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Walking the circular talk: Analyzing the soft and hard aspects of circular economy implementation of ten business cases within the textile and apparel value chain

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ABSTRACT

Companies in the textile and apparel value chain (TAVC) have been increasingly implementing Circular Economy (CE) practices to accomplish sustainable development. However, CE implementation focuses on the techno-environmental dimension, commonly associated with the "hard side" of businesses. Conversely, the social dimension, referred to as the "soft side" of business (e.g., workers impacts and corporate culture) has received less attention, even though the notion of a just CE transition is considered critical for the sector. There is a lack of empirical knowledge about how businesses in the TAVC simultaneously manage soft and hard aspects of Circularity and what kind of socio-environmental impact they generate.

This lack of comprehensive systemic vision creates blind spots, generating unintentional tradeoffs between social and environmental objectives.

Using a mixed method approach that borrows insights from Organizational Management and Systems thinking, this research analyzed both soft and hard aspects of ten circular business cases from three countries. The analysis resulted in a systemic socio-environmental baseline showcasing good practices that could be optimized in terms of material flows, critical social hotspots (e.g., earnings, workers well-being and collective bargain) and system-change conditions for both soft and hard aspects of CE implementation.

This research demonstrates that soft and hard aspects of CE are integral components of a comprehensive transformative CE transition framework that facilitates the adoption of more inclusive-circular practices while improving sustainability performance.

1. Introduction

The textile and apparel value chain (TAVC) is a complex system involving small, medium, and large corporations spread across various geographies. Due to the rapid growth of fast fashion significant environmental and social concerns have been triggered (Niinimäki, 2018). From an environmental perspective, the TAVC contributes to 20% of global waste (Papamichael et al., 2023), with only 20% of textile waste collected for reuse and recycling (Papamichael et al., 2023), (Jacometti, 2019). Additionally, the excessive use of pesticides and chemicals deems the sector as a heavy polluter spanning from extraction to end-of-life (EOL) segments (Cai and Choi, 2020), (Niinimäki et al., 2020). From the social side, the sector is also labor-intensive (Linden, 2016), often marked by dubious working conditions, wherein women constitute over 75% of the workforce and are over-represented in the most vulnerable jobs (Linden, 2016), (Fletcher and Tham, 2014), (Ascoly, 2009).

In recent years, according to studies such as (Todeschini et al., 2017), (Borms et al., 2023), (Henry et al., 2020), businesses in the sector have embraced the concept of circular economy ("CE") to mitigate sustainability challenges (Kirchherr et al., 2017). However, the predominant focus within CE has been on the techno-environmental dimension, commonly associated in organizational management studies with the "hard side" of businesses, which, according to (Goyal et al., 2018), (Abdelmeguid et al., 2022), involves optimizing the utility and value of components and materials, closing material loops to reduce waste, and minimizing the extraction and processing of virgin resources (Lenka et al., 2010).

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Abbreviations

TAVC	Textile and Apparel Value chain
CE	Circular Economy
JCET	Just Circular Economy transition
CS	Circular Strategies
VC	Value Chain
SME	Small and Medium Enterprises
QOJ	Quality of Jobs
GEI	Gender Equality & Inclusion
EOL	End-of-life
OCM	Organizational Change Management
OCCE	Organizational Change for Circular Economy
HR	Human Resources
SIAF-CE♀♂	Social Impact Assessment Framework for Circularity
MFA	Material Flow Analysis
LCA	Life cycle assessment
EPR	Extended Producer Responsibility
♀	Female worker
♂	Male worker

Authors such as (Geissdoerfer et al., 2017), (Hobson and Lynch, 2016), (Padilla-Rivera et al., 2021) have highlighted the lack of attention to the social dimension of CE, although the concept of a just CE transition is increasingly recognized as a critical consideration for the sector (Schröder et al., 2020), (Sharpe and Martinez-Fernandez, 2021). A Just Circular Economy transition (JCET) emphasizes ensuring good quality employment, robust social protection systems, and poverty reduction while carbon emissions are minimized, and the ecosystem restored (Swilling, 2019), (Sharpe et al., 2022). Current JCET studies refer mainly to the policy side; however, at the business level, JCET approaches are still underdeveloped but deemed relevant to avoid trade-offs between social and environmental impacts. For instance, (Bertassini et al., 2021), (Yang et al., 2021) have highlighted the importance of including factors such as quality of jobs, workers well-being and gender equality and inclusion (Suarez-Visbal et al., 2022a). While (Muster and Schrader, 2011), (Chiappetta Jabbour et al., 2019), refer to a broader definition of the "soft side of business" that includes social considerations related to human resources practices and corporate culture.

Additionally, studies such as (Kirchherr et al., 2018), (Padilla-Rivera et al., 2020), (Ghisellini et al., 2016) emphasize the importance of an orchestrated transformation in companies' organizational structure, operational processes, and product offerings. However, there is still a lack of empirical knowledge about how businesses' internal organizational systems are aligned to CE and how they currently assess their circular activities' environmental and social impacts. This knowledge gap is crucial, as empirical insights can pave the way for establishing a coherent socio-environmental baseline and thus avoid unintentional trade-offs between sustainability objectives. Additionally, as expressed by (Dachs et al., 2019), (Strange and Zucchella, 2017) given the global span of the TAVC, identifying social and material-related hotspots across different geographies is imperative (Mishra et al., 2021), (Moktadir et al., 2020). A holistic approach is essential for economically viable outcomes that benefit people and the environment.

Therefore, we formulate the following research question:

How do TAVC companies applying circular strategies in different geographical locations manage social and environmental considerations?

By gaining in-depth qualitative insight of business cases, this research aims to.

i) Understand from a system perspective how TAVC businesses handle hard and soft aspects when implementing circular strategies.
ii) Establish a socio-environmental impact baseline from which improvements can be developed.
iii) Identify the challenges and opportunities of inclusive circular process when considering different geographies.

The paper is organized as follows: Section 2 covers the theoretical background on CE and organizational change management. Section 3 describes the methods adopted. Section 4 presents the results from ten business cases. Section 5 addresses discussion, limitations, and potential directions for future research, followed by conclusions in Section 6.

2. Theory

2.1. Circular economy at the firm level in the TAVC

CE has been defined as an alternative to the take-make-waste concept (Homrich et al., 2018). At the firm level, CE central idea is to close resource loops and optimize resource utilization by designing materials, products and business model that minimize waste (Kirchherr et al., 2017), (Macarthur, 2013). CE accomplishes this by replacing the end-of-life concept with different circular strategies (CS) (Kirchherr et al., 2017). These CS are grouped and categorized in a waste hierarchy called the R-framework (Achterberg et al., 2016), (Urbinati et al., 2017). There are several R-frameworks in literature ranging from 3 Rs (Blomsma and Brennan, 2017), (Sihvonen and Ritola, 2015) to 10 Rs (Reike et al., 2018). In the TAVC most relevant CS are Rethink, Redesign-Reduce, Rental, Resale, Repair, Remanufacture, and Recycle, described in Table 1 (Suarez-Visbal et al., 2022a), (Jung and Jin, 2016), (Guldmann, 2016), (Accenture, 2019).

The transition from a linear economy to a CE, require organizations to re-think and restructure their business model, and their organizational configuration, which encompass both internal and external transformation (Hofmann and Jaeger-Erben, 2020).

2.2. Circular economy, organizational change management and systems-thinking

CE is considered a systemic shift towards sustainable development at the organizational level. Organizational change management (OCM) is a field of study concerned with internal organization changes and their triggers (Association of Change Management Professionals), (Todnem, 2005). A recent stream Of OCM called the OCCE (Organizational Change for CE) (Graessler et al., 2024) has emerged to guide the organizational transition to CE planning. OCCE entails multidimensional, holistic, and systemic change that requires fundamental shifts in every aspect of the organization (Eikelenboom and de Jong, 2022), (Zollo et al., 2013). It concerns planned 'deliberate activities that move an organization from its present state to a desired CE future state' (Stouten et al., 2018). According to (Graessler et al., 2024) OCCE studies analyze change from several perspectives, such as changes from the hard or technical perspective (e.g., products, services, and business models), soft-human related perspective (e.g., behaviors, culture, and mindsets), and organizational changes (e.g., structures, strategies, and capabilities).

2.2.1. The hard aspects of CE at the business level

From the hard aspect perspective, OCCE studies are concerned with technical and quantitative attributes, including systems, tools, technology, and policies (Abdelmeguid et al., 2022), (Lenka et al., 2010). External barriers related to hard aspects of CE have been extensively documented. These include regulatory barriers and a lack of financial incentives to support the CE transition (Pheifer), (Vermunt et al., 2019). They also include market issues related to the viability of circular business models due to raw and secondary material scarcity (de Jesus

Table 1
Most common Circular Strategies in the TAVC.

