The circular economy challenges and its paradigm shift in the tourism industry: lessons from a mature touristic destination

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INTRODUCTION

The shift towards circular economy (CE) has begun. If we continue with our current linear economic model and due to the increasing population estimations for the next century, moving from 5 to 10 billion[1], we will need three planets by 2050 to provide the sufficient natural resources to maintain our current lifestyle.[2] Hence, we must start acting to invert and boost the present situation of the planet by changing the economic rules of the game.[3] Furthermore, the tourism sector plays a very important role in the economies of many countries around the world[4] and is the world's fastest growing industry generating 10.3% of global GDP.[5] It is also a major source of waste generation and environmental impacts, being responsible for 8% of global CO_2 emissions.[6] Thus, the implementation of CE in this sector remains crucial to the well-being of society, environment and the economy.

The CE has become a popular concept over the last 10 years as an alternative option to the linear economy.[7] It has gained traction among policymakers and it is currently promoted by the EU and several national governments such as China, The Netherlands, Canada and others.[8]

A lot of research has been done on CE with a total of 5,696 scientific papers published between 1914 and January 2020.[9] However, very little research has been done for CE and tourism with only 55 articles and books found between 2009 and January 2020. Hence, Florido, Jacob and Payeras call for further research on CE in tourism in

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[1] NOAA. National Oceanographic and Atmospheric Agency: Climate Change, accessed March 9, 2020, https://oceanexplorer.noaa.gov/explorations/deepeast01/background/dumping/dumping.html

[2] United Nations-Goal 12: Ensure sustainable consumption and production patterns, accessed May 28, 2020, https://www.un.org/sustainabledevelopment/sustainable-consumption-production/

[3] Florido, Carmen, Marta Jacob, and Margarita Payeras. "How to Carry out the Transition Towards a More Circular Tourist Activity in the Hotel Sector. The Role of Innovation." Administrative Sciences 9, no. 2 (2019): 47.

[4] Corina Larisa Bunghez, "The importance of tourism to a destination's economy," *Journal of Eastern Europe Research in Business & Economics* 1, no. 1 (2016).

[5] WTTC. World Travel & Tourism Council, accessed May 28, 2020, https://wttc.org

[6] Tourism responsible for 8% of global greenhouse gas emissions, study finds, accessed May 28, 2020, https://www.carbonbrief.org/tourism-responsible-for-8-of-global-greenhouse-gas-emissions-study-finds

[7] David Ness, "Sustainable urban infrastructure in China: Towards a Factor 10 improvement in resource productivity through integrated infrastructure systems," *The International Journal of Sustainable Development & World Ecology* 15, no. 4 (2008).

[8] Jouni Korhonen, Antero Honkasalo, and Jyri Seppälä, "Circular economy: the concept and its limitations," *Ecological economics* 143 (2018).

[9] Carlos Rodríguez, Carmen Florido, and Marta Jacob, "Circular Economy Contributions to the Tourism Sector: A Critical Literature Review," Sustainability 12, no. 11 (2020).

particular "on the study of how specific companies within the industry are adopting the CE and what are the challenges and barriers they face throughout their supply chain as well as in demand".[10] CE challenges in the tourism sector is a field that has been under-researched, only one article has started analysing this field. However, the article is still not going far enough due to some limitations such as: only three challenges identified which apply to only one part of the value chain (the tourists), the small number of expert interviews and these being from only one country (Denmark).[11]

Therefore, our research question is: what are the challenges of implementing CE in the tourism sector for the case study of the Canary Islands? To approach this, first we will outline the theory describing the CE, circular tourism and the Canary Islands (CN) key characteristics. Second, we will describe the methodology which is based on three pillars:

(i) Phase I: identification of CE challenges through a systematic literature review.
(ii) Phase II: codification of CE challenges to identify the CE challenge patterns.
(iii) Phase III: mapping input from EU, ESP & CN CE Strategies to the identified patterns).

Third, we will discuss for the three key players (public administration/destination management organisation (DMO), the tourism sector and the residents),[12] two key CE challenges each for the tourism sector in the Canary Islands.

THEORY

For the theoretical background, we will introduce 3 topic areas in the following order: CE, circular tourism and the specific features of the Canary Islands.

Circular economy – A new way to reshape the current economy

The concept of circular economy (CE) has become increasingly popular around the world over the last the 10 years as a means to disrupt the present linear economic production and consumption model of "take, make, dispose".[13] Although CE might seem relatively new due to its popularity and renowned significance to tackle many sustainability matters among the agendas of policymakers, such as Europe with the Circular Economy Action Plan[14] and China with its Chinese Circular Economy Promotion Law[15] it is not that recent.[16] It dates back to the 1960's with Boulding.[17] Many academics

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[10] Carmen Florido, Marta Jacob, and Margarita Payeras, "How to Carry out the Transition towards a More Circular Tourist Activity in the Hotel Sector. The Role of Innovation," *Administrative Sciences* 9, no. 2 (2019): 13.

[11] Flemming Sørensen, Jørgen Ole Bærenholdt, and Kim Andreas Gjetting Møller Greve, "Circular economy tourist practices," *Current Issues in Tourism* (2019).

[12] Florido, Jacob, and Payeras, "How to Carry out the Transition towards a More Circular Tourist Activity in the Hotel Sector. The Role of Innovation," 13.: 47

[13] Ness, "Sustainable urban infrastructure in China: Towards a Factor 10 improvement in resource productivity through integrated infrastructure systems."

[14] Circular Economy Action Plan, "For a cleaner and more competitive Europe," *Available online at (accessed 07.04. 2020): https://ec. europa. eu/environment/circular-economy/pdf/new_circular_economy_action_plan. pdf* (2020).

[15] Michael Lieder and Amir Rashid, "Towards circular economy implementation: a comprehensive review in context of manufacturing industry," *Journal of cleaner production* 115 (2016).

such as Andersen[18], Ghisellini, Calani and Ulgiati[19], and Su et al.[20] refer to Pearce and Turner (1990) as the ones who first introduced the concept. However, Pearce and Turner got inspired from Boulding's 1966 work, where he characterized the earth as a circular and closed system and explained how the environment and the economy should coexist in harmony due to the earth's limited absorptive capacity.[21]

The academic researchers Schut, Crielaard and Mesman[22], and Geissdoerfer et al.[23] affirm that the most popular definition has been delivered by Ellen MacArthur Foundation (EMF) stating: "[CE] an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models" (7).[24]

Even though CE has received an increasing recognition throughout the last years, there is still a lack of a precise and elaborated definition of CE in the literature. Bressanelli et al[25] believe that the expertise regarding CE is still in its early stages of development. From the scientific side, research is not deep-rooted and systematic, and it appears to be a compilation of ambiguous and unrelated ideas from several semi-scientific realms.[26] Most of the knowledge and practice behind the concept of CE has been solely undertaken and managed by professionals e.g. business consultants, policy-makers, business associations.[27, 28]

Circular tourism – A paradigm shift in the tourism industry

According to Girard and Nocca, the circular tourism is defined as "not only a green tourism, addressed to limit the consumption and waste of non-renewable energy sources. Recovery, reuse, redevelopment, but also valorization and regeneration are key words if we think about sustainable and circular tourism" (69).[29] The tourism industry

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[16] Geraldine Brennan, Mike Tennant, and Fenna Blomsma, "Business and production solutions: Closing loops and the circular economy," in *Sustainability* (Routledge, 2015).

