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Barriers, Challenges, and Opportunities in the Adoption of the Circular Economy in Mexico: An Analysis through Social Perception

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Abstract: This study explores the transition toward sustainable economic models through the circular economy (CE) in Mexico. Utilizing a mixed-methods approach, this research incorporates a comprehensive literature review and analyzes responses from 42 stakeholders, gathered through surveys and focus groups. These stakeholders comprise a diverse group including PhD students, professors, researchers, industry professionals in sustainability and the environment, and government advisors and coordinators from the Mexican Secretary of Environment. This representative sample provides a broad perspective on the barriers, opportunities, and societal perceptions regarding CE. The findings reveal significant challenges such as economic barriers, regulatory inadequacies, and a lack of awareness and education, all of which hinder the adoption of CE practices. Despite these challenges, there is a generally optimistic view among stakeholders about CE's potential to positively impact societal needs, suggesting robust opportunities for innovation and policy enhancement to foster sustainable development. Key recommendations include intensifying educational programs to elevate public understanding and engagement, formulating supportive policies that facilitate CE adoption, and promoting intersectoral collaboration to leverage collective expertise and resources. Additionally, the research underscores the necessity of integrating CE principles into urban planning and policy frameworks to effectively address specific local challenges such as waste management, pollution, and urban sprawl. By providing a detailed analysis of the current state and potential of CE in Mexico, this paper contributes valuable insights to the global discourse on sustainability. It proposes strategic actions to overcome existing hurdles and capitalize on opportunities within the CE framework, charting a path forward for Mexico and serving as a model for other regions facing similar sustainability challenges

Keywords: circular economy; sustainable development; policy recommendations; stakeholder engagement; Mexico

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1. Introduction

The shift toward sustainable economic models is crucial in addressing the complex challenges of resource depletion, environmental degradation, and unsustainable economic practices. At the heart of this transition lies the circular economy (CE), a concept that proposes a radical departure from the traditional linear model of "take, make, dispose" to a

more regenerative approach focused on the reuse, repair, refurbishment, and recycling of materials and products [1,2]. By minimizing waste and optimizing the use of resource inputs, CE aims to establish a closed-loop system that promotes environmental conservation, economic resilience, and social well-being [3,4].

Adopting CE practices necessitates a fundamental transformation in production and consumption patterns, requiring technological innovations and significant changes in social norms, behaviors, and policies [3,4]. Research across various countries has highlighted the critical role of social perception in either facilitating or hindering this transition, underscoring the importance of public awareness, cultural attitudes, and stakeholder engagement in the successful implementation of CE practices [5,6].

While CE's potential to address the Sustainable Development Goals (SDGs) is acknowledged globally, with many countries adopting CE strategies for sustainable growth [7], its application varies significantly across regions. In Mexico, particularly, the CE transition is in its infancy, starkly contrasting with Europe where CE principles are more deeply integrated at both national and subnational levels. European countries benefit from robust directives and regulations that support CE transition, which are conspicuously absent in Mexico [8]. This study seeks to underscore the unique challenges and opportunities in Mexico by providing a detailed comparison of the CE landscapes between Europe and Mexico, including the legislative timelines and regulatory frameworks [9].

In North America, and specifically in Mexico, CE's evolution from theory to practice is evidenced by initiatives like the Circular Economy International Network for Sustainability, driven by collaborations among institutions like UQAM and UNAM [10,11]. However, the broader understanding and implementation of CE within Mexican society and industries lag behind, necessitating a focused discourse on contextual barriers and facilitators [8].

More precisely, Mexico City, with its unique sustainability challenges such as waste management, air and water pollution, and urban expansion, is making significant strides toward adopting CE principles [8,12]. The city's dynamic economic landscape and policy initiatives aimed at sustainability position it as a potential leader in CE practices in the region. Recent policies and initiatives reflect a commitment to incorporating circular principles into urban planning, waste management, and economic development, such as the Circular Economy Law of Mexico City [13], potentially serving as a model for other Latin American cities facing similar challenges. This law introduces various instruments, including the circularity assessment procedure and the circularity label, to encourage companies to adopt sustainable practices and reduce their environmental impact [14].

Despite growing interest in the CE as a sustainable economic model, studies specifically addressing the social dimension of its transition in Mexico remain sparse. While environmental and economic aspects have received considerable attention, the social implications—crucial for comprehensive CE adoption—are often overlooked. This oversight exists despite ongoing discussion on sustainability in Mexico and initiatives like the RISEC. In the business sector, this is also true despite current efforts to include the CE framework. The Circular Network [15], for instance, includes 15 companies and promotes recycling in Mexico City based on governmental guidelines. Other companies also have CE activities in the country [16], but these are focused on reusing, repurposing, and recycling, with none centered on the social dimensions of CE. It is thus essential that all efforts are grounded in sustainability principles, including its social implications, which this work aims to support.

This study aims to systematically explore the social dimensions of the CE transition in Mexico, a perspective often overlooked in the existing literature. By focusing on the complexities and multifaceted nature of this transition, we aim to identify both barriers and opportunities that affect CE adoption within different sectors of Mexican society. Our main objective is to offer an in-depth analysis that highlights the specific socio-economic and cultural factors influencing the adoption of CE practices in Mexico. In doing so, we address a critical knowledge gap highlighted in the literature [17] concerning the integration of social factors in CE research, thereby facilitating strategic interventions and effective policy

formulations. Furthermore, this study seeks to harness actionable insights into how CE principles can be effectively implemented for sustainable development in Mexico.

Additionally, this study aims to identify opportunities to harness CE for sustainable development, leading to several research questions.

1. What are the foundational challenges and critiques of CE in Mexico?
2. What is the implementation capacity of companies, and what social impacts do they perceive?
3. What perceptions do stakeholders hold regarding the policies, innovations, and consumer behaviors that influence CE adoption?
4. What are the anticipated future developments for CE in Mexico, and how might these impact its broader integration into the national economy?

By answering these questions, we provide a structured exploration of how CE can be integrated more effectively into the socioeconomic fabric of Mexico, offering strategic recommendations to support Mexico in its transition toward a more sustainable and circular economic model. Through this analysis, we aspire to contribute to the global dialogue on sustainability, providing insights on overcoming CE's challenges and harnessing its potential for fostering a sustainable future.

2. Background

2.1. The Context of the Circular Economy in Mexico

As the global community pivots toward more sustainable economic models, the CE has emerged as a pivotal strategy to mitigate the challenges associated with resource depletion and environmental degradation. Unlike the traditional linear economy's "take, make, dispose" model, CE emphasizes the regeneration and continual use of resources, integrating economic, environmental, and social dimensions into a cohesive system.

The socio-economic and cultural contexts of Mexico significantly influence the development and implementation of a circular economy in the country. Economic disparities and the extensive informal economy play a crucial role, with many activities aimed at prolonging the life of products informally due to economic necessity. The plastics industry, for instance, is a significant part of Mexico's economy, contributing 3.5% to the GDP of the manufacturing sector and employing around 1.2 million people, highlighting the sector's potential in recycling and reusing materials [18].