Circular Strategy		Definition	Place in Value chain				
			Design	Manufacturing	Distribution	Use	End-of-life
R1	Re-design	Products designed to extend their by using durable materials so that they can be returned to the circular process. *	•	•			
R2	Reduce	Minimize material use, making efficient use of resources to reduce environmental impact. *	•	•			
R3	Rental	Payment of a fee or rental to wear a luxury or designer garment. *			•	•	
R4	Resale	A strategy to extend the useful life of a product by selling it on both online and physical second-hand sites. **			•	•	
R5	Repair	A strategy that seeks to extend the useful life of the product by repairing it at specialized sites or by third parties. **			•	•	
R6	Re manufacture	Use of parts of a discarded product for the creation of a new one. Also known as Upcycling fashion, it creates garments with materials recovered from post-industrial or post-consumer waste whose quality is equal or superior to a new garment. ***		•	•	•	
R7	Recycle	Includes the entire process from collection, sorting, and recycling, which can be mechanical or chemical, the latter being linked to the recovery of resources or circular supplies. **					•

*Source: (** (European Commission, 2022), * (Garcia-Saravia Ortiz-de-Montellano and van der Meer, 2022), **(Ellen MacArthur Foundation, 2017); ** (Guldmann, 2016); ** (Accenture, 2019); ** (Lacy et al., 2014), *** (Reike et al., 2018); *** (Dissanayake and Sinha, 2015))*

and Mendonça, 2018), lack of standardization of secondary materials, high investment costs, limited financial resources, and technological barriers (Guldmann and Huulgaard, 2020).

Although less explored, Internal aspects have also been studied. For example, studies such as (Goyal et al., 2018), (Jun and Xiang, 2011), (Van Berkel, 2010) explored the introduction of renewables, improvement of material intensity, and a high-efficiency rate of closing material loops by reducing the output of waste at different production stages. In contrast, others have explored implementing circular business models and designs (Rouvin et al., 2016).

As argued by several authors such as (Kirchherr et al., 2018), (Padilla-Rivera et al., 2020), (Stouten et al., 2018), (Prieto-Sandoval et al., 2021), (Wiesner et al., 2017), (Ghisellini et al., 2016), (Murray et al., 2017), CE transitions at the business level require social changes to address sustainable development holistically and to generate internal CE uptake by employees.

2.2.2. Soft aspects related to circularity and social considerations toward a transformative CE

Within the OCCE perspective, CE practices' soft aspect (or the social side) is subject to various interpretations. Some studies refer to internal aspects such as employees and human resources (HR) management practices (Muster and Schrader, 2011). Others like (Chiappetta Jabbour et al., 2019) refer to green HR initiatives[1] aiming to enhance sustainable manufacturing practices and to improve employees' work-life balance. Such initiatives include eco-design, CE skills, incentives, and health and safety programs (Chiappetta Jabbour et al., 2019). For others like (Stouten et al., 2018), (Bertassini et al., 2021), (Cameron and Quinn, 2011), (Sarja et al., 2021) soft aspects refer to corporate culture, values, and behaviors and their adaptation to organization's vision and mission (Wiesner et al., 2017). According to (Bertassini et al., 2021) related to circularity, critical components of a CE corporate culture include CE skills (enhanced through training); CE capabilities and competencies of the team.

Additional studies such as (Sharpe et al., 2022), (Glewwe, 2014), (Rubery, 2019) support the notion that alongside functional aspects such as tasks, responsibilities, and number of positions created, a more personalized focus on the well-being of workers, their families, and communities is essential. Acknowledging gender gaps in wages, growth opportunities, and promotion practices, and incorporating gender and inclusion considerations into human resource policies is paramount for rebalancing the social dimension of CE in the sector[2] (Ascoly, 2009), (Hale and Wills, 2008), (Fukunishi et al., 2013), (Prakash and Dr Paterok, 2021). These considerations are critical in the TAVC, given its pronounced feminization.[3] Furthermore, (Suarez-Visbal et al., 2024) present critical recommendations for TAVC companies to increase social impact and circularity in the sector,[4] by addressing both CE's soft and hard aspects.

Finally, other studies include in the soft aspects organizational changes related to corporate strategy, (Svensson and Funck, 2019) and organizational vision (Zollo et al., 2013), that require analyzing different organizational levels processes and structures (Zollo et al., 2013), (Scarpellini et al., 2020). However, according to (Graessler et al., 2024), OCCE research lacks attention on systems *and metrics* aspects to understand and assess the CE transition at the organization level. Furthermore, they also highlight a lack of research focusing on the sustainability impacts CE generates at the organizational level. Supporting this gap, other authors such as (Muster and Schrader, 2011), (Korhonen et al., 2018), (Kumar and Anbanandam, 2020), (Piecyk and Björklund, 2015) argue that both hard and soft aspects should be addressed simultaneously to avoid trade-offs.

This brings us to the usefulness of melding systems thinking with OCCE studies to analyze how companies address the socio-environmental considerations of their CE implementation. Combining OECE with systems thinking allows for a deeper understanding of the multiple organizational changes at different levels while shedding light on environmental and social dimensions.

2.3. Systems-thinking and CE at the organizational level

Systems thinking provides a holistic view emphasizing interconnectedness and interdependences of different organizational aspects that hinder or enable CE change. This perspective helps to understand how changes in one part of the organization can influence the entire system to achieve more sustainable outcomes.

[1] Green Human resources refer to human resources practices that support sustainability goals within the company (Chiappetta Jabbour et al., 2019).

[2] Gender transformative initiatives seek to redefine women's and men's gender roles and relations to create greater equality (Interagency Gender Working Group, 2012).

[3] A term used to signify that women are disproportionally present in the most precarious jobs (Suarez-Visbal et al., 2022a).

[4] According to (Suarez-Visbal et al., 2024), a transformative CE is socially bounded and systemic, aiming to reduce environmental impact while improving its social impact for workers and communities.

A systems-change model that serves this purpose is presented by (Kania et al., 2018). It identifies six conditions operating at three system levels that enable socio-economic and environmental change. The system levels are structural, relational, and transformational. The system-change conditions are.

i) Rules & Regulations (including internal policies and practices)
ii) Resources (including financial and non-financial ones)
iii) Roles (that enable and oversee the application of the policies, such as human resources managers, corporate social responsibility (CSR) agents, or operational managers)
iv) Relations (defined as the quality of connections and communication amongst existing roles)
v) Power Dynamics (the distribution of decision-making and authority, both formal and informal) (Wallace and York, 2020).
vi) Mental Models include behaviors, values, shared beliefs, and mindsets in the organization (Cameron and Quinn, 2011), (Sarja et al., 2021), (Alm and Jönsson, 2014).

Alignment and interconnected operation of these six conditions are crucial for the emergence of effective system change.

2.4. Theoretical framework

Fig. 1 illustrates our theoretical framework, where CE practices are examined from a OCCE lens considering hard and soft aspects at the business level, combining elements from (Bertassini et al., 2021), (Suarez-Visbal et al., 2022b), (Kania et al., 2018) discussed in 2.1 and 2.2. On the left side of the framework, *the soft-social aspects* include dimensions of workers' social impacts such as quality of jobs (QOJ), well-being, and gender equality and inclusion (GEI). These dimensions are based on the Social Impact Assessment Framework for Circularity (SIAF-CE♀) (Suarez-Visbal et al., 2022b). Soft aspects also include human resources management practices and organizational culture. On the right side, the *hard environmental aspects* involve technology, resources, and infrastructure which are essential for achieving efficiency in circular practices. Three material impact indicators are highlighted: the influx of new and secondary materials, their recirculation through internal or external value chain collaborations (utilizing open or closed loops), and waste reduction.

At the center of Fig. 1, we find critical conditions according to (Kania et al., 2018) to facilitate system-change. We argue that these conditions encompass both *soft* and *hard aspects* of the CE transition. System-change conditions at the structural level, include policies, internal regulations, procedures, and practices interconnected to both human resources and operational management. Roles, relations, and power dynamics are found at the relational level, while the transformational level (which refers to the corporate culture includes values, behaviors, and mental models prevailing in the organization. By employing this framework, we can establish a comprehensive socio-environmental baseline for companies implementing circular strategies.

3. Method

This mixed-method research analyzed ten circular business cases in three countries. It followed 5 steps as shown in Fig. 2. It collect and analyze both quantitative and qualitative data related to soft and hard aspects of organizational system and socio-environmental impacts.

3.1. Sample

A sample of ten companies was selected using a snowball referral method, encompassing diverse companies (in terms of number of employees, CS,maturity and geographical location). Selection included start-ups and established businesses operating in the Netherlands, Spain, and India. Also, the pool of companies had participated in previous studies on the social impact of circular strategies in the sector (Suarez-Visbal et al., 2024). The business cases were chosen to represent diverse conditions of circular companies along the TAVC.

A minimum of one company per CS and value chain (VC) segment was required to ensure a heterogeneous sample,[5] for the purpose of business case comparison. VC segment included Manufacturing, Distribution, and End-of-life. Three companies were based in the Netherlands, two in Spain, and five in India. These countries were selected because they play a relevant role in the TAVC regarding circular practices. Spain is a major supplier of recycled fibers, fabrics, and clothing to the rest of Europe (Caritas, 2021) p.18. India is the fifth largest exporter of sustainable and recycled textiles and apparel globally and an important textile recycling hub (BSR, 2021), (Kotamaraju et al., 2021). The Netherlands has several CE pioneering companies in the sector; it is close to becoming the second European country to have an extended producer responsibility (EPR) scheme for textiles and has a goal to have a 100% circular textile sector by 2050 (Kirchherr et al., 2018), (Bąkowska, 2023), (Government of Netherlands, 2016), (Van Rompaey, 2019).

In Fig. 3, each company is represented by a color-coded circle and a letter corresponding to the business case; (A-E for India, F-G for Spain, and H-K for The Netherlands.) The circle also indicates the size of the companies in terms of number of employees, the VC segment where they operate and the CS that they have implemented. The arrows represent the movement from one stage of the value chain to another. The reverse arrows indicate that the end-of-life segments are connected again with the manufacturing stage in circularity, bringing recycled content in.