[17] Francesca Nocca, "The role of cultural heritage in sustainable development: Multidimensional indicators as decision-making tool," *Sustainability* 9, no. 10 (2017).

[18] Mikael Skou Andersen, "An introductory note on the environmental economics of the circular economy," *Sustainability science* 2, no. 1 (2007).

[19] Patrizia Ghisellini, Catia Cialani, and Sergio Ulgiati, "A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems," *Journal of Cleaner production* 114 (2016).

[20] Biwei Su et al., "A review of the circular economy in China: moving from rhetoric to implementation," *Journal of cleaner production* 42 (2013).

[21] Kenneth Boulding, "The economics of the coming spaceship earth," *New York* (1966).

[22] Evert. Schut, Machiel. Crielaard, and Miranda. Mesman, "Circular economy in the Dutch construction sector: A perspective for the market and government," (2016).

[23] Geissdoerfer, Martin, Paulo Savaget, Nancy M. P. Bocken, and Erik Jan Hultink. "The Circular Economy–a New Sustainability Paradigm?". *Journal of cleaner production* 143 (2017): 757-68.

[24] Foundation Ellen MacArthur, "Towards the circular economy: economic and business rationale for an accelerated transition," *Report commissioned by the Ellen MacArthur Foundation, UK* (2013a).

[25] Gianmarco Bressanelli et al., "Exploring how usage-focused business models enable circular economy through digital technologies," *Sustainability* 10, no. 3 (2018).

[26] Jouni. Seppälä, Antero. Honkasalob, and Jyri. Korhonena, "Circular Economy: The Concept and its Limitations," *Retrieved from ScienceDirect* (2017).

[27] Elisa Conticelli and Simona Tondelli, "Eco-industrial parks and sustainable spatial planning: a possible contradiction?," *administrative sciences* 4, no. 3 (2014).

[28] Foundation Ellen MacArthur, "Towards the circular economy: economic and business rationale"

[29] Luigi Fusco Girard and Francesca Nocca, "From linear to circular tourism," *Aestimum* 70 (2017).

plays an important role due to its multiplier effect in the entire economy, hence by applying a circular economy approach, tourism businesses can speed up their own sustainable development and advance in the creation of more circular experiences for all stakeholders in the tourism sector.[30]

To be a sustainable sector, the whole value chain of the tourism industry must adapt and be participate of this paradigm shift where nothing is waste, in order to continue and prosper within this new economic paradigm.[31]

The transition towards CE within the tourism sector cannot be solely executed by single companies without engaging with other players from the same industry and even further.[32] Therefore, Florido, Jacob and Payeras propose a three-axis model where 3 key actors (the Public Administration/DMO, the tourism sector and residents) play a crucial role towards the implementation of CE in a tourist destination.[33]

It is important to mention that many authors[34, 35, 36, 37] state that the CE literature on tourism is very limited, there is a reduced scope for its use, there is no previous studies on how to create circular business models in tourism, there is a lack of a shared understanding about CE and tourism, as well as it does not include any prior research on the transition of the tourism industry to a circular economy. In the case of the challenges of CE in tourism, there is only one paper[38] which has started researching this field with some limitations: the challenges identified were three and did not apply to the whole value chain just to the tourists, a limited number of experts interviewed in their Delphi study and that all experts came from Denmark. Nevertheless, the tourism sector can leverage the provided guidelines for other industrial fields, as the material and resource streams used are equivalent to those required by other sectors.[39]

Despite the scarce amount of CE literature on tourism, Rodríguez, Florido and Jacob carried out recently an extensive literature review on CE and tourism and found out that there are only 55 articles and books for the search period between 2009 and January 2020.[40] They did a very interesting classification of the identified literature by clustering the findings into 8 main streams, analysing the policy implications related to the main results per author publication and identifying the link to the 3R principles of each paper.

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[30] Arjan Van Rheede, "Circular economy as an accelerator for sustainable experiences in the hospitality and tourism industry," (2012).

[31] Alfonso Vargas-Sánchez, "The unavoidable disruption of the circular economy in tourism," *Worldwide Hospitality and Tourism Themes* (2018).

[32] Jesper Manniche et al., "Destination: A circular tourism economy: A handbook for transitioning toward a circular economy within the tourism and hospitality sectors in the South Baltic Region," (Centre for Regional and Tourism Research, 2017).

33. Florido, Jacob, and Payeras, "How to Carry out the Transition towards a More Circular Tourist Activity in the Hotel Sector": 47

[34] Florido, Jacob, and Payeras, "How to Carry out the Transition towards a More Circular Tourist Activity in the Hotel Sector": 47

[35] Peter Jones and Martin George Wynn, "The circular economy, natural capital and resilience in tourism and hospitality," *International Journal of Contemporary Hospitality Management* (2019).

[36] Manniche et al., "Destination: A circular tourism economy".

[37] Vargas-Sánchez, "The unavoidable disruption of the circular economy in tourism".

[38] Sørensen, Bærenholdt, and Greve, "Circular economy tourist practices."

[39] Manniche et al., "Destination: A circular tourism economy".

[40] Rodríguez, Florido, and Jacob, "Circular Economy Contributions to the Tourism Sector: A Critical Literature Review."

The specific features of the Canary Islands

In this section we will introduce the following 11 main features which are important to consider when analysing the challenges in the implementation of CE in the tourism sector of the Canary Islands.