Resource scarcity and the need for effective waste management drive Mexico's CE initiatives. The country generates over 44 million tons of waste annually, with projections to reach 65 million by 2030. The transition to CE is seen as essential to manage this waste sustainably and ensure supply security and environmental protection [19].

Culturally, there is a growing shift toward environmental awareness, supported by public policies aiming to promote waste valorization and minimize environmental impacts. This includes national programs for waste management and international commitments. Legislative support is evident in Mexico's enactment of a general circular economy law to promote the efficient use of products and materials through reuse and recycling, aiming to reduce the environmental impact of economic activities [20].

Furthermore, informal practices prevalent in the Mexican culture often involve systems to extend the life of products, reflecting a pragmatic approach to resource use. This includes repair and remanufacturing activities that align with circular economy principles. Innovation and adaptation are also crucial as Mexico looks to global leaders like the EU for models of circular economy, involving new technologies and policies to enhance sustainability across various sectors [21].

Globally, several countries have demonstrated significant advancements in implementing CE practices. For instance, the Netherlands aims to become 100% circular by 2050, and its business sector's adoption of circular practices has contributed to a 25% reduction in raw material use since 2010, showcasing substantial economic and environmental benefits [22]. In Asia, China has incorporated CE principles into its national development

strategy, with recycling industries generating substantial economic output [23]. The European Union, with its Circular Economy Action Plan, outlines a broad agenda for reducing waste and enhancing resource efficiency, with countries like France achieving notable recycling rates [24].

However, transitioning to a CE requires more than just policy adjustments; it demands a cultural shift in how society values and utilizes resources. In Mexico, despite growing awareness and initiatives, the CE is still in its nascent stages, reflecting the broader challenges in shifting societal and industrial practices [25]. The unique socio-economic and cultural contexts of Mexico require tailored approaches to successfully implement CE principles, making this an area ripe for focused research and strategic interventions.

2.2. Literature Review

This literature review includes an in-depth analysis of the existing literature on CE in Mexico, focusing on its implementation challenges, sector-specific applications, and the potential for integrating CE principles across various industries. Additionally, the review covers the legal framework supporting CE in Mexico, examining national laws and policies that facilitate or hinder the adoption of CE practices. This dual focus on both the practical and legislative aspects provides a robust foundation for understanding the current state and potential growth of CE within the Mexican context. To conduct this literature review, we used databases such as Scopus and Google Scholar. The keywords employed in our search included "Circular economy Mexico", "Circular economy sustainability", "CE implementation challenges", and "CE legal framework Mexico". This involved analyzing academic journals, industry reports, and case studies to understand the current state of knowledge in the field. As such, the theoretical framework of CE, sustainability practices, and the significance of social perceptions in the adoption of CE practices were all taken into account.

Circular Economy in Mexico

The CE in Mexico stands at a crucial juncture, showcasing significant potential despite substantial challenges. Dieleman and Martínez-Rodríguez [26] explored the "Potentials and Challenges for a Circular Economy in Mexico," identifying that while Mexico is far from fully adopting a CE model, it has considerable potential, especially through enhanced recycling practices. However, obstacles such as cultural complexities and deeply ingrained economic and political interests—including informal and mafia-type waste management systems—hinder progress.

Mexico's legal framework provides a foundation for CE, underpinned by the Political Constitution of the United Mexican States [27] and further detailed in environmental legislation such as the General Law on Ecological Equilibrium and Environmental Protection (LGEEPA) [28]. This legislation facilitates economic instruments, recycling, and clean energy schemes that are vital for supporting CE. Additionally, the General Act on Prevention and Integral Management of Waste (LGPGIR) [29] defines specific waste management responsibilities and categories, augmented by climate change mitigation strategies under the General Law on Climate Change (LGCC) [30] and the Energy Transition Law (LTE) [31].

Sector-specific studies provide insight into the varied levels of CE integration across different industries in Mexico, illustrating both the potential and the challenges of implementing CE principles. Winning et al. [32] used the Environmental Global Applied General Equilibrium (ENGAGE-materials) model to evaluate the economic and sectorial impacts of potential CE policies on steel production. Their findings suggest a potential reduction in GDP by 2030, highlighting the economic challenges that might offset the environmental benefits of increased secondary steel production within a circular framework.

Similarly, Nava et al. [33] explored the agro-industry's potential to adopt CE principles through the case of the mealworm industry, which seeks to provide sustainable alternatives to traditional meat-based proteins. This study emphasizes not only the industry's capability to enhance resource efficiency but also its role in promoting sustainable protein production

as a part of CE. These examples underscore the need for strategies that address both the economic and environmental aspects of CE, ensuring that the transition supports economic growth while enhancing sustainability.

Challenges in adopting CE are also evident in the fashion and textile industries, where Carrillo Fuentes [34] conducted legal and stakeholder analysis to facilitate CE adoption, highlighting regulatory and operational barriers. In the tourism sector, Cornejo-Ortega and Chavez-Dagostino [35] surveyed Puerto Vallarta's industry, finding limited CE awareness and reluctance from hoteliers to invest initially despite recognizing cost-saving potential.

Furthermore, water management initiatives, such as those examined by Casiano Flores et al. [36], advocate for enhanced water quality and availability through CE strategies, emphasizing the necessity of improved policies and resource management. Research into e-waste and urban solid waste by Nuricumbo et al. [37] and Delgado Ramos [38] underscores the benefits of efficient recycling systems and urban mining for reducing GHG emissions and promoting waste governance.

In the agricultural sector, Cervantes et al. [39] studied the valorization of cactus fruit, demonstrating how agricultural waste can be transformed into valuable resources, thus enhancing the profitability and sustainability of the agricultural sector.

These studies collectively underline the need for a comprehensive approach to advance CE in Mexico, emphasizing the enhancement of legal frameworks, stakeholder engagement, and the adoption of technological and cultural shifts across diverse industries. However, it is important to note that none of the studies explicitly highlights warnings or considerations regarding the inclusion of social aspects or the sustainability challenges of implementing CE. This omission suggests a gap in the current research, pointing to the need for further investigation into how social factors and sustainable practices can be integrated effectively within the CE framework in Mexico.

3. Results and Discussion

3.1. Thematic Exploration of Circular Economy Practices

CE emerges as a transformative approach to sustainability, advocating for a shift from traditional linear models to a system that emphasizes recycling, reusing, and reducing waste. This paradigm aims to decouple economic activity from finite resource consumption, minimizing environmental impacts while promoting economic growth [40].

As such, based on the literature review, we uncovered several key insights to inform the development of our questionnaires.