3.2. Critical research steps

3.2.1. Step 1: qualitative data collection

Qualitative Data for social impacts and material flows was collected using i) semi-structured interviews with the CEO, CSR agent, and HR manager. The semi-structured interviews were based on the approach followed by (Suarez-Visbal et al., 2022b) same questionary and protocol were used. Details of the semi-structured interview guide and questions can be found in Annex 1. The covered topics included existing policies, programs, and perceptions of management around the quality of jobs, workers' well-being, and gender equality and inclusion, as well as current circular practices. A total of 20 semi-structured interviews were performed in person or via Microsoft Teams. They were confidential, anonymized, and lasted around 45 min. They were conducted in English, Spanish, Dutch, Hindi, and Arabic. They were recorded, translated to English when needed, using micro-soft teams' translation service and transcribed using otter.ai software. They were conducted from September 2022 to December 2022.

3.2.2. Step 2: quantitative data collection

Worker's data was collected through the *SIAF-CE♀* surveys developed by (Suarez-Visbal et al., 2022b), who had developed a framework that was operationalized, validated and tested with 60 businesses. Surveys comprise 90 questions (85 multiple-choice and five open-ended questions). From these 90 questions, 28 referred to socio-demographic factors, 27 to the Gender equality and inclusion (GEI)dimension, 19 to Well-being, and 16 to quality of job (QOJ). In total, 132 surveys were conducted. Surveys were personal, anonymized, and confidential. They took around 30–40 min to complete.

Material flow data was inspired on (Gao et al., 2021) approach and collected using a pre-set Excel spreadsheet (see Annex 2). It contained the material input (detailing product types, quantities, material purchase frequency) material output and waste generation for each company's top 3 best-selling products. The year (2022) was used as a reference year.

[5] A VC segment (VCS) is a defined value chain stage: extraction, manufacturing, distribution, or distribution end of life (EOL).

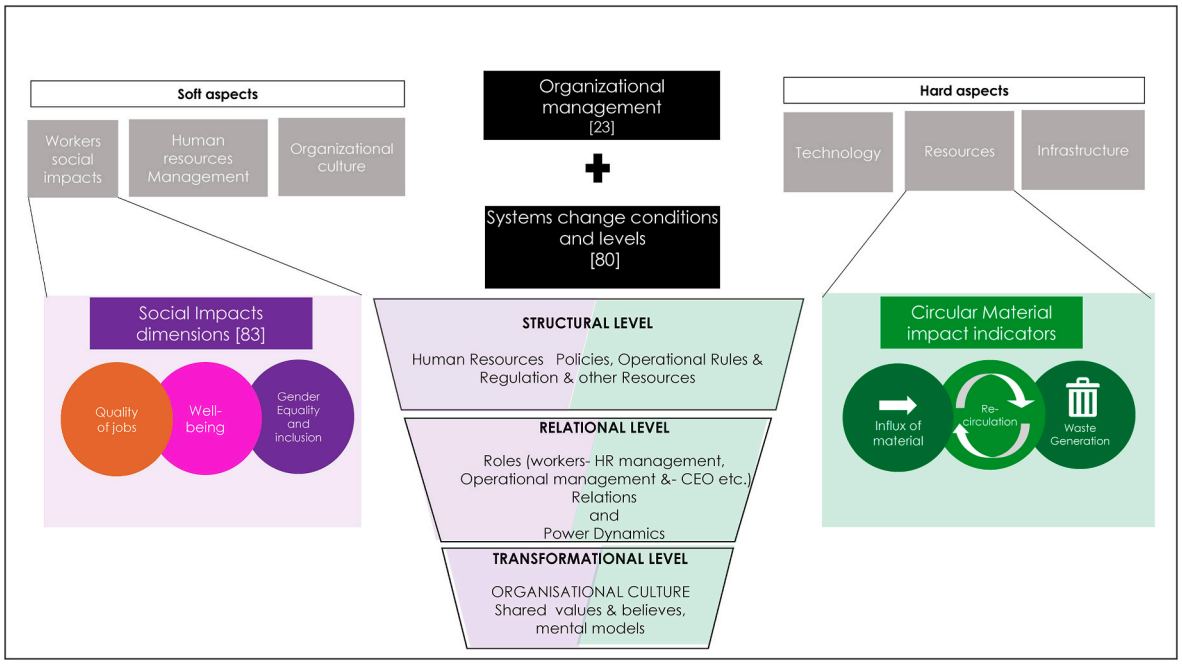


Fig. 1. *Theoretical framework illustrating soft and hard aspect of* CE at the business level analyzed from an organizational management systems-change approach (including social and material flow impacts). *Source: Own elaboration based on* (Bertassini et al., 2021), (Kania et al., 2018), (Suarez-Visbal et al., 2022b).

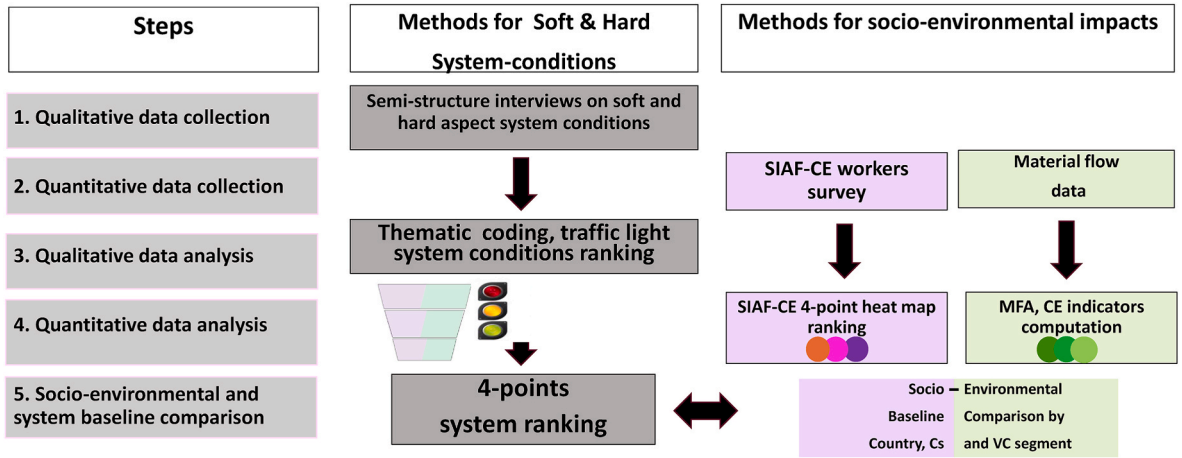


Fig. 2. Phases, data collection and analyzing methods.

3.2.3. Step 3: qualitative data analysis

Qualitative analysis followed a thematic coding and comparison. The semi-structured interviews were coded following the analytical framework explained in section 2.4. We identified system-change levels (structural, relational, transformational), the six system-change conditions present (rules, resources, roles, relations, power dynamics and mental models (corporate culture), and social impact dimensions as shown in Fig. 1. Coding was done manually by one researcher in an excel spreadsheet. When new concepts emerged that did not fall under the predetermined themes, new codes were created.

The system-level conditions were compared using a traffic light ranking. This method was privileged as it makes measure more intuitively understandable and indicate a relative performance (Thøgersen and Nielsen, 2016). In our traffic light red indicated lack of attributes related to system-change conditions and this is considered a challenge, yellow indicated that some attributes were in place (not a challenge but also not a priority), and green indicated that most attributes were in place, and it shows a good practice. in place, and it shows a good practice.

3.2.4. Step 4: quantitative data analysis

The quantitative data on soft aspects were analyzed following the SIAF-CE♀♂ methodology described by (Suarez-Visbal et al., 2022b). The data was incorporated into a Microsoft Excel database, categorizing responses by gender, roles, company, circular strategy by VC segment, and country. Responses based on sixteen composite indicators (annex 3) were aggregated per indicator (using a simple average) and then ranked on a 4-point color coded Likert scale as shown in Table 2.

The resulting numerical scale was used to illustrate and facilitate comparison. The ranking system assigned red shades to the most critical challenges (scores between 1.0 and 1.9), indicating high priority. Orange shades were assigned to significant challenges (scores between 2.0 and 2.6). Yellow shades indicated presence but not priority challenges (score between 2.7 and 3.3), while green shades indicated no significant risk, reflecting good practices (3.4 and 4.0). The survey's internal consistency was validated with Cronbach's alpha method shown as reliable.