1. Heavy dependence on the tourism industry, which accounts for 35% of the GDP in the canarian economy and is responsible for 40.4% of the jobs.[41]
2. There were 15,110,866 tourist arrivals in 2019.[42]
3. It is one of the most densely populated archipelagos in the world[43], with a population density of 298 inhabitants/km^2. Being the most populated island Gran Canaria (545.12 inhabitants/km^2) and the least El Hierro (40.81 inhabitants/km^2).[44]
4. Most of the tourists are from: 1st United Kingdom: 4,939,404 (32.8%); 2nd Germany: 2,651,378 (18.0%); 3rd mainland Spain: 1,963,390 (17,1%).[45]
5. Tourists going on holiday spend on average 139€/day and under the main reasons for coming to the Canary Islands for vacation are: the weather (78%), safety (52%), tranquillity (48%) and price (37%).[46]
6. Most of the tourists take hotel accommodation (58.1%), 22.5% of them take an apartment/villa and 7.2% take an Airbnb's. Statistics show that 34.9% of tourists from the four main incoming markets, take all-inclusive board in hotels.[47]
7. They are considered Ultra Peripheral Regions of the European Union, which means they have certain special characteristics such as[48]:
   - Long distance from the European continent (1,100-1,400km from mainland Spain).
   - Geographic fragmentation.
   - High transportation costs.
   - Limited possibilities to develop certain activities with economies of scale, decreasing competitiveness in the market.
8. The scarcity of land and its high degree of environmental protection[49] restrict the change of energy model with the use of alternative technologies such as wind and/or photovoltaic energy, as it requires an extensive use of land compared to conventional technologies. 40% of the territorial surface of the Archipelago is protected. The most protected island is El Hierro with 58.1% and Tenerife with 48.6% of the surface is protected under the Canary Island Network of Natural Protected Areas.[50]

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[41] EXCELTUR, *IMPACTUR CANARIAS 2018–Estudio del impacto económico del turismo sobre la economía y el empleo de las Islas Canarias* (2018), https://www.exceltur.org/wp-content/uploads/2019/12/IMPACTUR-Canarias-2018.pdf.

[42] FRONTUR, *Serie histórica de la llega de turistas a Canarias e islas (FRONTUR). 1997-2019* (2019), https://turismodeislascanarias.com/sites/default/files/promotur_serie_frontur_1997-2019.pdf.

[43] Raquel Guerra Talavera and Tanausú Perez Garcia, "Canarias: entre el desarrollo turístico y la protección al medio," *Études caribéennes*, no. 9-10 (2008).

[44] "Cifras oficiales de población/ Series anuales. Municipios por islas de Canarias. 2000-2019," 2019, http://www.gobiernodecanarias.org/istac/jaxi-istac/tabla.do?uripx=urn:uuid:d73bd9de-e6ed-4821-808a-616b34df9655&uripub=urn:uuid:febb02fd-d4fd-4e6d-bed4-0496d4a95f88.

[45] FRONTUR, *Serie histórica de la llega de turistas a Canarias e islas (FRONTUR). 1997-2019.*

[46] PROMOTUR, *Perfil del Turista. Islas Canarias* (2019a), https://turismodeislascanarias.com/sites/default/files/promotur_islas_canarias_2019.pdf.

[47] PROMOTUR, *Perfil del Turista. Islas Canarias.*

[48] Talavera and Garcia, "Canarias: entre el desarrollo turístico y la protección al medio".

[49] Talavera and Garcia, "Canarias: entre el desarrollo turístico y la protección al medio".

[50] "Red Canaria de Espacio Naturales Protegidos," n.d, https://www.gobiernodecanarias.org/planificacionterritorial/temas/informacion-territorial/enp/.

9. High volumes of waste. The volume of waste generated per capita from tourists compared to the resident population is twice as high.[51] If we consider a resident population of 2,153,389 inhabitants in 2019 and an influx of 15,110,866 tourists in 2019 with an average stay of 9.09 days, we would obtain (considering that a tourist generates twice as much waste as a resident) that tourists are responsible for 25.9% of the waste in the Canary Islands.
10. High energy consumption.[52] Thermal electricity generation in 2015 was 8,056 GWH and it came from oil products. From the total 8,056 GWH of electricity generation, only 7.6% came from renewable energy mostly from the wind.[53] There is a high dependence on oil and a very low penetration of renewable energies, which results in a poorly diversified energy mix. In 2016 92% of the energy in the Canary Islands came from non-renewable resources.[54]
11. Existence of an *Economic and Fiscal Regime (EFR)*: is a comprehensive set of regulations to compensate for the Archipelago's remoteness, insularity and structural limitations.[55] A special tax regime based on commercial freedom of import and export, non-application of monopolies, tax relief on consumption and the existence of local taxes such as '*General Canary Island Indirect Tax'* with lower rates compared to VAT in mainland Spain. Apart from the *Reserve for Investments in the Canary Islands* and other relevant tax incentives under this Economic and Fiscal Regime, we would like to highlight the *Canary Islands Special Zone (CNZ):*
    - A low tax area created within the framework of the EFR in order to promote the creation of quality employment, the economic and social development of the Islands and the diversification of their production structure.

METHODOLOGY

For the methodology part, we will use the following three phases approach to provide an overview on how research was conducted. We will then go into further detail for each of the three phases stated on table 1 below.

Table 1. Research process

Title	Phase 1: Identification of CE challenges in literature	Phase 2: Codification of CE challenges to identify the CE challenge patterns	Phase 3: Mapping input from EU, ESP & CN CE Strategies to the identified patterns
Steps	Following Paré et al. six review steps[56]: • Research plan development. • Literature search performance. • Literature content is	• Identification of challenges in 42 articles through open coding following Corbin & Strauss.[57] • Mapped them into 3 levels and located them into the	• Identification of challenges in the EU, ESP & CN CE Strategies through open coding following Corbin & Strauss.[64]

[51] Cristina González Camazón, "La Fiscalidad Verde. Creación de nuevos tributos sobre emisiones y residuos" (Law Dissertation, 2016), https://uvadoc.uva.es/bitstream/10324/21005/1/TFG-D_0263.pdf.

[52] Talavera and Garcia, "Canarias: entre el desarrollo turístico y la protección al medio"

[53] Gobierno-de-Canarias, *EECan25. Estrategia Energética de Canarias 2015-2025.* (2017), https://www.gobiernodecanarias.org/cmsweb/export/sites/energia/temas/planificacion/EECan25_DocumentoPreliminar_junio2017.pdf.

[54] "Herramienta de análisis para sistemas de Autoconsumo Fotovoltáico," 2020a, https://www3.gobiernodecanarias.org/ceic/energia/temas/autoconsumo/.

[55] ZEC. https://canariaszec.com/que-es-la-zec/

[56] Guy Paré et al., "Contextualizing the twin concepts of systematicity and transparency in information systems literature reviews," *European Journal of Information Systems* 25, no. 6 (2016).

