholders hinders the integration of circular practices, while insufficient policy support reinforces a fragmented transition process in which isolated initiatives fail to achieve systemic change.

5. Comparative analyses

A comparative analysis of the European Union, Asia, and Brazil reveals that, despite contextual differences, several barriers to the circular economy are shared across regions. In particular, the literature highlights the persistence of economic constraints and coordination challenges as common obstacles to circular transition [5]. Across all cases, high implementation costs, financial risks, and uncertain returns continue to discourage firms from adopting circular business models. At the same time, the effective functioning of circular systems depends on

strong coordination across value chains, which remains difficult due to fragmented supply structures, limited collaboration, and misaligned incentives [5]. These findings are consistent with broader evidence in the literature, which identifies economic and organizational barriers as recurring challenges in different contexts [5,6].

Despite these similarities, the analysis also reveals important regional differences in the predominant types of barriers. In the European Union, barriers are more closely associated with regulatory complexity and implementation challenges [4,8]. Despite relatively advanced institutional frameworks, practical adoption remains constrained by market dynamics and behavioral factors [4]. In Asia, the transition is more strongly limited by technological and operational barriers, including gaps in infrastructure, processing capabilities, and system integration, particularly given the region's scale and diversity of production systems [6,9]. In contrast, Brazil faces primarily structural and institutional barriers, including weak policy support, limited coordination mechanisms, and the persistence of informality, which constrain the development and scalability of circular initiatives [11,12].

A key insight emerging from this comparison is that the predominant type of barrier varies according to the level of economic development and institutional capacity [5]. More developed regions, such as the European Union, tend to face challenges related to implementation and system optimization, whereas emerging and developing economies are more constrained by structural limitations, technological gaps, and weaker institutional frameworks [6,11]. This pattern reinforces the argument that the transition to a circular economy is highly context-dependent and requires differentiated policy approaches tailored to the specific conditions and stage of development of each region.

6. Conclusion

This study analyzed and compared the barriers to circular economy implementation across the European Union, Asia, and Brazil. The findings confirm that the transition from linear to circular models remains uneven and context dependent, shaped by distinct economic structures, institutional capacities, and developmental stages.

Three main insights emerge from the comparative analysis. First, economic barriers are persistent across all regions. High upfront costs, price disparities between virgin and recycled materials, and uncertain returns discourage firms from adopting circular business models regardless of geographic context [4,5].

Second, the predominant type of barrier varies according to levels of development and institutional maturity. In the European Union, barriers are largely cultural and regulatory, related to implementation complexity and consumer behavior [4]. In Asia, technological and infrastructural gaps are more

pronounced, limiting scalability in a region marked by rapid industrialization and manufacturing intensity [6,9]. In Brazil, structural and institutional weaknesses prevail, including policy fragmentation, lack of standardized indicators, and high informality in key sectors such as textiles [11,12].

Third, no single barrier operates in isolation. Economic, institutional, technological, and social constraints interact in mutually reinforcing ways [4,5]. For example, high costs reinforce organizational resistance, while weak enforcement perpetuates linear lock in. This interdependence suggests that piecemeal interventions are unlikely to succeed.

The study also highlights a common challenge across all three regions: coordination failure across value chains [5,11]. Even where policies exist or technologies are available, fragmented supply structures and limited stakeholder collaboration hinder systemic change.

From a policy perspective, these findings point to the need for tailored strategies. Advanced economies like the European Union should focus on aligning regulation with market dynamics and fostering behavioral change [8]. Rapidly industrializing Asian economies require sustained investment in infrastructure, R&D, and human capital [9]. Emerging economies like Brazil need foundational institutional reforms, including clear metrics, enforcement mechanisms, and targeted support for small and medium enterprises [11,12].

This study has limitations. The literature reviewed concentrates heavily on product-based sectors, particularly textiles, fashion, and waste management [6,11]. Service based circular models remain underexplored, which may bias the findings toward industrial perspectives. Future research should examine circular economy barriers in service sectors and investigate how informal economies shape transition pathways in developing regions.

In conclusion, the circular economy is not a one size fits all solution. Its successful implementation depends on recognizing regional specificities and designing interventions that address the particular mix of barriers present in each context. Without such differentiation, even well-intentioned policies risk reinforcing the very linear systems they seek to replace.

7. References

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