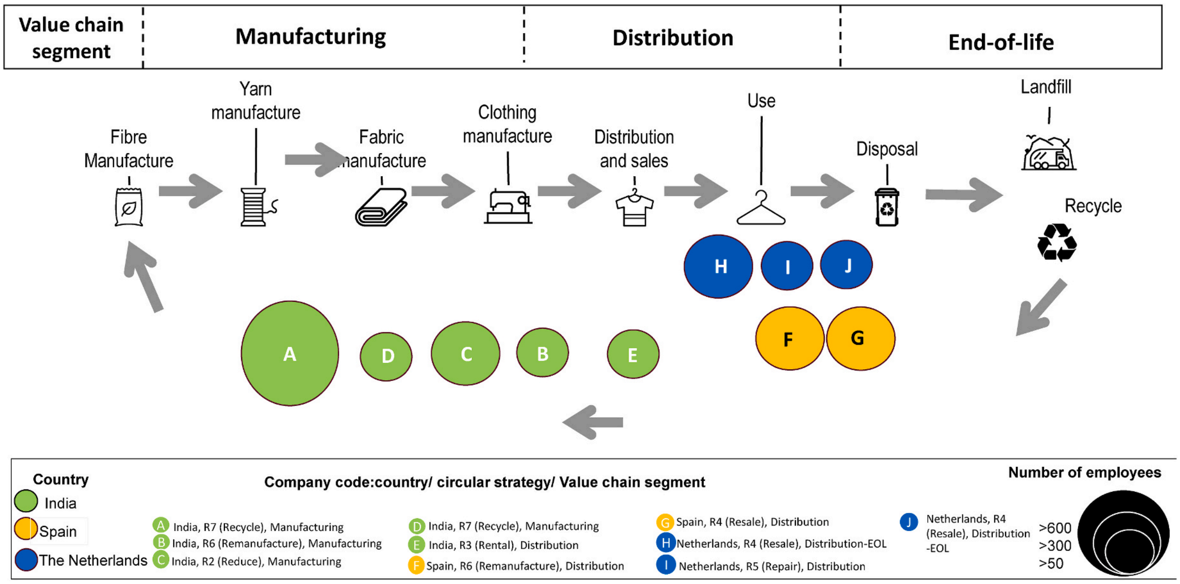


Fig. 3. The ten Business cases indicated with circles organized by size, country, circular strategy, and place on VC segment. *Source: Own elaboration.*

Table 2
Scale to rank soft and hard system conditions and the indicators of the SIAF-CE⚥ adapted.

<table>
<tr><td>4-Point Likert scale</td><td colspan="7">1</td><td colspan="7">2</td><td colspan="7">3</td><td colspan="7">4</td></tr>
<tr><td>Numerical scale</td><td>1</td><td>1,4</td><td>1,5</td><td>1,6</td><td>1,7</td><td>1,8</td><td>1,9</td><td>2,0</td><td>2,1</td><td>2,2</td><td>2,3</td><td>2,4</td><td>2,5</td><td>2,6</td><td>2,7</td><td>2,8</td><td>2,9</td><td>3,0</td><td>3,1</td><td>3,2</td><td>3,3</td><td>3,4</td><td>3,5</td><td>3,6</td><td>3,7</td><td>3,8</td><td>3,9</td><td>4</td></tr>
<tr><td>Ranking scale for Earning quality (SIAF-CE)</td><td>Below poverty line</td><td colspan="6">Between poverty line and minimum salary</td><td colspan="3">minimum wage</td><td colspan="4">Between minimum wage and living wage</td><td colspan="7">living wage</td><td colspan="7">Average median salary sector</td></tr>
<tr><td>Social Impact (SIAF-CE) Indicators</td><td colspan="7">Most critical challenge</td><td colspan="7">significant challenge</td><td colspan="7">challenge but no priority</td><td colspan="7">Good practice</td></tr>
</table>

For the hard aspect, a Material flow analysis (MFA) was used to quantify material flows in the selected companies. An MFA systematically accounts for the flows and stocks of materials within a given system (Brunner and Rechberger, 2004). It helps companies identify priority inefficiency areas, commonly called hotspots (Barthel et al., 2015), (Millette et al., 2019). MFAs were performed with the top three selling products per company (Müller et al., 2014). Additionally, based on (Moraga et al., 2019), three material impact indicators were calculated using the following formulas.

(i) $\textit{Use of reused material}\ (\%) = \frac{\textit{total use of secondhand material (in kg) in 2022}}{\textit{total material input (kg) in 2022}}.$

(ii) $\textit{Use of recycled material}\ (\%) = \frac{\textit{total use of recycled material (in kg) in 2022}}{\textit{total material input (kg) in 2022}}.$

(iii) $\textit{Waste generation}\ (\%) = \frac{\textit{total waste generated material (in kg) in 2022}}{\textit{total material input (kg) in 2022}}.$

Recirculation was not a formula per se but was estimated based on the number of times each product or material was recirculated on a close loop (same industry before being discarded). This information was validated during interviews.

Total textile waste means "materials deemed unusable for their original purpose by the owners" (Polajnar Horvat and Šrimpf Vendramin, 2021). *Reused material (or product)* means that the material is used for its intended purposes in its original form over multiple cycles (Ghisellini and Ulgiati, 2020), (Yawar and Kuula, 2021). Total *recycled materials* are fibers (or fabrics) derived from previously used or discarded textiles. These materials are processed and transformed into new textile products. A Sankey diagram was created for each company, showing the material hotspots of the selected product lines (Annex 4).

3.2.5. Step 5. socio-environmental and system baseline comparison

Merging the different outcomes of step 4, we compared the SIAF-CE⚥ results, MFAs, and three material impact indicators across different countries, Circular Strategies (CS), and Value Chain (VC) segments, as illustrated in Fig. 3. This comparison process involved identifying social and material hotspots, as well as analyzing commonalities and differences in organizational systems. By doing so, we established a socio-environmental baseline analysis, which simultaneously examined the socio-environmental systems of businesses and their corresponding socio-environmenal impacts. This baseline analysis allowed for a comprehensive comparison of businesses' socio-environmental performance across various dimensions.

4. Results

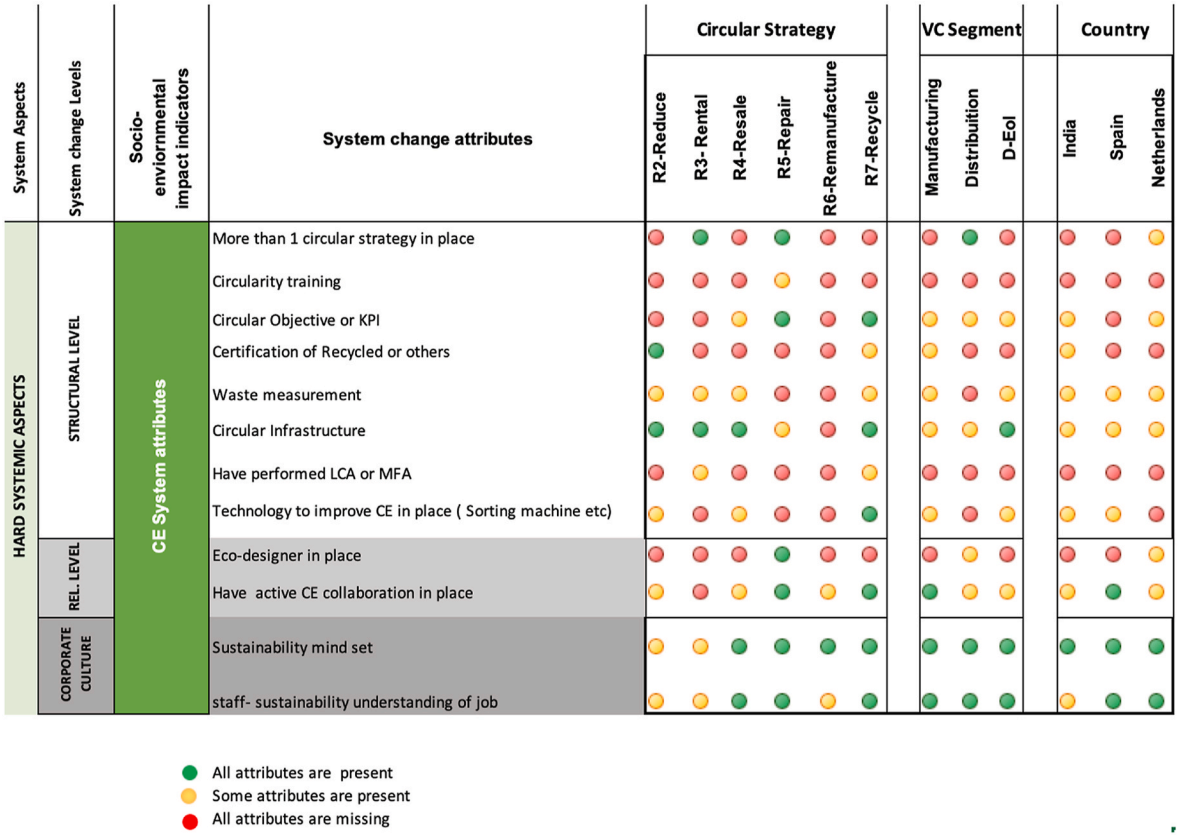
Results are presented by the hard and *soft system-change conditions* existing in the companies, followed by the respective environmental material and workers' social impacts as shown in the conceptual framework (Fig. 2). Lastly, the socio-environmental baseline is displayed.

4.1. Hard aspects

4.1.1. Organizational system

Table 3 illustrates the organizational system-change conditions related to *hard*-environmental aspects at the three system-change levels (structural, relational, and transformational). The table organizes the findings per CS, VC segment and country. The first (structural) level includes environmental policies, circular training programs, and circular indicators. At the relational level, the roles of eco-designers (i.e., designers with a circularity approach), CE managers and the internal or external relations were considered as indicators of network collaboration for circularity. At the transformational level, values, behaviors, and

Table 3
Circularity's hard system-aspects disaggregated by CS, VC segment and country. Source: Own elaboration.



corporate mental models related to sustainability or circularity were analyzed. Table 3 uses a color-code where a red shade is associated with the absence of an attribute, yellow presence of some attributes, and green presence of most or all attributes, as explained in section 3.1.3.

At the manufacturing segment most common CSs are Reduce, Remanufacturing, and Recycling. While half of the companies use more than one CS, only one CS is considered as the core monetary driver. This is relevant because other CS could be articulated within the business and value model and generate additional economic benefits.