[57] Juliet M. Corbin and Anselm Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria," *Qualitative sociology* 13, no. 1 (1990).

	screened. • Quality of papers assessed (skipped). • Extraction of relevant aspects for analysis and synthesis. • Extracted data is synthesised and analysed.	elements of corresponding frameworks: ○ Macroenvironmental: PESTEL.[58, 59, 60] ○ Microenvironmental: Resources, Value Chain, Infrastructure. ○ Organisational: Ordering moments,[61] Business Model Canvas,[62] EMF Butterfly Diagram/ Systems Diagram.[63] • Per framework element (e.g. political within PESTLE) identification of CE challenge patterns.	• Mapped them to the identified 68 CE challenge patterns.
Source	Databases: • EBSCO – Business Source Complete. • EBSCO – Academic Source Complete. • Web of Science Core Collection.	Literature identified in phase I.	• Circular Economy Action Plan: For a cleaner and more competitive Europe.[65] • Spain Circular 2030: Spanish Circular Economy Strategy.[66] • Canarian Strategy for Circular Economy.[67]
Results	1,106 papers reviewed, 138 papers left after abstract screening and selected 42 papers for the body of research.	731 CE challenges were identified and clustered into 68 CE challenge patterns (18 in macro, 14 in micro and 36 in organisational).	256 CE challenges were identified across the 3 strategies. In the EU: 127, ESP: 69, CN: 60.

Phase I: identification of the CE challenges in literature

To identify the challenges on CE in literature, we performed a systematic literature review following the approach consisting of 6 steps proposed by Paré et al.

In step one the research plan is developed: The research question of this paper is to identify the challenges on the implementation of CE in the Canary Islands tourism sector. For phase I, the sub-research question of this systematic literature review is to identify the industry unspecific challenges of implementing CE.

In step two the literature search is performed: We used a pre-defined and transparent search strategy that aligns with the sub-research question of this systematic literature review. The following table 2 summarises the literature search process.

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[64] Corbin and Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria."

[58] Francis Joseph Aguilar, *Scanning the business environment* (New York: Macmillan, 1967).

[59] Gerry Johnson, Kevan Scholes, and Richard Whittington, *Exploring corporate strategy: text & cases* (Essex: Pearson education, 2008).

[60] Davorin Kralj, "Sustainable green business" (2009).

[61] Johannes Rüegg-Stürm, *The new St. Gallen management model: Basic categories of an approach to integrated management* (New York: Palgrave Macmillan, 2004).

[62] Alexander Osterwalder and Yves Pigneur, *Business model generation: a handbook for visionaries, game changers, and challengers* (New Jersey and Canada: John Wiley & Sons, 2010).

[63] "Circular economy systems diagram," 2019, https://www.ellenmacarthurfoundation.org/explore/the-circular-economy-in-detail.

[65] Plan, "For a cleaner and more competitive Europe."

[66] Gobierno-de-España, *España Circular 2030- Estrategia Española de Economía Circular. Borrador para información pública.* (2018).

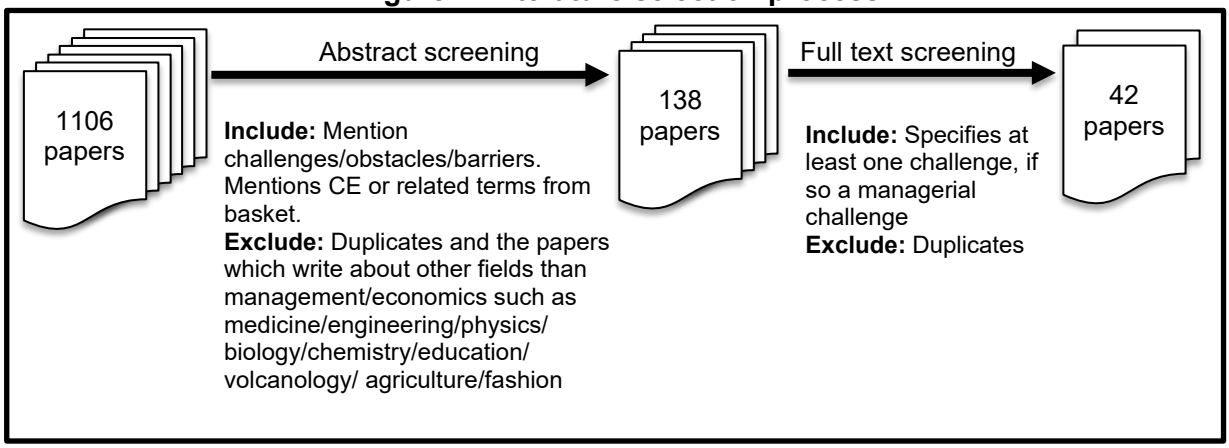
[67] Consulta-Europa, *Estrategia Canaria para la Economía Circular. Borrador* (2018).

Table 2. Literature search process

Search process	When: 28th of February to 10th of March 2020 – Tool to manage identified papers: Data base save functions		
Search terms	("circular economy" OR "circle economy" OR "closed loop* economy" OR "zero waste" OR "regenerative economy" OR "restorative economy" OR "closed system" OR "circular system" OR "circular flow economy" OR "cradle to cradle" OR "loop* economy" OR "regenerative design economy" OR "cyclical economy") AND (challeng* OR barrier* OR obstacle*)		
Data bases	*EBSCO –Business Source Complete*	*EBSCO – Academic Source Complete*	*Web of Science Core Selection*
Search fields	AB – Abstract or author-supplied abstract	AB – Abstract or author-supplied abstract	TS – Topic
Source types	Publication type: Academic journal Document type: Article	Document type: Article	Document type: Article
Inclusion/ exclusion criteria	Included languages: English, Spanish Publication date: 2010- 2020		
# papers	228	445	433

In step three the literature content is screened based on specific inclusion and exclusion criteria to identify the papers relevant to the sub-research question. Figure 1 summarizes the literature selection process.

Figure 1: Literature selection process



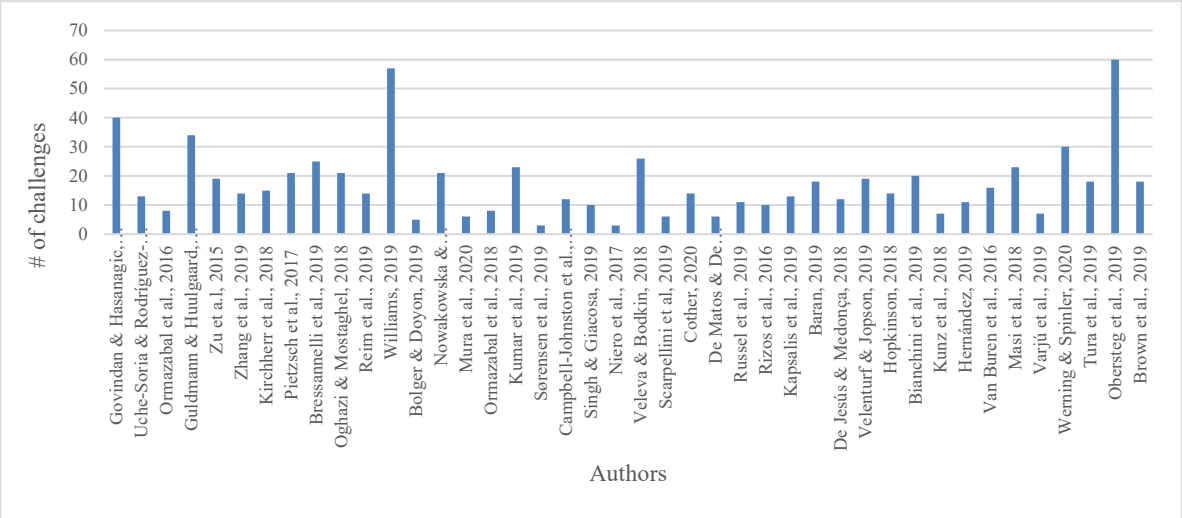
In the fourth step, the quality of the papers needs to be assessed. However, Paré et al. point out that for "reviews that aim to map out, describe or categorize the existing literature and identify gaps […] quality assessment in its strict sense is not essential or a key requirement" (501).[68] Thus we decided to skip this step of quality assessment of the academic papers for this article.