- Implementation Challenges: The transition to CE is hindered by numerous barriers, including a lack of information, entrenched unsustainable economic practices, and missing incentives. These challenges highlight the need for a substantial shift in societal and economic paradigms [41];
- Importance of Sustainable Supply Chain Management: Across various sectors, sustainable supply chain management emerges as a critical factor for integrating ecological considerations into business strategies. Despite the growing awareness, there are notable difficulties in applying CE principles, characterized by diverse drivers, barriers, and performance indicators [42];
- Integration into Corporate Strategies: The increasing incorporation of CE concepts into corporate sustainability strategies signals progress. However, there is an identified need for a greater emphasis on circular product design, business model innovation, and particularly, consumer engagement, which is identified as a critical yet underexplored area [43];
- Circular Business Models and Supply Chains: The adoption of circular business models and supply chains is vital for realizing sustainability goals. The complexity and variety of these models affect their sustainability performance, underscoring the need for nuanced approaches [44];
- Challenges for SMEs: Small- and medium-sized enterprises (SMEs) face unique challenges in embracing CE practices. While economic benefits are generally recognized,

the connection to environmental and social performance is less clear, pointing to a gap in comprehensive strategy development [45];

- Implications for Business Operations: CE practices impact critical business areas such as strategic planning and supply chain management, which are essential for guiding sustainable management. A lack of clarity regarding the implications for key business areas poses a significant challenge [46];
- Overlooked Social Dimension: The literature review underscores the often-neglected social dimension of CE, emphasizing the need for a balanced integration of social sustainability aspects for a truly holistic approach [17];
- Need for Environmental Economics Integration: The analysis highlights the importance of internalizing unpriced or underpriced services within the economy to support CE, requiring interdisciplinary efforts to address environmental consequences [47];
- Definitional Clarity and Consensus: A recurring issue is the lack of consensus on CE definitions, which creates confusion and impedes progress. The need for quantitative studies to measure the impact of transitioning to sustainable and circular economies is evident [48].

These outcomes are instrumental in shaping the themes and questions for the subsequent questionnaires. By addressing the identified barriers, challenges, and opportunities, this study aims to provide actionable insights and recommendations to facilitate the adoption of CE practices, contributing to sustainable development efforts.

3.2. Analysis and Interpretation

In this section, we analyze the insights from 42 stakeholders who responded to our survey, exploring their perspectives across 12 carefully crafted questions. Our analysis is organized into four distinct thematic areas: (1) Foundational Challenges and Critiques, (2) Implementation and Social Impact, (3) Policy, Innovation, and Consumer Behavior, and (4) Future Outlook and Additional Insights. This structured approach allows us to concentrate on each critical aspect of the CE, enhancing our understanding of the diverse and complex viewpoints presented by the participants. Table 1 and Figure 1 summarize the response data based on the survey responses, providing a clear snapshot of the aggregated feedback across all thematic areas.

Table 1. Summary of survey responses (%) across thematic areas.

Question	Thematic Areas	Top Response 1	Top Response 2	Top Response 3
Q1. What do you consider to be the biggest limitation of CE in its practical application?	Limitations	33.3% Lack of education and awareness	33.3% Economic or investment barriers	21.4% Inadequate regulations
Q2. What is the most frequent or relevant criticism of CE?	Critiques	45.2% Difficult to implement	26.2% Neglects social impact	16.7% May slow economic growth
Q3. In relation to companies, how would you rate their ability to implement CE practices with the tools and resources available?	Business Implementation	69% With great difficulty	31% Moderately capable	
Q4. In general, how do you perceive the social impact of CE?	Social Impact	50% Partially positive, with some benefits	33.3% Very positive, with extensive benefits for society	9.5% Neutral, no significant changes for society
Q4.1 Rate the most important themes related to the social aspects of CE from 1 to 5, where 1 is "least important" and 5 is "very important".	Social Aspects			

Table 1. *Cont.*

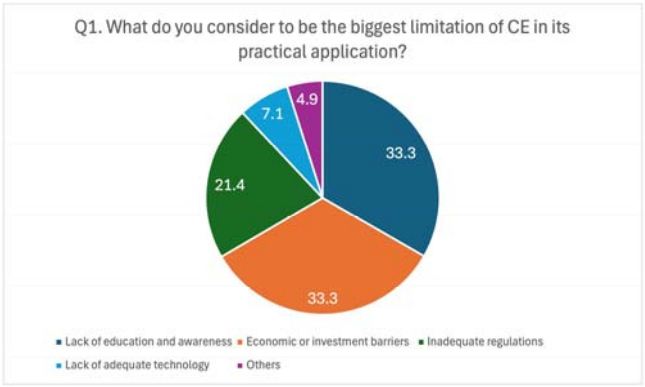
Question	Thematic Areas	Top Response 1	Top Response 2	Top Response 3
Job Creation		28.6% Very important	35.7% Fairly important	23.8% Important
Training and Education		33.3% Very important	28.6% Fairly important	21.4% Important
Innovation		57.1% Very important	16.7% Fairly important	9.5% Important
Social Commitment		52.4% Very important	19% Fairly important	11.9% Important
Social Acceptance		40.5% Very important	11.9% Fairly important	26.2% Important
Q4.2 In your opinion, what elements should be considered for CE to have a positive social impact?	Positive Social Impact	66.7% Adaptation to local needs	42.9% Education and awareness in communities	38.1% Incentives and government support
Q5. Considering national and/or local policies and regulations, how do you see these influencing the transition to CE?	Policies and Regulations	48.8% Provide some support, but could be improved	26.8% Neutral or indifferent to the transition	17.1% Hinder the transition
Q6. In your opinion, what are the essential elements to drive innovation and develop technology in the context of CE?	Innovation and Technology	66.7% Intersectoral collaboration (public-private-academia)	57.1% Investment in research and development	19% Education and specialized training
Q7. In the context of CE, what do you consider to be the most relevant aspects to optimize supply chains?	Supply Chain Optimization	45.2% Design of products designed for recycling and reuse	38.1% Transparency and traceability in the entire chain	33.3% Promotion of local and sustainable suppliers
Q8. In relation to the behavior of the average consumer toward CE, which of the following options most aligns with your perception?	Consumer Behavior	39% Completely unaware of what CE is	29.3% Reaction to change their consumption behavior	17.1% Partially willing to make minor changes
Q9. Regarding current education and its focus on CE, how would you rate the coverage of the topic?	Education Focus	64.3% Rarely covered or mentioned	23.8% Completely absent in current education	11.9% Covered, but with areas for improvement
Q10. Of the following strategies related to CE, please rank the three that you consider most important for your context.	Strategy Prioritization	54.8% Responsible consumption and purchasing	47.6% Ecodesign	42.9% Service and repair
Q11. On a scale from 1 to 5, with 1 being "very pessimistic" and 5 "very optimistic", how do you see the future of CE over the next decade?	Future Outlook	33.3% Neutral	33.3% Optimistic	14.3% Very Optimistic
Q12. Comments/Doubts/Opinions	Additional Insights	Network and Community Engagement	Policy and Educational Support	Improvements in Event Management and Follow-up

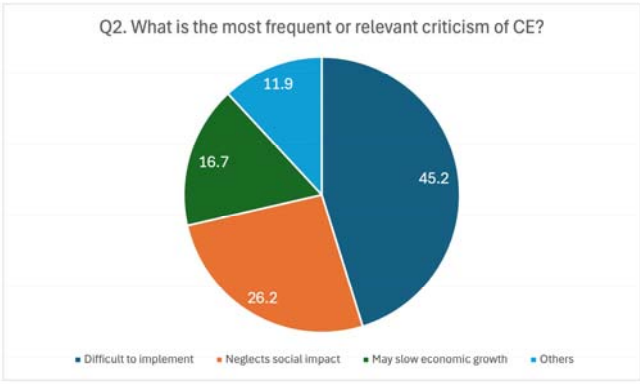
Table 2. Thematic organization of circular economy survey questions.