No company provides circularity training, which is critical to ensure the adoption of circular practices on the production floor. As stated by manager B: "If Circular training is only reserved for the design department of a brand, the manufacturer does not know how to optimize the process and become more competitive". This is relevant as it indicates that circular practices are currently replicating the same production patterns of traditional linear production, where the design process is reserved to the brand only (Gereffi and Memedovic, 2003). Most companies in this segment use technology to optimize production and enable circularity.

However, waste is not measured because it is not seen as a value-added commodity, as stated by several managers in Spain and the Netherlands.

Additionally, in terms of roles, no company in the VC segment has eco-designers, despite Redesign being one of the most relevant strategies for circularity. Finally, although all companies collaborate with external stakeholders, few collaborations are used to directly enable circularity. In the Distribution segment (represented by four companies in Europe and one in India), the implemented CS are Rental, Resale, Repair, and Remanufacture. All companies combined several CSs, in which only one is part of business model and while the other hardly generate any economic compensation. About half provide circularity training. None use technology to leverage circularity, while half have performed environmental assessments (such as LCAs) and calculate sustainability indicators like water use or CO_2 emission reduction. However, the outcome of these analyses is not directly linked to any specific circular practice. Half of the companies have eco-designers in place, and circular collaborations are used specifically in this segment to drive circularity.

Companies in the distribution-EOL segment (mainly present in the Netherlands and Spain) use Resale as their main CS. Repair and Remanufacture are secondary CSs and are not monetized. Most of these companies do not offer circularity training, which if offered, could help monetized CSs and improve set-skill of employees and adoption of CE practices (Chiappetta Jabbour et al., 2019). These companies do measure the amount of waste generated, but not in a disaggregated way, making it hard to establish what part of waste could be reused by other industries. Some use technology to drive efficiency and leverage circularity. None have conducted environmental assessment before. Finally, half of these companies have an eco-designer or circularity related role, and most have active collaborations to enable circularity.

4.1.2. Material circularity indicators and impacts

Table 4 illustrates different CSs and their circularity indicators. It also shows the most wasteful process that resulted from MFA analysis. Using a traffic light system, the darker green indicates the best performance and the red the lowest perfprmance. As seen in this table all CSs use more than 85% of circular material input. As Repair uses little material, it only generated 1% of waste. However, 50% of the actual repairing material is discarded as waste because the repairing process is not optimized for material recovery.

The Reduce CS produce on demand and is, in principle, the most waste-efficient strategy, as the use of technology has helped to minimize waste on pattern and on cutting, which are the most wasteful processes

Table 4
Circularity indicators per Circular strategy. Source: Own elaboration.

Circular Strategy		Reduce-R2	Rental- R3	Resale- R4	Repair- R5	Remanufacture-R6	Recycle-R7
Influx % of new and second-hand material	% Bio-material	100%					
	% of reused material		89%	100%	98%	84%	86%
	% of recycled material					8%	14%
% Waste generation	% of waste generated	7%	10%	17%	1%	23%	46%
Recirculation	# of times product was recirculated	0	9	2	2	2	3
Most wasteful process		Cutting and then QC	Re-used Clothing inventory dead stock	Presorting, sorting	Cutting	Pre-sorting washing cutting	Sorting, cleaning cutting

of the manufacturing segment. Rental is the CS with the highest closed-loop material recirculation and the one that integrates the most CSs (Rental, Repair and Resale), leading to a low waste generation of 9%.

Recycle uses a 100% of circular material input, with 86% coming from reused material and 14% from recycled material re-integrated into the system. It has the highest generation waste percentage of all CS followed by Remanufacture and then by Resale. Most of this waste is produced during the pre-sorting processes needed for Resale, Remanufacturing, or Recycling because input materials need either considerable cleaning or are too damaged to be reintegrated in the system. However, it is critical to note that this waste is already considered discarded material when it enters the sorting process, hence, the companies applying these CSs are technically not generating more waste, but rather reducing the amount of existing waste.

Fig. 4 compares the circular material input (biomaterial, reused and recycled material) and waste generation by VC segment and country. According to this figure, all companies use almost 100% of either reused material or recycled material as input, as this is inherent to their circular model. The highest amount of waste is produced in the manufacturing segment, followed by the distribution-EOL segment.

The Manufacturing segment uses the highest input of both recycled and reused material from open-loop process. For instance, post-consumer plastic bottles, post-consumer cotton waste and discarded plastics bags are used as input for the manufacturing process. Most waste is generated by the Indian businesses; however, they are the only companies incorporating recycled material input as most manufacturing of fibers and fabrics happens there. Currently, the Spanish businesses are producing the second highest amount waste, which shows a critical hotspot.

4.2. Soft aspects

4.2.1. Organizational system

Table 5 provides an overview of the organizational system related to soft social aspects. It shows the three levels of system change discussed in Section 2.2 and the presence of attributes such as job quality (QOJ), worker well-being, and gender equality and inclusion (GEI). It categorizes findings by value chain segment and circular strategies, employing the same traffic light system as in 4.1.1.

At the Structural level, the table specifies attributes such as human resources policies (e.g., open salary policy, internal promotion), practices (e.g., flexibility, trainings), and relational elements (e.g., collaboration between human resources and sustainability manager). Additionally, at the relational level, we find roles like well-being, diversity and inclusion (DAI) agents, and the existence of collaborations supporting employees' well-being (e.g., collaboration with municipality or NGOs). The transformational level encompasses mission, values, and initiatives supporting either the well-being of vulnerable populations, or the use of justice and fair-trade principles.

As shown in Table 5, the Reduce CS shows the most critical challenges in policies related to salaries, internal promotions, and training. However, Rental, Remanufacture, and Recycling, also experience the absence of open salary policies, while Repair lacks equal salary practices and incentive programs.

The workers' well-being dimension from a system perspective reveals multiple hotspots across most VC segments and CSs, encompassing deficiencies in well-being programs, incentives, transportation and childcare support, personal growth opportunities, and flexible schedules. Recycling is an exception, exhibiting no significant hotspots in this regard.

Furthermore, the absence of gender equality and inclusion policies is common across different VC segments and CSs, with an overall deficiency in anti-discrimination and anti-harassment policies. Gender equality training is predominantly present in Recycling and Remanufacturing, possibly influenced by audits recommendations or by the companies' missions aligned towards women's empowerment.

At the relational level, and across VC segments and CSs, the absence of specific roles for gender equality and inclusion is noted. Adherence to labour agreements is only present mainly in European companies implementing Repair and Resale while non-existent in India or in the manufacturing VC segment. Overall, there is a minimal representation of workers as evidenced by few companies having workers' committees or unions.

From a corporate culture perspective, some inconsistencies between intention and practice are present across countries. Although companies implementing CSs define themselves as sustainable, the social aspect of sustainability is less present in their practices, such is the case for Remanufacture, Resale, and Repair. For instance, while companies in the distribution segment employ the most migrant workers across countries, they are the ones lacking most anti-discrimination policies, and workers well-being programs.

Additionally, across all VC segments, women workers seem to be earning less than their male counterparts for the same job performed (see Table 6), with several companies are lacking a policy of salary parity. Corroborating this point manager (G) in Spain said, "we want to strive for parity, and though it has not been the case in the past, we are now putting a salary parity program in place".

Furthermore, it seems that Indian companies implementing CSs follow several prevalent practices and behaviors of traditional manufacturing companies. For instance, as in the traditional linear production system, they hire temporary workers on contractual or piece-rate terms (Lazear and Shaw, 2007), (Lollo and O Rourke, 2020), (Lazear, 2000). Three different managers reported that migrant workers prefer open contracts with the most cash-in value which also aligns with a preference from companies to work in this manner. As manager (E) said, "working with migrant workers implies they come and go, so it is easier for us to work this way" and (C), "as orders from brands are not steady, we prefer having a flexible workforce for peak production". This reliance on a flexible workforce contributes to a lack of worker representation and further underscores negotiating salary parity which reinforces companies' interests. Additionally, some Indian companies forgo open salary disclosure, citing it as unconventional in the industry. Finally, most companies also distance themselves from unions, a recurrent practice in Indian textile manufacturing companies, as expressed by (Sen, 2012). This was corroborated by managers who emphasize direct communication with workers as a point of pride.

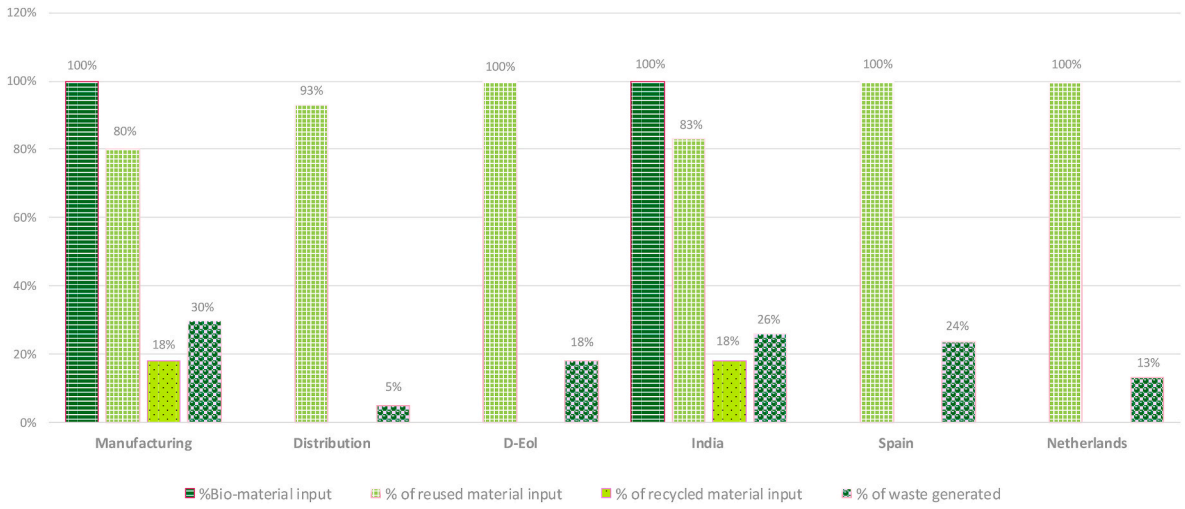


Fig. 4. Comparison between circular indicators by value chain Segment and country.
Source: Own elaboration

Table 5
Soft organizational system-aspects disaggregated by CS, VC segment and country. Source: Own Elaboration.