In the fifth step, the relevant data/aspects for analysis and synthesis is extracted. We decided to present the most relevant aspects of the 42 articles analysed in 3 different types of graphs (see sixth step).

[68] Paré et al., "Contextualizing the twin concepts of systematicity and transparency in information systems literature reviews."

In the sixth step, the extracted data is synthesised and analysed. In figure 2, the number of challenges identified per author in the 42 articles retrieved from the systematic literature review is shown.

Figure 2. Number of challenges in each one of the 42 selected articles



To sum up, in phase I we have identified 731 CE challenges in 42 articles, which will serve as foundation for phase II.

Phase II: codification of CE challenges to identify the CE challenge patterns

To build the theory on existing industry unspecific challenges for CE, we adopted an open coding approach as proposed by Corbin & Strauss.[69] Therefore, text elements of the 42 articles describing relevant CE challenges have been copied and pasted in an Excel sheet and described with open codes.

Furthermore, the identified challenges have been mapped into 3 different levels, leveraging different frameworks for this:

- Macroenvironmental level: we leveraged the PESTEL framework [70] complemented by the list of often comprised elements by Kralj, [71] differentiating between the following elements: political, economic, social, technological, environmental and legal.
- Microenvironmental level: we differentiated between resources (human, financial, physical and intellectual), value chain and infrastructure.
- Organisational: it proved to be useful to differentiate between 3 sublevels:
  - Ordering moments[72]: strategy, structures, culture.
  - Business Model Canvas[73]: key partners, key activities, key resources, value propositions, customer relationship, customer segments, channels, cost structure and revenue streams.
  - EMF Butterfly Diagram/Systems Diagram[74]: We differentiated between the left side (biological spheres) and the right side (technical spheres).

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[69] Corbin and Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria."

[70] Johnson, Scholes, and Whittington, *Exploring corporate strategy: text & cases*.

[71] Kralj, "Sustainable green business".

[72] Rüegg-Stürm, *The new St. Gallen management model: Basic categories of an approach to integrated management*.

[73] Osterwalder and Pigneur, *Business model generation: a handbook for visionaries, game changers, and challengers*.

[74] "Circular economy systems diagram."

Once the CE challenges in literature were clustered by framework elements within the 3 levels, the next step was to group them into CE challenge patterns. We leveraged the concept of "patterns", a concept leveraged initially in engineering.[75] Altshuller studied 40,000 patents and identified 40 patterns to solve all technical problems in engineering and the corresponding TRIZ model is still one of the leading design tools in mechanical engineering.[76] The concept of "patterns" has also been adopted within other fields of research. For example, in business model innovation.[77, 78, 79, 80, 81] "Patterns" are generally characterised elements to recurring problems,[82] describing a core idea[83] and requires a certain level of generalisation.[84] When applied to my context of CE challenges we describe them as: the core idea of recurring and similar CE challenges at a generalisation level applicable to different industries and geographic scopes. Based on this definition, we studied each framework element separately to identify a total of 68 CE challenge patterns. This approach has proven to be very efficient when dealing with 731 CE challenges mentioned in literature.

Phase III. Mapping input from EU, ESP & CN CE Strategies to the identified patterns

Having identified the general CE challenges, the link to the context of the tourism sector in the Canary Islands with a CE focus had to be established. Therefore, our aim was to map relevant content of the European Union, Spain and Canary Islands CE strategies to the identified 68 CE challenge patterns. To be able to do this, we leveraged a similar approach as in phase II. First, we copied and pasted the relevant text elements from the strategies in an Excel sheet and described them through open coding following Corbin and Strauss.[85] Second, we mapped the open codes to the identified 68 CE challenge patterns.

For 50 CE challenge patterns, relevant information within the CE strategies was found. Due to the fact that the CE strategies[86, 87, 88] were written from a governmental perspective, the information was mainly mapped on a macro- and micro-environmental level.

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[75] Genrikh Saulovich Altshuller, *The innovation algorithm: TRIZ, systematic innovation and technical creativity* (Technical innovation center, Inc., 1999).

[76] Oliver Gassmann, Karolin Frankenberger, and Michaela Csik, *The business model navigator: 55 models that will revolutionise your business* (Pearson UK, 2014).

[77] Nizar Abdelkafi, Sergiy Makhotin, and Thorsten Posselt, "Business model innovations for electric mobility—what can be learned from existing business model patterns?," *International Journal of Innovation Management* 17, no. 01 (2013).

[78] Benjamin Amshoff et al., "Business model patterns for disruptive technologies," *International Journal of Innovation Management* 19, no. 03 (2015).

[79] Gassmann, Frankenberger, and Csik, *The business model navigator: 55 models that will revolutionise your business*.

[80] Osterwalder and Pigneur, *Business model generation: a handbook for visionaries, game changers, and challengers*.

[81] Peter Weill and Michael Vitale, *Place to space: Migrating to eBusiness Models* (Harvard Business Press, 2001).

[82] Abdelkafi, Makhotin, and Posselt, "Business model innovations for electric mobility—what can be learned from existing business model patterns?."

[83] Weill and Vitale, *Place to space: Migrating to eBusiness Models*.

[84] Amshoff et al., "Business model patterns for disruptive technologies."

[85] Corbin and Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria."

[86] Consulta-Europa, *Estrategia Canaria para la Economía Circular. Borrador*.