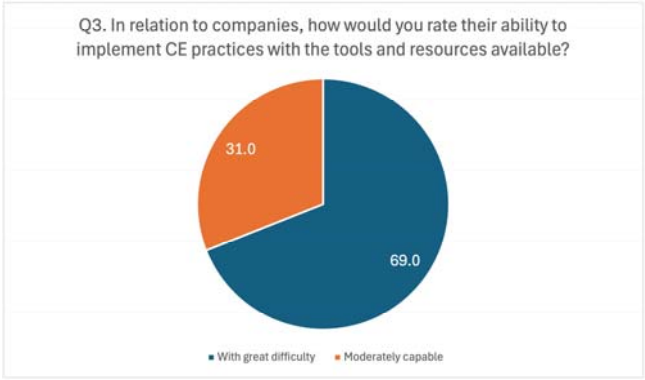
Section	Questions (Q)	Theme
Section 1	Q1: Major limitation of CE in its application	Limitations
	Q2: Most frequent or relevant critique toward CE	Critiques

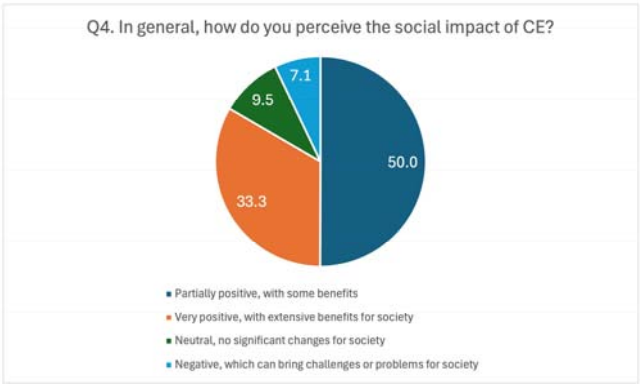
Table 2. *Cont.*

Section	Questions (Q)	Theme
Section 2	Q3: Businesses' capability to implement CE practices	Business Implementation
	Q4: General perception of the social impact of CE	Social Impact
	Q4.1: Importance of social aspects (job creation, education, etc.)	Social Aspects
	Q4.2: Elements for positive social impact in CE	Positive Social Impact
Section 3	Q5: Influence of policies and regulations	Policies and Regulations
	Q6: Essential elements for innovation and technology development	Innovation and Technology
	Q7: Aspects relevant for optimizing supply chains	Supply Chain Optimization
	Q8: Perception of consumer behavior toward CE	Consumer Behavior
	Q9: Rating of education focus on CE	Education Focus
Section 4	Q10: Prioritization of CE strategies	Strategy Prioritization
	Q11: Optimism for the future of CE	Future Outlook
	Q12: Comments, doubts, and opinions	Additional Insights









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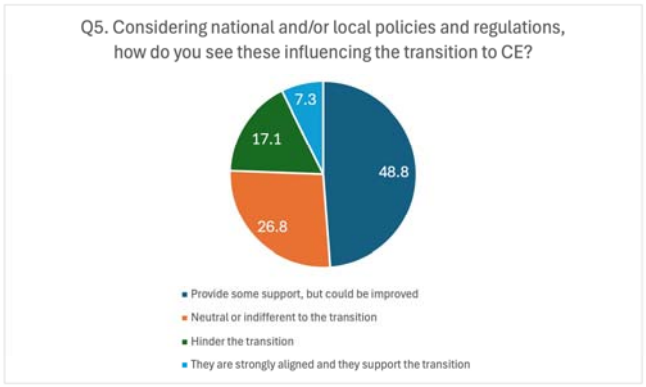

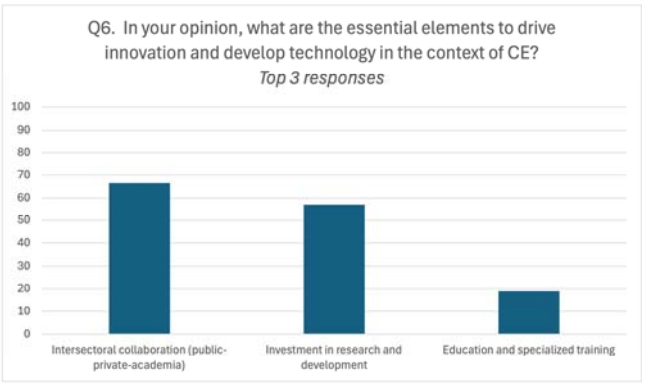

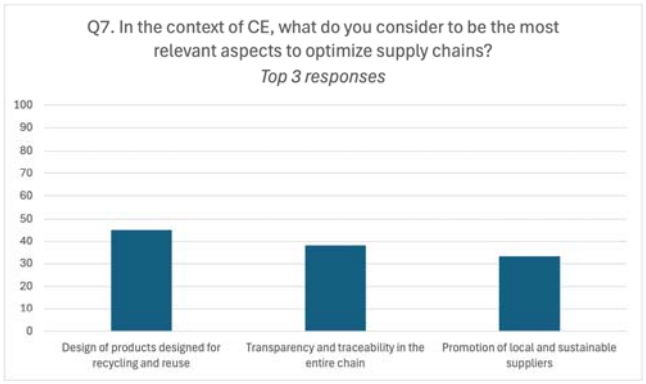

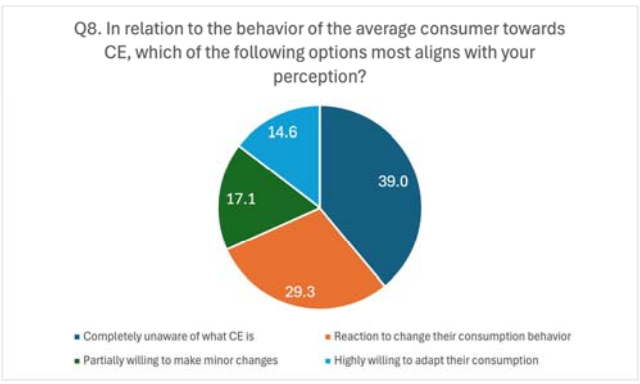

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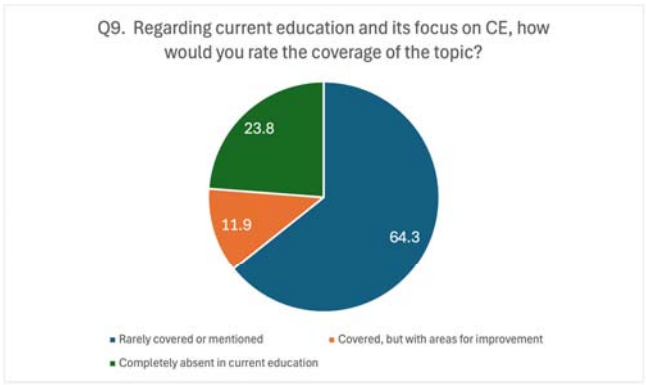