System Aspects	System change Levels	Socio-enviornmental impact indicators	System change attributes	Circular strategy						VC Segment			Country		
				R2-Reduce	R3- Rental	R4-Resale	R5-Repair	R6-Remanufactu	R7-Recycle	Manufacturing	Distribution	D-Eol	India	Spain	Netherlands
SOFT SYSTEMIC ASPECTS	STRUCTURAL LEVEL	Quality of Job	Open SALARY position policy	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🟡
			Health Security	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
			Equal opportunity	🔴	🟢	🟡	🟢	🔴	🟡	🔴	🟢	🟡	🟡	🟡	🟡
			Written contracts	🟡	🟡	🟢	🟡	🟢	🟡	🟡	🟡	🟢	🟡	🟢	🟢
			Permanent contract	🟡	🟢	🟡	🟡	🔴	🟢	🟡	🟢	🟡	🟡	🟡	🟡
			Equal salaries policy and practice	🔴	🟢	🟡	🔴	🔴	🟢	🟡	🟡	🟡	🟡	🟡	🟡
			Internal promotion	🔴	🟢	🟡	🟢	🔴	🟢	🟡	🟢	🟡	🟡	🟢	🟡
			Incentive program	🔴	🟢	🔴	🔴	🔴	🟢	🟡	🟡	🔴	🟡	🔴	🔴
			Training program	🔴	🔴	🟡	🟢	🔴	🟢	🟡	🟡	🔴	🟡	🟢	🟡
			Training budget	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
			Working hours (LEGAL OR EXCESS)	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟡
		Workers wellbeing	Vacations	🔴	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
			Wellness program on place	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
			Incentive programs for wellness	🔴	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴
			Transports subsidy/ pay card	🔴	🔴	🔴	🟢	🟡	🟡	🟡	🟡	🔴	🔴	🟡	🟡
			Child support/ child time	🔴	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴
			Personal growth program training	🔴	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🔴
			Other benefits	🟢	🔴	🔴	🟡	🔴	🟡	🟡	🔴	🔴	🟡	🔴	🔴
			Flexible schedule others	🔴	🟡	🟡	🟢	🔴	🟡	🔴	🟢	🟡	🔴	🟡	🟡
		Gender Equality and Inclusion Practices	Gender Policy on place	🔴	🔴	🟡	🔴	🟡	🟡	🟡	🔴	🟡	🔴	🟢	🔴
			Training on V&H	🔴	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴
	REL. LEVEL		Specific Role for Gender or Diversity	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
			Existence of Workers committee	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
			CAO adherence	🔴	🔴	🟢	🟢	🟡	🔴	🔴	🟡	🟢	🔴	🟢	🟢
	CORPORATE CULTURE		Gender + training for women workers specially	🔴	🔴	🔴	🔴	🟡	🟢	🟡	🔴	🔴	🟡	🟢	🔴
			Social mission values and mindset	🔴	🔴	🟢	🟢	🟡	🟡	🟡	🟡	🟢	🔴	🟢	🟢

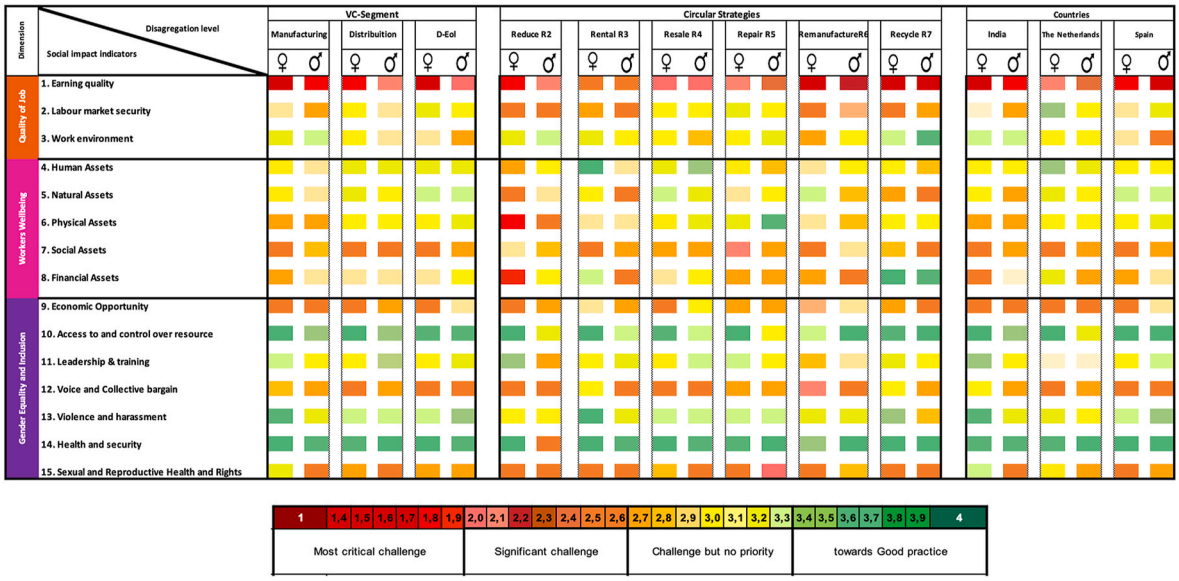
🟢 All attributes are present
🟡 Most attributes are present
🔴 All attributes are missing

4.2.2. *Social impacts of workers*

Table 6 illustrates the workers' social impact hotspots using the heat-map system that goes from dark red to light green, where the darker the shade, the more critical the indicator is. Earning quality (red shade) is the indicator with the lowest score across all CSs, VC segments, and countries, and it is consistently lower for female workers and lower for Indian companies, where 45% of the women surveyed have incomes just below the minimum wage. Job security is also a major challenge, particularly for Remanufacture, where in both cases men and women have the lowest indicators. This could be partially explained by the mix between permanent and contract or informal workers, where most hires are women.

Reduce has critical challenges related to earnings, labor security, physical, financial, and social assets, and for voice, and collective bargaining. In India female sorters working on the Recycle CS were the most vulnerable workers of all, as they have the lowest earning capacity, economic opportunity, voice, and collective bargaining. Rental has the highest earning of all CSs compared (although it remains a critical social

Table 6
Workers social impacts disaggregated by VC segment CS and country. Red illustrates critical challenge, orange, significant one, yellow not a priority and green absence of challenge or good practice. Source: Own elaboration.



hotspot). It is to be noted that workers on this strategy have a higher education than workers on other CSs, which could justify the higher earnings.

Well-being, family time, community engagement, and participation are critical challenges, especially for Rental, Resale, Repair, and Recycle, followed by Remanufacture where women workers are most affected. Interestingly, even though Resale across the three countries is mainly carried out by non-profit organizations with a social mission, workers' well-being and gender equality and inclusion programs and resources show a hotspot where several aspects could be improved. Financial assets related to the capacity to save or pay debts are also significant challenges for Repair, Reduce, Remanufacture, and Resale. From the VC perspective, significant challenges remain for all three segments and for both types of workers. From the GEI dimension, economic opportunity, voice & collective bargaining and sexual and reproductive health rights (SRHR) are critical challenges for several CS as well, but slightly lower for female workers.

4.3. Socio-environmental baseline comparison

Fig. 5 illustrates the socio-environmental baseline of the ten businesses. In the figure, system aspects are positioned above the respective