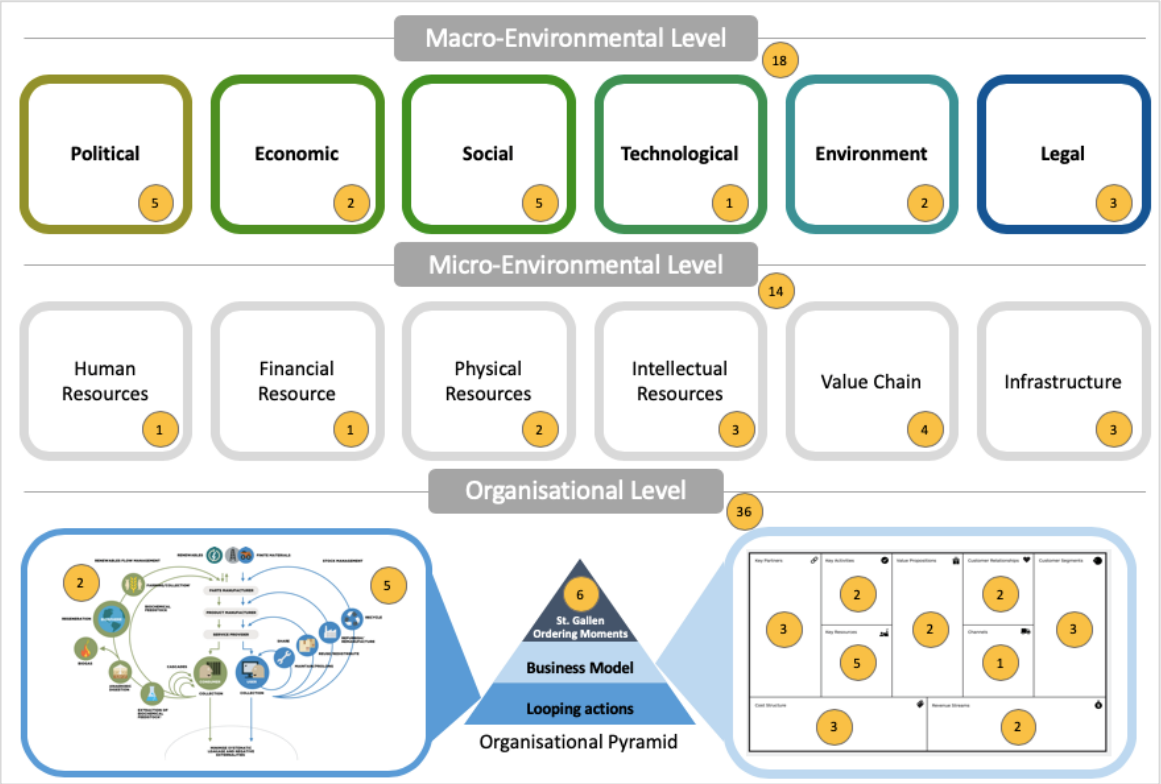
[87] Gobierno-de-España, *España Circular 2030- Estrategia Española de Economía Circular. Borrador para información pública.*

[88] Plan, "For a cleaner and more competitive Europe."

FINDINGS

We have clustered the 731 CE challenges identified across 42 scientific articles into 68 CE patterns of challenges. These 68 patterns have been classified into 3 different levels: macroenvironmental (18 challenge patterns), microenvironmental (14 challenge patterns) and organisational (6 challenge patterns for the Ordering Moments, 23 challenge patterns in the Business Model Canvas, 7 challenge patterns in the EMF Butterfly Diagram). Figure 3 below provides an overview of the CE challenges mapping.

Figure 3. Overview of the CE challenges mapping



Figures 4, 5, 6, 7 and 8 show the 68 different CE challenges patterns across the 3 different levels mentioned before. For further information regarding each of the 68 CE challenge patterns, tables 'Annex I, Annex II, Annex III, Annex IV' (pp.18-38) provide a full description on the latter and the link to the CE Strategies at European Union, Spain and Canary Islands level. Furthermore, table 'Annex V', allows the reader to link the superscripts in the tables to the authors and article titles.