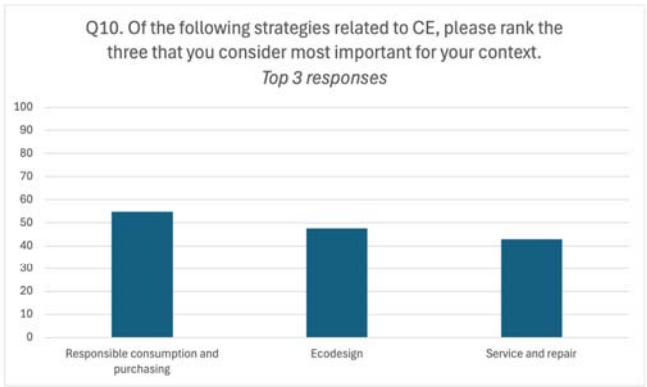

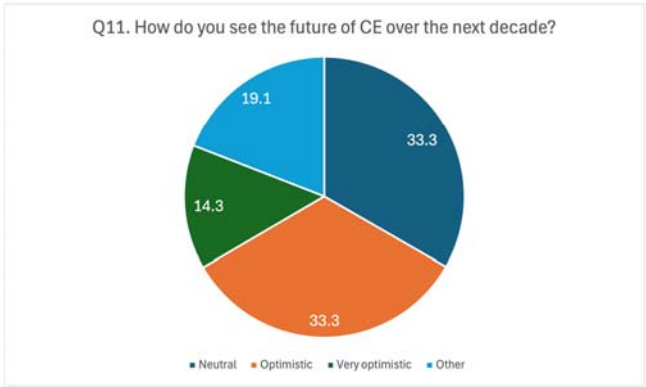

(**c**)

Figure 1. (**a**) Summary graph of the main answers obtained from the respondents (Q1–Q4). Note: Q4 is represented, only the primary question is shown, excluding its five detailed subsections as originally presented in Table 2. (**b**) Summary graph of the main answers obtained from the respondents (Q5–Q8). (**c**) Summary graph of the main answers obtained from the respondents (Q9–Q11).

The methodology adopted for this analysis involves categorizing the data into coherent themes that reflect the complexities and interconnectedness of CE issues, as described under the "Ecological Approach to Content Analysis" in our methodology section. By segmenting the responses into these thematic areas, we aim to highlight the unique yet interrelated challenges and opportunities within the Mexican CE landscape. This method enhances the clarity and precision of our analysis and is instrumental in formulating targeted recommendations. These recommendations are designed to advance the CE framework effectively, tailored to the needs and contexts of Mexican stakeholders and policymakers.

This analytical strategy not only aligns with academic rigor but also ensures that our conclusions are deeply rooted in the practical realities and theoretical frameworks recognized in the field. By leveraging this approach, we provide a detailed and actionable overview of the state of CE in Mexico, facilitating strategic interventions and policy formulations that are both relevant and impactful.

3.2.1. Foundational Challenges and Critiques

Despite its increasing popularity, CE still has several limitations and critiques that must be addressed in order to promote a successful transition. In the literature, a review by Bressanelli et al. [49] noted that "circular economy challenges are quite distributed among the different lifecycle phases and supply chain actors" (p. 7416), meaning a systemic and holistic approach is needed when planning for CE transition.

In that sense, we presented five main challenges to the 42 respondents with regard to the practical application of CE, namely the Lack of adequate technology, the Lack of education and awareness, Economic or investment barriers, Inadequate regulations, Narrow vision of the problems, or All of the above.

The challenges of Economic or investment barriers and the Lack of education and awareness were both chosen the most at rates of 33.3% each. The former illustrates the financial barriers to making the transition from a linear economy to a circular one. Since materials and waste are reused, this can theoretically save costs for companies in the long term. However, the proper technology to transition can often be expensive and represent significant upfront investments, causing reluctance in investors. Plus, when positioned in the regular market, CE products must compete with those issued from a linear economy, which can trigger economic barriers due to price differences. For the latter challenge, the lack of education and awareness can be found in all sectors of society, from consumers to producers. Since CE requires the participation of all actors in order to be successful, there is a need for an integral approach to create both consumer demand for CE goods and services, as well as the producer's capacity to deliver them.

To a lesser extent, Inadequate regulations were chosen at a rate of 21.4%. In fact, one of the respondents explained that regulations must be accompanied by environmental and social Life Cycle Assessment (LCA) studies that help identify actual areas of need. This was followed by the Lack of adequate technology at 7.1%, meaning there is a perception that the technology needed to achieve the transition already exists. As highlighted before, the financial access to said technology is one of the main constraints perceived. Finally, the Narrow vision of the problems was the least popular option, chosen by one person only, meaning there is an awareness of the scope of the challenges for CE.

As noted by the respondents, these challenges pose limitations to the practical application of CE, preventing a successful transition. In fact, during the last decade, numerous critiques of CE have been formulated, sparking debate among numerous stakeholders. In the Mexican context, when asked what they thought was the most frequent or relevant criticism of CE, nearly half of the respondents (45.2%) in our study indicated that It is a difficult theoretical model to implement. This answer was followed by Does not sufficiently consider the social impact at 26.2%, which can be related to the concept of sustainability and its environmental, economic, and social pillars. It is common to see a focus on the first two components, sometimes even only on the first one, meaning the social aspect

ends up being neglected. Finally, the answer May slow economic growth was chosen to a lesser extent at 16.7%, indicating that CE is mainly not perceived as so by the respondents. This opens the conversation to what growth means for Mexican stakeholders, maybe even representing an opportunity for holistic growth since it seems to be interpreted with its social and environmental pillars.

3.2.2. Implementation and Social Impact

Increasingly, companies are taking the leap to transition toward CE and need insight regarding their implementation capacity. In the Mexican context, to the question In relation to companies, how would you rate their ability to implement CE practices with the tools and resources available?, over half of the respondents (69%) answered With great difficulties and a third (31%) answered Moderately capable. This can be related to the numerous limitations identified earlier, fostering the need for concrete solutions and echoing Velasco-Muñoz et al. [50], who focus on the agricultural sector and also insist on the need for practical theoretical models. Some examples can be found in the literature, such as Barreiro-Gen and Lozano [51] who recommend the "4Rs" model as a way to analyze concrete CE principles, which stands for "Reduction, repairing, remanufacturing and recycling".

Next, to the question, In general, how do you perceive the social impact of CE?, half of the respondents chose Partially positive, with some benefits. A third chose Very positive, with extensive benefits for society, followed by 9.5% by Neutral, no significant changes for the society, and finally Negative, which can bring challenges or problems for society at 7.1%. Concerning the latter, scholars such as Corvellec et al. [52] argue that CE is "based on an ideological agenda dominated by technical and economic accounts, which brings uncertain contributions to sustainability and depoliticizes sustainable growth" (p. 421). Therefore, even though the vast majority of the respondents have positive perceptions of CE's social impacts, these results show that there is still reluctance from some actors when it comes to CE's outcomes for society.