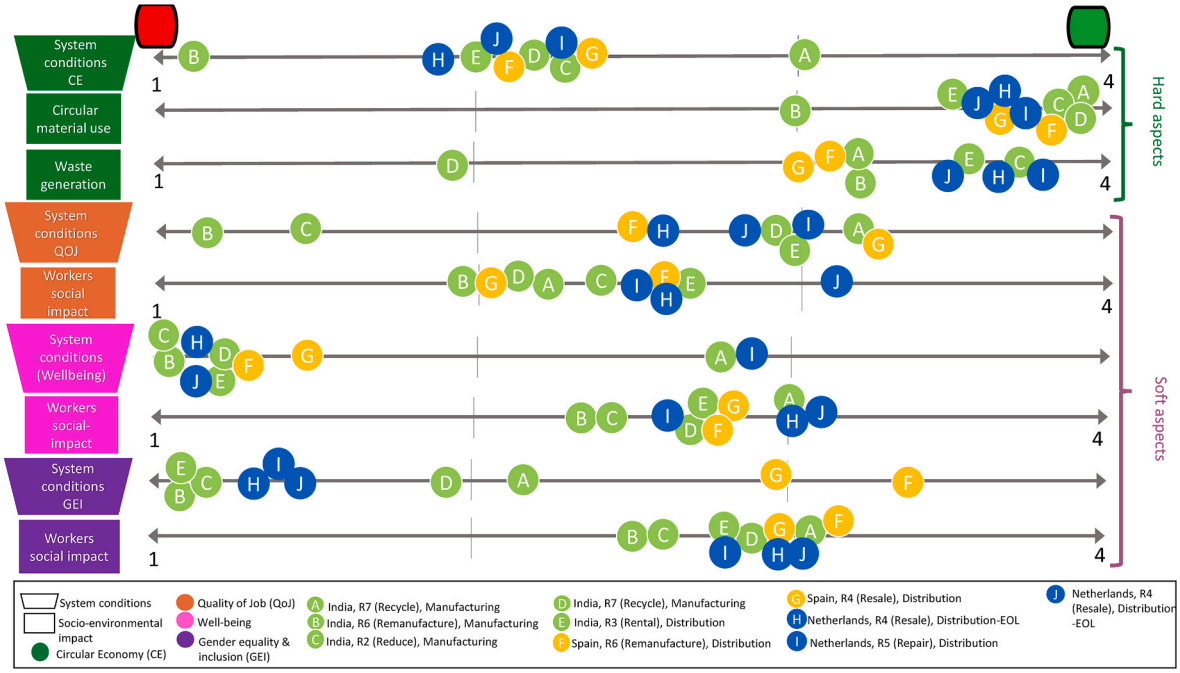


Fig. 5. Socio-environmental baseline combined with the hard and soft organizational system aspects of the ten companies analyzed. Source: Own elaboration.

environmental (material flow) or social impacts (workers' QOJ, well-being, and GEI initiatives). Each company is represented by a color-coded circle containing an specific letter from A to J. The placement of these circles is determined by the presence or absence of specific system conditions or socio-environmental impacts attributes. A value of 1 (lagger side in red) denotes the absence of the attributes, while a value of 4 (leader side in green) signifies presence of attributes and thus good practice.

These values were computed by summing the number of attributes present, dividing by the total attributes per category (CE, QOJ, well-being and GEI), and then normalizing to a four-point scale, as detailed in Table 2. This normalization process aligned system conditions with socio-material impacts and facilitated cross-company comparisons (see Annex 6).

Most companies and CS are positioned towards the lagger side concerning well-being and GEI system aspects. Absent attributes in this context include salary parity, well-being programs, gender equality initiatives, and roles like diversity and inclusion (DAI) officers. This finding is relevant considering that most CS operate with a large migrant and refugee workforce in the assessed countries. However, some companies exhibit good practices, such as having a designated well-being officer and a budget for personal growth (I) or providing child-care facilities and support (A).

Conversely, when examining the hard system aspects of CE, companies generally are placed in the middle on the scale. Attributes like eco-designers, circular skills, circular capabilities, and waste monitoring emerge as commonly missing. Company (A) led by having most CE attributes, likely explained by the fact that Recycle is a well-established circular strategy. In contrast, companies focusing on Remanufacture (B and F) lack several system conditions, possibly due to the novelty of this CS, which is predominantly employed by SMEs(Dissanayake and Sinha, 2015).

Regarding material impacts and CE Indicators, most companies exhibit stewardship by addressing waste generation and incorporating circular materials in their CS implementation. However, as most companies are SMEs with restricted production capacity, it is critical to monitor overtime the potential presence of rebound effects where production efficiencies might be offset by over-production (Zink and Geyer, 2017), (Siderius and Poldner, 2021).

While the QOJ system aspects are also placed in the middle of the scale, the impacts on workers' QOJ, are slightly lower with hotspot on earning quality and job security. This discrepancy arises from the lack of accessibility to existing policies and user orientation, hindering their recognition by workers and impeding the adoption of inclusive CE practices. Furthermore, despite workers' well-being impacts ranking slightly higher than related system aspects, the persistent lack of financial and social assets remains concerning. Similarly, while GEI impacts slightly surpass GEI system conditions, economic opportunity, voice, and collective bargaining are existing challenges. This misalignment between system conditions and socio-environmental impacts stems from blue-collar workers not directly associating their work with personal well-being or GEI, as highlighted by (Müller et al., 2014). This underscores the importance of creating more awareness of these critical aspects among workers.

5. Discussion

5.1. Challenges for improving social and environmental performance

Three main challenges surface by simultaneously analyzing both systemic aspects and internal sustainability impacts of CE. First, there is insufficient systemic integration of soft and hard aspects of CE implementation. This lack of integration mentioned by (Muster and Schrader, 2011), (Korhonen et al., 2018), (Kumar and Anbanandam, 2020), (Piecyk and Björklund, 2015) is critical for developing an inclusive circular corporate culture, where mindset, skills, and capabilities are aligned to enable an organizational CE transition, as indicated by (Bertassini et al., 2021). For instance, hard aspect at the structural level such as CE training programs, CE indicators, and accurate waste measurement are absent. Additionally, many companies lack roles such as eco-designers or circularity officers while at the corporate culture level, there are significant gaps in circular skills, capabilities, and values.

In terms of material impacts, the circular indicators show a spectrum of progress towards circularity. While material reuse is in most cases optimized, and waste reduction is promising in seven cases, challenges are found in the recirculation of materials. This shows that there is room for system optimization and overall improvement of material impact.

In the case of QOJ, some inclusive-social system conditions such as policies related to salary parity, and ongoing training are present. However, according to workers responses (Table 6) a gender pay gap is present in all VC segments and countries analyzed. This shows that, in practice, the current gender parity policies and programs are ineffective in improving diversity and inclusion. According to (Kania et al., 2018), system change conditions at the structural level, such as policies, programs, and regulations, are the easiest and often the first attributes to implement. However, if not done in consultation with the people affected by these policies, our study shows that they are useless.

The second challenge concerns the asymmetrical performance of social and environmental impacts. Circular businesses need to do more on the social side if they want CE implementation to help them achieve more sustainable development objectives at the business level. Specifically, in terms of raising wages, improving workers' well-being, equality of opportunity, salary and voice, and collective bargaining, they currently show the same low conditions as linear business models, echoing the findings of (Suarez-Visbal et al., 2022a) and (BSR, 2021). Furthermore, there is a lack of roles to promote GEI and well-being and a lack of relation between human resources and circularity-sustainability staff, as their functions are compartmentalized. For instance, in most companies, HR managers are rarely present when the operational team meets, and the operational team rarely discusses workers' well-being as this is considered out of their scope. This finding echoes the results by (Suarez-Visbal et al., 2022a), where it is signaled that "companies seem to be a bit lost as to how to approach the social side of circularity."

A last challenge concerns the lack of optimization when combining multiple CS. Fewer than 25% of companies monetize the combination of more than two CS. Additionally, circular hierarchy principles are seldomly used, with recycling being the most common CS, which can be explained by the fact that recycling is the strategy that requires the least system adaptations to the linear model. This aligns with (Battesini Teixeira et al., 2023) observation that (CE) at the business level is still in its infancy, with rather reactive implementation and insufficient integration into companies' core modus operandi.

Furthermore, companies implementing CSs in all three countries seem to follow the same pattern of production of linear businesses, where the prevailing mental model is towards increasing the production of green products instead of producing less with fewer materials and an equal or greater gain (Suarez-Visbal et al., 2022a). For circularity to play a more transformative role at the company level, it is critical to incorporate principles of sufficiency, which emphasize producing just enough to avoid unnecessary production, thereby preserving natural resources and minimizing environmental degradation. Sufficiency encourages a mindset shift towards producing and consuming less, essential to achieve long-term sustainability goals in a circular economy (Bocken and Short, 2016), (Schroeder et al., 2018).

5.2. Opportunities and enablers

Despite these challenges, enablers and opportunities are also present. First, regarding material efficiency, implementing CSs brings material impact improvements compared to linear production models echoing findings of (Goyal et al., 2018), (Jun and Xiang, 2011), (Van Berkel, 2010). Companies implementing CS generate significantly less waste

than their linear counterparts, with waste generation ranging from 1% to 23%, while linear waste generation ranges from 25% to 40% (Jordeva et al., 2020), (Li et al., 2021).

Second, the reused material input of 91% is significantly higher than the European average of 25% of industrial waste reuse (European Commission), which shows production efficiency at the SME level. However, as explained by (Zink and Geyer, 2017), (Siderius and Poldner, 2021) if production increases, there is a potential to generate rebound effects, as higher efficiency is canceled out due to absolute increases in production.

Regarding recirculation, the Rental strategy outperformed other CSs. Products under the Rental strategy extended the life eight times through Repair before being finally recirculated through Resale. In contrast, all other CSs, except for Recycle, extended the life of items twice as the input material was reused. The Recycle strategy combined Reused and Recycled inputs, leading to materials being kept three times in the production process/loop. However, this was not always in a closed-loop system, as in some cases, the input materials were plastic bottles or plastic bag waste. This variability in the Recycle strategy's performance highlights the influence of different input materials. These results indicate that companies implementing more than one CS demonstrate better circular material performance across the three environmental/circularity indicators than companies using only one CS.

Third, although health and safety have been previously identified as critical issues for circularity in the TAVC (Fürtner et al., 2021), they were generally well-addressed. This is likely due to increased scrutiny of sustainable practices. However, the long-term health risks associated with circular jobs may be challenging for workers to identify (Suarez-Visbal et al., 2022a).

Finally, as EU regulations on human rights and circular due diligence are emerging around the globe, implementing frameworks combining social and environmental risk assessments will help businesses in the sector build anticipatory capacity for the new legal requirements to come (Suarez-Visbal et al., 2023).