Figure 4. Macroenvironmental challenges

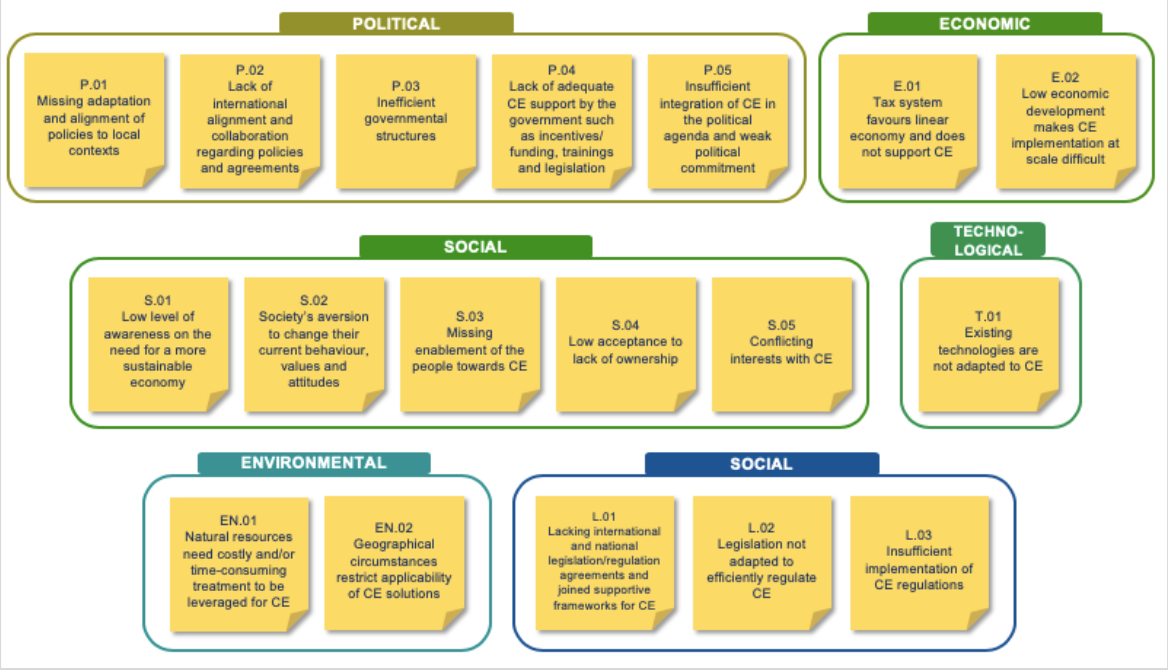


Figure 5. Microenvironmental challenges

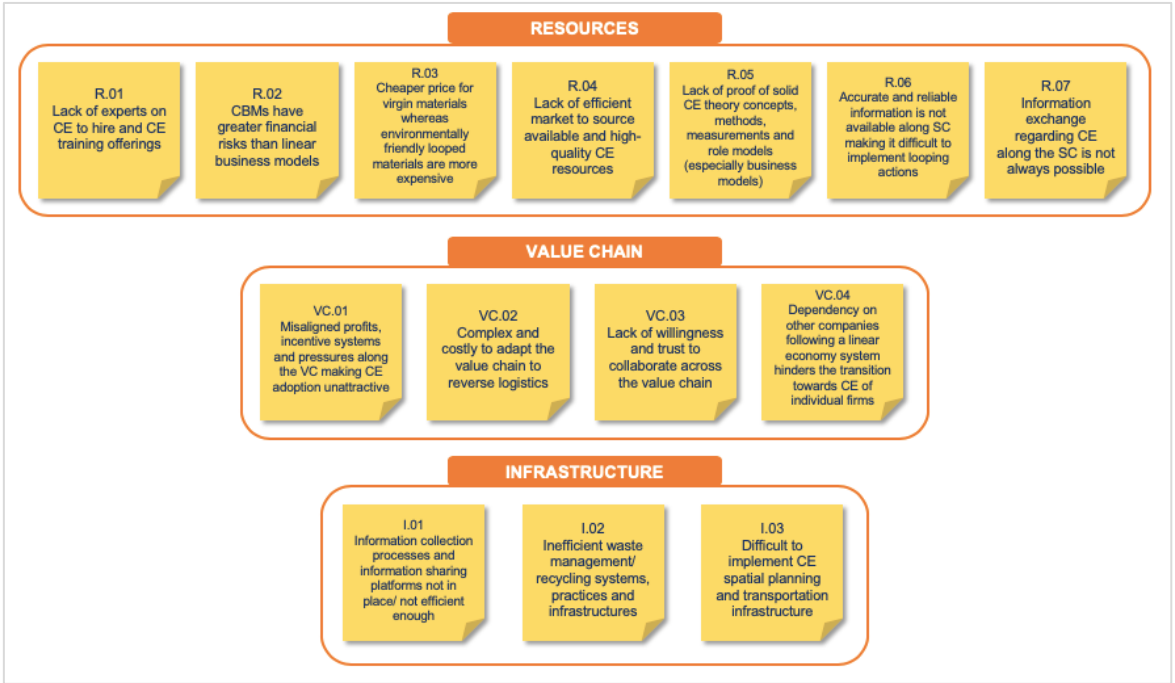


Figure 6. Organisational challenges – Ordering Moments St. Gallen Management Model

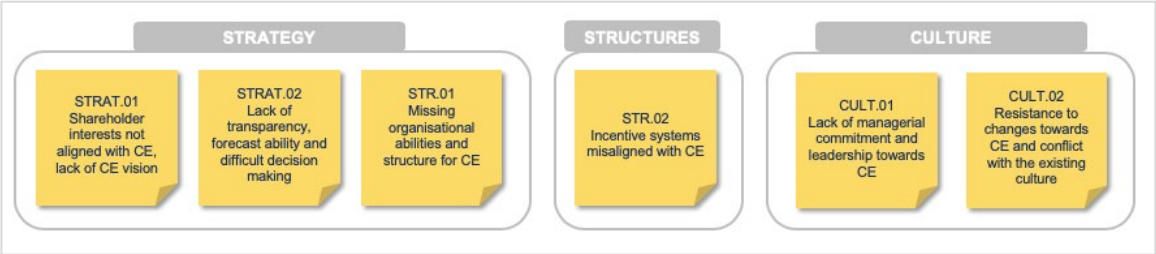
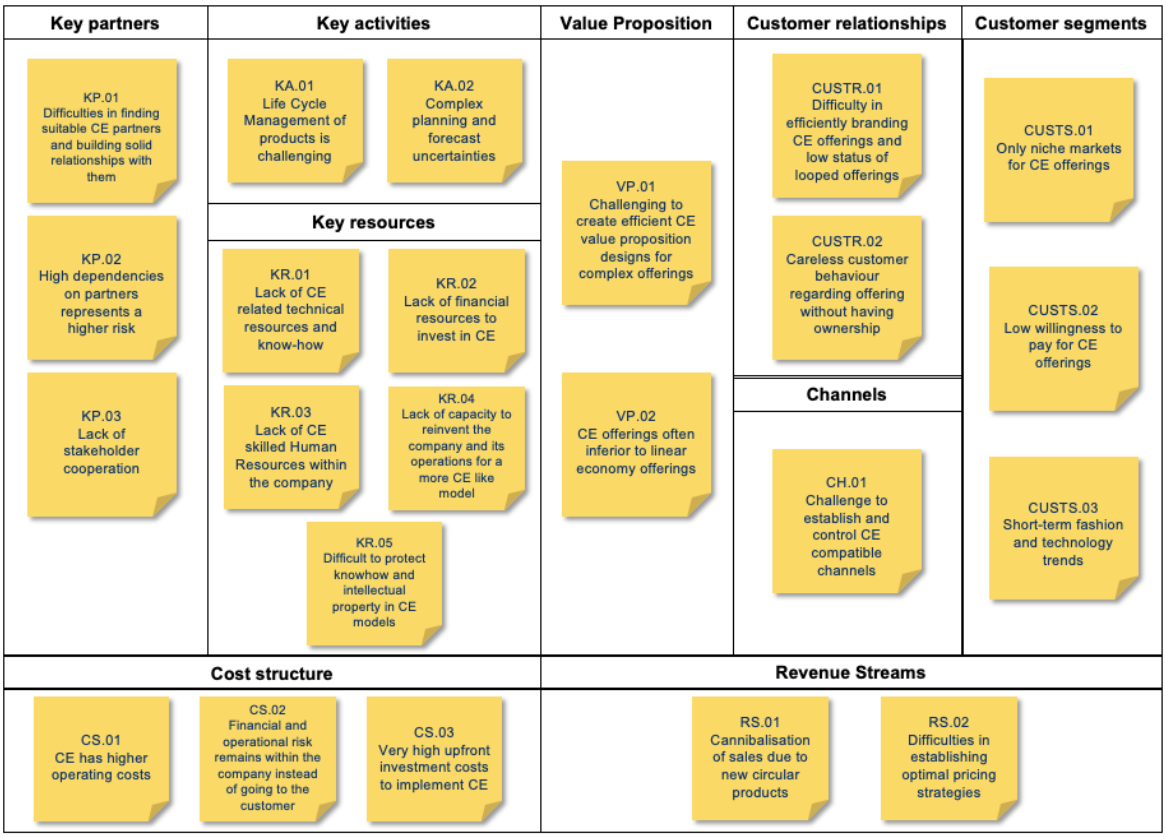