Plus, to the question In your opinion, what elements must be considered for CE to have a positive social impact?, the most popular element was Adaptation to local needs at a rate of 66.7%. That was followed by Education and awareness in communities at 42.9% and Incentives and government support for the transition at 38.1%. Finally, elements such as Inclusion and equity in participation and Access to technologies and knowledge for all social strata were chosen at 31% each. The popularity of most answers, when compared to previous questions, shows that it is important to address social impact through different strategies. For instance, it is not enough to just adapt to local needs. One must also seek education and awareness in communities and so forth.

In that sense, when asked to rate the most important topics related to the social aspects of CE, the feature of Social commitment was mostly considered Very important at 52.4%. The rest of the respondents had mitigated answers ranging from Fairly important, Important, Slightly important, and Not at all important. In terms of Social acceptance, results were similar, with the answer Very important dominating the panorama at 40.5%. These results show that companies must be committed to the transition fully from all three pillars of sustainability and that they cannot neglect social aspects in order to be successful. In that sense, Geissdoerfer et al. [5] warn that while CE can contribute to sustainability, it is not sustainability itself. Both concepts are often used interchangeably, but they are not the same, requiring caution from stakeholders.

With regard to the feature of Job creation when asked to rate the most important topics related to the social aspects of CE, respondents had mitigated answers. For instance, 28.6% thought it was Very important, 35.7% thought it was Fairly important, 23.8% thought it was Important, and the remaining thought it was either Slightly important or Not at all important. Similarly, for the feature Training and education (for employees), answers were mitigated. These insights tell us that the respondents do not necessarily see the social aspects of CE trickling down to employees or benefitting them.

Finally, Lieder and Rashid [53] explain that the implementation of CE in companies can either be top-down or bottom-up. This is strongly related to the social aspects previously mentioned, in which Social commitment and Social acceptance were mostly considered Very important. In that sense, even though the decision to transition to CE comes from a top-down approach, the bottom-up process is just as important. It could even be considered as part of the solution to the difficult implementation of CE in companies, since collective efforts and acceptance can make the process more resilient in the face of adversity.

3.2.3. Policy, Innovation, and Consumer Behavior

Policies and regulations are key to CE, as it entails government intervention in the topic. In their review of public policies from the period of 2017–2021 across the globe, De Melo et al. [54] highlight that, as opposed to Europe, Latin America has no official CE definition as a region, which can make project implementation difficult. Nonetheless, they note an increasing interest in CE with a focus on energy and carbon emissions. It is also worth noting that the Mexican government has defined CE for its own context [44], in which it recognizes its importance for sustainability.

From a global perspective, other regions have also implemented CE policies and regulations. In the Chinese context, Zhu et al. [55] explain that CE is characterized by a top-down approach led by the government, which adopted China's Circular Economy Promotion Law as early as 2008. Nonetheless, its policies often ignore sustainable consumption, which is a key component of CE, focusing instead on resource flows and production efficiency. In the European context, the European Union's Circular Economy Action Plan was published in 2015 and Calisto Friant et al. [56] assess that, despite boosting the recycling industry due to its technocentric approach, the Plan has done "little to seriously disrupt linear business-models and practices" (p. 350).

In that sense, when asked Considering national and/or local policies and regulations, how do you see these influencing the transition to CE? almost half of the respondents answered the following: They provide some support, but they could be improved. This is followed by 26.6% of people answering They are neutral or indifferent to the transition, 17.1% answering that They hinder the transition, and 7.3% answering that They are strongly aligned and they support the transition. Thus, these insights show us that government influence on the topic has been limited. CE could definitely benefit from more interest since there is a lack of it particularly in its social aspects.

Next, innovation and technological development are also key to CE, particularly for its environmental aspects that require new methods for managing waste. To the question In your opinion, what are the essential elements to drive innovation and develop technology in the context of CE?, the two most popular elements were Intersectoral collaboration (public-private-academia) at 66.7% and Investment in research and development at 57.1%. For the former, the need for collaboration brings us back again to the importance of CE's social aspects that require collaboration and acceptance. For the latter, examples of relevant topics for research and development can be found in the literature. Zeng et al. [57], for instance, raise the issue of how some recycling processes, such as mixing materials, can downgrade product quality. Singh et al. [58] also highlight the importance of innovation, explaining how automated cloud-based platforms can facilitate stakeholder engagement using insights from theoretical models. This resonates with previous findings of this study that call for concrete solutions through theoretical data. Plus, when asked to rate the most important topics related to the social aspects of CE, the feature of Innovation came out as Very important with 57.1% of respondents. One of them even highlighted that sharing success stories in the Latin American context as well as new visions could be a significant way to inspire stakeholders to transition to CE. In contrast, only 2.4% of respondents thought it was Not at all important.

Now, in terms of supply chain optimization, some authors have developed CE frameworks for it, such as Baratsas et al. [59] for the food industry or Karayılan et al. [60] for plastics. Thus, to the question In the context of CE, what do you consider to be the most

relevant aspects to optimize supply chains?, the most popular answer at 45.2% was the Design of products designed for recycling and reuse. The circular aspect of this answer is interesting, considering that "the reduction of waste is the main aim both from a business and scientific point of view" (p. 13) [61] in order to save costs and be environmentally sustainable. The rest of the answers were mitigated. For instance, the least popular answer at 11.9% was Integration of digital technologies (such as IoT, blockchain). This suggests that the concept of digital technology is not necessarily related to Innovation, which was a feature previously addressed and perceived as Very important by respondents. Other forms of innovation could therefore be relevant, such as the Design of products designed for recycling and reuse signaled by most. Nonetheless, Del Giudice et al. [62] study the implications of linking CE supply chain practices and big data, noting that "managers who can exploit big data better than their competitors can expect their firms to achieve better performance" (p. 349). Therefore, Mexican stakeholders should probably consider this feature to optimize their supply chains.

Finally, consumers are crucial for the success of CE. They are the ones purchasing the final products and services, guaranteeing the economic sustainability of the company. In fact, Bressanelli et al. [49] explain that one of the key limitations in that area is the user's willingness to pay in traditional transaction-based models, which should be one of the primary inquiries of companies looking to transition to CE. When asked In relation to the behavior of the average consumer towards CE, which of the following options most aligns with your perception?, 39% of respondents answered that they are Completely unaware of what CE is, followed by 29.3% answering Reaction to change their consumption behavior. As little as 17.1% thought they were Partially willing to make minor changes and only 14.6% thought they were Highly willing to adapt their consumption. These perceptions are relevant since consumption behavior is the way in which people, communities, or industries adjust and modify their consumption patterns to align with CE and sustainability principles. To the question Regarding current education and its focus on CE, how would you rate the coverage of the topic?, the majority of respondents thought it was Rarely covered or mentioned, i.e., 64.3%. No one thought it was Widely covered and well taught. These results demonstrate that respondents mostly perceive a lack of awareness from consumers, while also acknowledging that there is more to it. For instance, the work of Cantú et al. [63] in Mexico addresses these complexities, noting a lack of financial inclusion that simply prevents consumers from purchasing CE goods or services.