5.3. Recommendations

A list of recommendations to improve both the material circularity (hard aspects) and the social elements (soft aspects) of business cases was created following the baseline analysis. Material circularity recommendations were developed based on current best practices found in literature and adapted to the specific requirements of each business case (refer to Annex 5 for a comprehensive list of recommendations). The social recommendations draw inspiration from the suggestions made by (Suarez-Visbal et al., 2024) to improve social impact in the TAVC. These recommendations were evaluated in the context of each company and tailored to their circumstances.

5.3.1. Main common recommendations on hard aspects and environmental impact

Regarding environmental material circularity and waste reduction.

- Improve waste segregation and cleaning. One possible avenue could be to explore the mutualization of services,[6] creating specialized eco-centers for segregation and preparation for circularity, as waste segregation and cleaning is a common challenge in all analyzed countries.
- Incorporate eco-design and waste hierarchy principles into daily operations, extending from design teams to management and floor teams.
- Integrate complementary circular strategies, such as Repair and Remanufacture, to Reduce the direct flow of unwanted materials going directly to Recycling.
- Establish and improve a segregated waste inventory to maximize collaborative alliances between different companies in the sector and across sectors to optimize open and closed loop material circulation processes.

Regarding circular skills and capabilities.

- Implement an ongoing Circularity-readiness training program accessible to employees at different levels (from floor workers to middle and high management). This training should offer modules linking circular production with circular consumption to encourage circular habits both at work and at home. Additionally, the training program could be tied to a reward system to incentivize improved circular performance among teams and across organizational levels and functions.

5.3.2. Main common recommendations for better social performance of different CSs implemented by businesses

Regarding quality of jobs.

- Increase salaries by implementing short and medium-term plans to establish a living wage structure within an agreed-upon timeframe. This initiative should aim to address income disparities among different types of workers, starting with the most vulnerable jobs.
- Revise current human resources practices related to hiring and internal promotion to identify and eliminate biases, ensuring gender equity across all positions. Recognizing the presence of a gender pay gap in all businesses analyzed, it is essential to establish a gender pay gap parity plan within a specified timeframe. This may involve a detailed evaluation of job requirements, roles, and pay scales compared to sector benchmarks.
- Develop, if non-existent, and disseminate existing human resources policies, programs, and resources aimed at workers' well-being, gender equality and inclusion more effectively, fostering a deeper understanding among employees. This not only enhances organizational performance but also builds empathy and loyalty.
- Implement multilingual regular training on anti-discrimination, violence, harassment, and SRHR issues. This is particularly crucial as a significant number of workers in all three countries are internal or external migrants or refugees.

Regarding workers' well-being.

- Establishing better and ongoing communication mechanisms, allowing employees to provide feedback on current practices and suggest solutions.
- Incentivize the creation of a well-being committee, ideally comprising workers from all departments. This committee can function as a consultative body and potentially have decision-making authority. Topics for discussion may include flexible work schedules and ergonomic working spaces.
- Co-develop alongside employees professional and personal growth programs through training, educational opportunities, and financial support. This could be done by strengthened connections with employee and community centers that offer literacy and savings plans, training and resources, and cultural integration programs.
- For companies with a high percentage of migrant workers create a role such as inclusion and diversity or well-being officer. Such roles could guarantee the incorporation of good practices when working with multicultural populations.

[6] "Rather than one firm creating a single solution for its own use, in a mutualized model, the solution is created for many, with the vendor distributing the benefits to all involved. Among them are increased cost savings, improved reliability of operational productivity, more efficient regulatory compliance, and access to greater innovation through network effects" pg 1 https://www.broadridge.com/_assets/pdf/broadridge-mutualization-whitepaper.pdf.

5.4. Limitations

The main limitations of this study relate to sample size and potential biases in survey responses. The small sample size restricts the generalizability of results, instead our findings offer insights into specific commonalities and differences among companies, circular strategies, employees, and operating countries.

Potential biases in survey responses cannot be neglected, as the surveys were facilitated on-site during working hours by the companies themselves. Efforts to minimize this risk included using separate rooms and ensuring no direct supervision, however, complete elimination of this risk could not be guaranteed. Consequently, some responses may have been more favourable than in alternative survey settings.

Additionally, there is a potential risk that companies presented a more positive image of their practices during interviews. To mitigate this risk, interview responses were cross verified with workers' surveys, and workers' responses were cross-checked with salary data provided by the companies.

Due to the diverse backgrounds, geographic locations, and educational levels of workers, there was a potential for misinterpretation of survey questions. To mitigate this, a multilingual canvasser team conducted the survey, incorporating videos and providing the option to speak or select answers using a software interface to enhance comprehension. Despite these measures, the risk of workers not fully understanding the questions could not be completely eliminated.

In terms of the MFA, assumptions were made as companies in the three countries did not always have written records of all the information needed. The reliability of the data was sometimes difficult to verify. As the MFA process requires a mass balance validation, some of this data was corrected by companies. However, official documents that could be used as evidence of what they were saying were not always available. To reduce the bias, data was triangulated with literature to ensure common practices were still present.

5.5. Future research

Future research could focus on i) implementing the given recommendations with businesses to understand how they transition to more inclusive circular practices and what challenges they face. ii) Extending the sample size to more companies or more countries of the value chain, allowing for more generalization of research outputs. iii) Integrating the energy flow analysis in addition to the material one. iv) Additionally, given that long-term health considerations are critical for the implementation of CS, future research could focus on a longitudinal study for potential health and toxicity associated with Remanufacture, Reuse and Recycling of textile waste. Finally, a comprehensive external analysis that includes regional policies and socio-cultural aspects will undoubtedly enhance the exhaustive internal analysis performed by this study, by proving a more richer and nuance understanding.

6. Conclusions

The aims of this study were to provide empirical evidence on the internal challenges and opportunities faced by circular businesses in managing both the soft and hard aspects of Circularity and to identify associated socio-environmental impacts and potential trade-offs of CE implementation at the business level. We achieved this by establishing a systemic socio-environmental baseline for ten businesses implementing CS across three countries.

According to the socio-environmental baseline, CSs in general outperform linear models in terms of material impacts, with "Reduce," "Rental," and "Repair" showing the highest potential for material efficiency. Additionally, combining different circular strategies could further improve material efficiency, presenting an underexplored opportunity.

However, workers' social considerations lag behind with common critical hotspots across countries and CSs, including earning quality, voice, collective bargaining and SRHR.

Furthermore, the lack of a holistic system perspective that considers both social and environmental aspects was the most critical challenge for all companies implementing CSs. Many companies exhibit incomplete or disconnected system-change conditions, lacking integration between the hard and soft aspects of circularity. Despite some existing policies and programs at the structural level, there is lack of initiatives addressing well-being and gender equality. Gaps in CE metrics and CE indicators were evident from the hard side. At the relational level, key roles to accelerate the uptake of inclusive circular practices, such as circular managers, eco-designers and well-being and diversity officers, are often missing.

Finally at the transformational level, CE corporate culture was not explicit in at least half of the companies. Although companies implementing circular strategies have sustainability values in place, these are not explicitly articulated for circularity, with evident gaps related to circular capabilities and CE skills. Furthermore, well-being HR capabilities and associated mental models are rather the exception than the norm. These gaps in corporate culture are reinforced by behaviors still engrained into the linear production model, where producing more green products is preferred, rather than producing less, with less materials and equal or greater gain.

These findings are critical for businesses implementing CS, as results make evident the need for businesses to align internal systems to improve performance in both social and environmental dimensions of CE. In this regard, businesses should ensure that their policies regarding workers' well-being and gender equality and inclusion are actionable, adaptable, and well-understood by all staff, not only managers. They should establish dedicated roles to safeguard and champion workers' well-being and circular considerations, and finally, they should reinforce their corporate culture with both inclusive circular skills and capabilities, and circular mindset to complement circular values.

This research contributes to the CE managerial field by offering a comprehensive lens for assessing circular management practices, integrating environmental and social impact indicators with systemic attributes and organizational culture. Additionally, it provides a holistic socio-environmental baseline assessment framework that can highlight potential sustainability trade-offs and opportunities to enhance CE's socio-environmental performance. Implementing a framework such as the one presented in this research (combining social and environmental risk assessments and outcome performance) will help businesses in the sector build anticipatory capacity for the new legal requirements to come.

Furthermore, this study contributes to the literature on Organizational Change in Circular Economy (OCCE) by developing a systemic socio-environmental baseline framework that melds systems thinking with organizational management for CE combining processes and metrics to evaluate (identify trigger points, challenges and opportunities) of the transition to a CE at the organizational level, addressing a gap identified in the literature. It also advances the theory by providing evidence and concrete empirical examples of the sustainability impacts, both present and potential, generated by CE practices implemented by TAVC businesses in various geographical locations.

Finally, by combining soft and hard systemic aspects of CE into this comprehensive, transformative CE transition framework, this research facilitates the adoption of more inclusive circular practices, improving businesses' internal sustainability performance.

Availability of data and materials

The data are available upon request to the corresponding author on reasonable request.

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CRediT authorship contribution statement

Lis J. Suarez-Visbal: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jesús Rosales-Carreón:** Writing – review & editing, Supervision, Project administration. **Blanca Corona:** Writing – review & editing. **William Alomoto:** Writing – review & editing, Formal analysis. **Ernst Worrell:** Writing – review & editing.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used [Chat-GPT/Grammarly] to improve language and readability. After using this tool, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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