Nonetheless, as explained by Guerra-Rodríguez et al. [64], "the consumption model of modern society is the first step toward avoiding the exertion of pressure over natural resources, and this change can be applied in all of the industrial activities" (p. 38). Arruda et al. [65] even identified CE as the sustainability concept with "the greatest probability of favorable economic development" (p. 86). CE is thus an inspiring path to promote change, which raises the question of how consumers can be socially and financially included to access the final products and services offered by CE companies.

3.2.4. Future Outlook and Additional Insights

Considering the extent of CE's limitations, it is important to discuss different strategies from a holistic viewpoint in order to avoid a one-size-fits-all approach. To the question Of the following strategies related to CE, please rank the three that you consider most important for your context, the three most popular strategies were Responsible consumption and purchasing, Ecodesign, and Service and repair. The first option is directly related to the consumer education mentioned earlier. The least popular options were Renting and Donation and reselling, which is logical, since CE wants to integrate waste in its own circular chain in order to generate profit from it and not donate it away. This suggests a certain distance from charities, for instance, community thrift stores in the clothing industry, which are often presented as a solution to manage waste.

To delve deeper into the topic, respondents also shared different strategies tailored to the Mexican context. One of them suggested the use of LCA as a relevant method

to analyze different areas for improvements, which has also been reported by Santagata et al. [61] as a method to identify hotspots in supply chains. Another concrete example of LCA application is Nasir et al. [66], who identify CE as a way of reducing carbon emissions. This respondent also suggested starting the CE transition with voluntary participation coupled with incentives for sustainability processes and services. Another one mentioned the RISEC as an important way to bring academia and the government together, creating a relevant tool to reduce the climate-economic-social crisis currently unfolding. Three other respondents then mentioned companies more directly, explaining the need for greater dissemination in the government and business areas, as well as clear directives as to how adequate mechanisms to promote the participation of all stakeholders can be implemented. Concerning this last point, it was noted that public policies are what really alienate companies from perspectives such as CE. However, it is not enough to address companies only, since another respondent insisted on the importance of environmental education strategies for sustainability and research programs at different levels. Finally, another respondent highlighted that CE must be implemented both in small and large companies, not only medium-sized ones, in order to involve multiple types of industries in the transition.

Before moving on to the future of CE, it is interesting to highlight the distinct viewpoint of one more respondent. Since CE emerges from the current mode of production, this person considers that extractivism will continue to exist if the operation criteria of CE are not clearly delimited, as well as which sectors it is applicable to. Therefore, there is a risk of CE reproducing some current unsustainable features of the linear economy, which could hinder the sustainable development it seeks to achieve.

Now, when asked about the future of CE in the next decade, the majority of respondents felt Neutral or Optimistic. No one felt Very pessimistic. Nonetheless, one respondent highlighted that the change will require a lot of environmental education to raise awareness among consumers and demand that companies rely on CE for mutual benefit. Another mentioned that great efforts are still required to promote an education that can generate positive global changes within ten years. In that sense, Lieder and Rashid [53] warn that the "prioritization of either environmental or economic benefits at the expense of each other must be avoided" (p. 48), especially when considering that environmental resources are finite, but this study also reaffirms the need to address the social aspects of CE that are often neglected.

4. Materias and Methods

The methodology of this study involves a thorough examination of social perceptions regarding CE in Mexico, utilizing a mixed-methods approach that integrates quantitative survey data with qualitative insights from interviews and focus groups. This approach is justified by the necessity to encompass a diverse range of perspectives from various stakeholders, including individuals, businesses, governmental bodies, and participants of the RISEC. Prior to this methodology, the study sets the foundational context and identifies existing gaps in research concerning social dimensions of CE adoption in Mexico through a comprehensive literature review, detailed in the Section 2 following the introduction.

4.1. Questionnaire Design

Based on the insights gained from the literature review, we developed structured questionnaires aimed at gathering quantitative data on the awareness, attitudes, and perceptions surrounding CE among diverse stakeholders in Mexico. Informed by the literature review's emphasis on implementation challenges, the importance of sustainable supply chain management, the need for deeper consumer engagement, and the integration of social sustainability into CE practices, our questionnaires were meticulously designed to probe these areas comprehensively.

Based on the identified themes, we developed a structured questionnaire comprising 12 questions to collect both quantitative and qualitative data. This design enabled a com-

prehensive analysis of respondents' awareness, attitudes, and perceptions. The questions, which encompassed multiple-choice and open-ended formats, covered key aspects such as the practical limitations of CE implementation, critiques of the model, the capacity of businesses to implement circular practices, and the perceived social impact of these practices. Each question was tailored to elucidate specific elements of circular economy adoption, ensuring that responses could be effectively analyzed to reveal underlying trends and insights. This approach ensured that we comprehensively addressed the research questions, capturing a holistic view of the circular economy's impact across different social and economic sectors.

The survey was divided into four main sections:

- Section 1: Foundational Challenges and Critiques delves into the core obstacles and common criticisms of CE. By identifying these primary limitations and critiques, this section sets the stage for understanding the broader context in which CE operates and the perception challenges it faces;
- Section 2: Implementation and Social Impact shifts focus toward the practical application of CE principles within businesses and their societal ramifications. It explores the capacity of companies to transition to circular practices and assesses the social implications of such a shift, emphasizing the importance of education, job creation, and community engagement in fostering a positive societal impact;
- Section 3: Policy, Innovation, and Consumer Behavior examines the role of governmental policies and the necessity for innovation in facilitating CE's growth. Furthermore, it gauges consumer attitudes toward circular practices, highlighting the critical intersection between public perception and the successful implementation of CE strategies;
- Section 4: Future Outlook and Additional Insights looks forward, soliciting opinions on CE's future within the next decade and inviting open-ended comments to capture a broader range of insights and personal reflections on the topic.

To ensure a broad and representative engagement, the survey targeted 42 stakeholders, representing a cross-section of Mexico's socio-economic landscape, including academics, industry professionals, and government officials. This diverse participant base was carefully selected based on their demonstrated interest in or engagement with CE practices during the years 2022 and 2023, predominantly from key regional hubs across Mexico such as Nuevo Leon in the North, Mexico City and the State of Mexico in the Center, and Yucatan in the South.

This meticulous approach to questionnaire design and participant selection was crucial not only for gathering detailed and insightful feedback but also for ensuring that our study comprehensively addressed the unique challenges and opportunities of CE in Mexico. The complete questionnaires, including all response options, are detailed in the Supplementary Material for thorough review and validation. Table 2 presents the questions into thematic sections, offering a clear view of the survey's scope and focus areas

Prior to their broader distribution, the questionnaires underwent a pilot testing phase with a select group of participants. This preliminary step was crucial for ensuring the questions were clear, relevant, and effectively structured to elicit the necessary information.

4.2. Implementation and Distribution of Questionnaires

The implementation and distribution phase of the questionnaire was meticulously orchestrated to capture a comprehensive and diverse array of insights into CE. Rooted in an extensive preliminary literature review, the design of the questionnaire covered a broad range of critical issues—from implementation challenges to opportunities for innovation and social advancement. This preparation was crucial for gathering detailed and insightful feedback.

The participants for the study were selected based on their demonstrated interest in CE during events and forums held at UNAM in 2022 and 2023. More than 100 individuals were invited, achieving an 80% attendance rate, with 42 individuals completing the surveys. The respondents were diverse, coming from various regions across Mexico, including the

North (Nuevo Leon), Central (Mexico City and the State of Mexico), and Southern parts (Yucatan and Veracruz). This geographical distribution ensured a broad perspective of social perceptions toward CE within different socioeconomic contexts in Mexico.

The survey targeted stakeholders representing a diverse array of profiles: 60% were Ph.D. students, professors, and researchers, reflecting the substantial academic attendance; 25% were from industry, including roles such as sustainability coordinators (small and medium enterprises), environmental managers (medium enterprises), and consultants; and the remaining 15% were government coordinators and advisors from the Mexican Secretary of Environment. Personal information such as names and ages was not requested to maintain the anonymity of participants. The distribution of questionnaires was executed through multiple channels, ensuring broad engagement across these varied segments within the RISEC.

Online platforms, email communications, and direct engagement during two-day meetings facilitated extensive outreach. To foster an environment of openness and ensure the integrity of the collected data, participants were guaranteed anonymity and the strict confidentiality of their responses. This strategic approach was pivotal in encouraging candid and insightful contributions, laying a robust foundation for an in-depth exploration of CE's multifaceted landscape.

As a result, we collected 42 responses, offering a rich tapestry of perspectives that highlight both challenges and opportunities within CE. The depth and intricacy of these responses warranted an elaborate analytical process, the results of which are organized in a structured table available in the Supplementary Material. This compilation methodically presents the survey outcomes, correlating them with key themes identified during the literature review, such as economic barriers, the imperative for educational efforts, the impact of regulatory conditions, and the nuances of consumer engagement. The findings from these questionnaires are instrumental in providing a detailed and nuanced understanding of the prevailing state and prospective developments of CE in Mexico, as thoroughly documented in the full responses within the Supplementary Material.

4.3. Analysis and Interpretation of Questionnaires

Following the collection of questionnaire responses, we embarked on a comprehensive analysis to identify patterns, discrepancies, and thematic consistencies in the data. Our approach incorporated both statistical and ecological methods [67] to process the quantitative and qualitative data, respectively.

For the quantitative segments, we utilized basic statistical tools to assess awareness levels, attitudes, and perceptions of the CE among diverse stakeholder groups. This analysis helped us to measure engagement levels and pinpoint significant trends or gaps in understanding and support for CE initiatives.

The qualitative data underwent a thorough content analysis, categorizing responses into themes that reflect the core barriers, opportunities, and challenges perceived by participants within Mexico's CE landscape. We analyzed each question within these thematic areas, further enhancing our insights by comparing them with the existing literature and external references. This method not only anchored our findings within the broader discourse on CE but also deepened the validation of our conclusions, illustrating the dynamic and ongoing interaction of individuals with their environmental contexts. This ecological approach emphasizes the active role of perceivers in exploring and understanding environmental potentials, providing a rich context for interpreting the data collected.

By synthesizing the outcomes from both quantitative and qualitative analyses, we crafted a comprehensive portrait of societal views on CE. Grouping each question into thematic areas and contrasting them with the literature before drawing final interpretations not only aligned with academic rigor but also ensured that our analysis was rooted in a well-balanced consideration of both statistical evidence and narrative depth.

5. Conclusions

This research systematically explored the complexities of transitioning toward a sustainable economic model through the lens of CE within the context of Mexico. Drawing from a comprehensive literature review and the analysis of responses from 42 stakeholders, we identified several critical insights and implications for future research and policymaking.

For instance, respondents highlighted significant hurdles that constitute barriers to implementation, such as economic and investment barriers, lack of education and awareness, and inadequate regulations. These obstacles underscore the need for integrated approaches that address both technological and socio-economic factors in the implementation of CE practices. In terms of social impact and perception, there is a strong indication that the social impact of CE is perceived as predominantly positive, yet there are critical voices that point to the potential social challenges and the need for more inclusive strategies that consider local needs and equity in participation. Then, for policy and regulation, the findings suggest that existing ones provide some support for the transition to CE but are often seen as inadequate. This calls for more robust and aligned policies that not only promote but also facilitate broader adoption of circular practices.

Additionally, this study revealed significant observations in terms of future outlooks and strategic recommendations. Optimism about the future of CE is prevalent among stakeholders, though it is tempered by the recognition of the substantial challenges ahead. The need for educational programs to raise awareness and the development of more sustainable business models are recurrent themes. This process of integration led to an enriched understanding that guided the formulation of strategic recommendations aimed at overcoming obstacles and capitalizing on opportunities for the broader adoption of CE in Mexico.

Based on these key findings, we provide the following recommendations for future research and policy actions. To promote enhanced focus on education and awareness, future initiatives should prioritize educational programs that target all levels of society to increase understanding and support for CE. These programs should aim to shift cultural attitudes and foster a more profound public engagement with CE principles. In terms of the development of inclusive and supportive policies, policymakers should consider creating more comprehensive and supportive frameworks that facilitate the transition to CE. This includes incentives for businesses to adopt circular practices and regulations that ensure these practices are both environmentally sustainable and socially equitable. Plus, for further encouragement of intersectoral collaboration, we note that strengthening the collaboration between academia, industry, and government can lead to more innovative solutions and the effective scaling of CE practices. Such partnerships are crucial for pooling resources, sharing knowledge, and driving systemic change.

Furthermore, the systematic integration of CE in urban planning is recommended, given the unique challenges faced by Mexico City. There is a critical need to integrate CE principles into urban development and planning, which can help address specific issues like waste management, pollution, and urban sprawl more effectively. In that sense, adaptive policy frameworks are needed, in which policies should be responsive to the changing dynamics within the economic, environmental, and social landscapes. This flexibility will be crucial in accommodating new insights and innovations that may emerge from ongoing research and practice. To analyze these features, we finally recommend longitudinal studies, since long-term studies could provide deeper insights into the impacts of CE over time, helping to trace the evolution of practices and policies and their effects on economic resilience and sustainability.

To conclude, our findings provide valuable insights for stakeholders to successfully transition to CE in Mexico. We assert that CE can be part of the solution to address sustainability challenges in the region, positioning itself as a relevant tool to promote change. However, it is important to recognize the limitations inherent in our study, such as the inability to perform segmented analyses due to a lack of detailed demographic and professional data on participants. This acknowledgment not only underscores the challenges

in conducting comprehensive social research within this domain but also highlights areas for future studies to collect more detailed data, enabling more targeted analysis and contributing significantly to the discourse on CE in diverse socio-economic contexts.

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