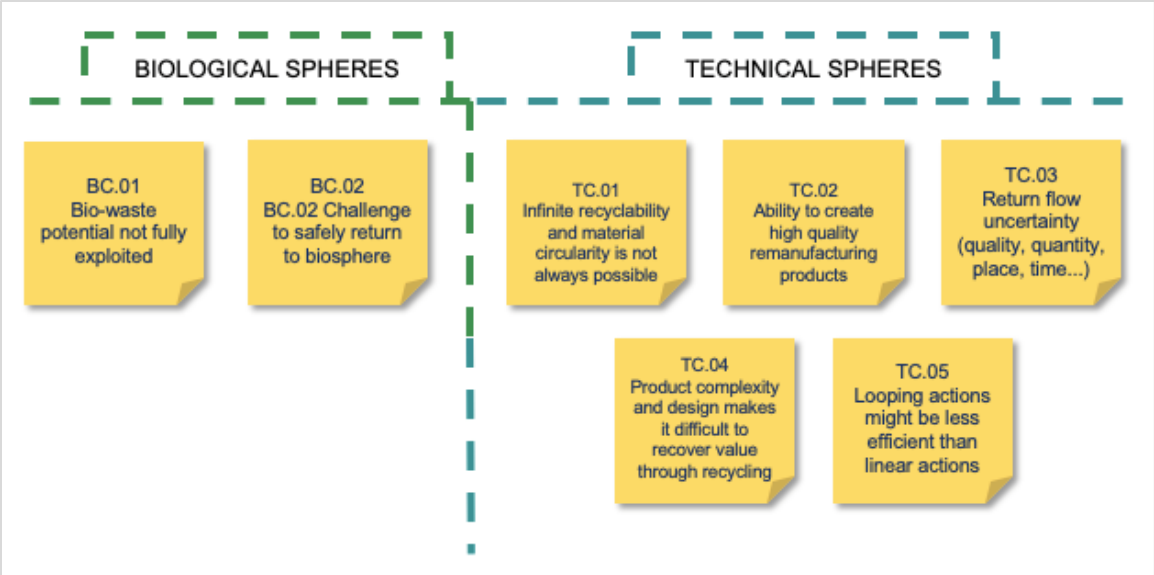
Figure 7. Organisational challenges – Business Model Canvas



Source: Adapted from Osterwalder and Pigneur[89]

[89] Osterwalder and Pigneur, *Business model generation: a handbook for visionaries, game changers, and challengers*.

Figure 8. Organisational challenges – EMF Butterfly Diagram



Source: Adapted from EMF[90]

DISCUSSION

Based on the challenges present in the previous findings chapter, in this chapter we will discuss the CE challenges specific to the tourism sector of the Canary Islands. We will analyse for each of the 3 main actors of the "three-axis model for a circular destination"[91] the 2 most important challenges to be considered when implementing CE in the Canary Islands tourism sector. The selection process of the 6 most important challenges was based on the 11 key characteristics of the Canary Islands, presented in the theory, and on the importance of the challenges, these being a selection of those that appear most frequently in the literature.

Player 1 – Public Administration/Destination Management Organisation (DMO)

E.01 Tax system favours linear economy and does not support CE

A key challenge in the Canary Islands tourism sector is the unfavourable tax system that promotes linear practices rather than circular practices. The special aspect of the Canarian tax system is that it benefits from certain tax reductions thanks to CNZ, and other characteristics mentioned in point 11 from the theory. Tax reductions aim to promote the creation of quality employment, the economic and social development of the Archipelago and diversification of its productive structure. However, the tax system does not focus on incentivising the transition towards CE. A possible approach has been discussed for the adoption of a 'tourist tax' in the Canary Islands since 2004 which has not been implemented so far. This is due to the very different political views. One side argues that the tax would contribute to offset environmental degradation caused by the millions of tourists that visit the islands each year, renovate infrastructures, prevent overflow of the island's carrying capacity and provide funds to promote a more sustainable tourism. The other side argues that it might have a negative impact on tourist arrivals and burden on competitiveness. As an alternative, there are already some

[90] "Circular economy systems diagram."

[91] Florido, Jacob, and Payeras, "How to Carry out the Transition towards a More Circular Tourist Activity in the Hotel Sector. The Role of Innovation."

first approaches for hotel and non-hotel establishments, as the 'handbook on waste management in tourist establishments' from the Gran Canaria Island Council proposes. These include tax deductions in corporate income tax for those establishments that carry out environmental investments (e.g. encouraging the reduction, recovery or correct environmental treatment of waste).[92] In the future, these kinds of initiatives should be pushed forwards as it could incentivise players in the tourism sector, such as hotels, to become more circular.

I.02 Inefficient waste management/recycling systems, practices and infrastructures
The inefficient waste management systems remain a challenge. The Canary Islands face several challenges when dealing with the huge amounts of waste, as they are one the most densely populated archipelagos in the world, they are the second autonomous community in Spain with the biggest amount of solid waste generation (594kg/capita/year), and waste management proves to be difficult due to several reasons such as being an ultraperipheral region which translates into higher transportation costs for waste being sent to mainland Spain for its special treatment. Furthermore, geographic fragmentation makes it more expensive to collect waste across the islands. If we add on top of all these constraining factors, the arrival of more than 15 million tourists a year, the efficient management of waste in the tourism sector of the Canary Island remains crucial in order to implement CE. Several solutions are going to be implemented by the Government of the Canary Islands to tackle this situation, by implementing the "Integral Waste Plan for the Canary Islands 2020-2026" which will be aligned with the "Canarian Strategy for Circular Economy".[93, 94] Also, the Canary Islands will become the first autonomous region in Spain to implement the law against single use plastics in 2021.[95,96] For example, establishing a plastic/glass bottle recollecting machine in all supermarkets of the island (similar to Germany's system) could be a further step for efficient waste management. Even though, the Canary Islands are making important progress on waste management, it still remains one of the key challenges for the CE transition and the islands are still far behind compared to Germany.

Player 2 – Tourism sector

R.06 Accurate and reliable information is not available along SC making it difficult to implement looping actions
There is a lack of accurate and reliable information on who is already performing circular economy practices across the sector. One clear example is the fact that there are many certifications/labels for sustainability such as ISO 14001, EMAS and Travellife Sustainability System.[97] However, there are no circular economy certifications/label for tourism businesses and destinations. Therefore, in order to be able to identify the

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[92] Fundación-Canarias-Recicla, *Manual de gestión de residuos en establecimientos turísticos*, Cabildo de Gran Canaria (n.d.), http://descargas.grancanaria.com/medio_ambiente/residuos/generica/Manual-de-Gestion-de-Residuos-en-Establecimientos-Turisticos.pdf.

[93] EFE, "El Plan de Residuos prevé que la basura se traslade de unas islas a otras," *RTVC* 2019.

[94] Gobierno-de-Canarias, "El Gobierno regional presenta a los cabildos el borrador del Plan Integral de Residuos de Canarias," news release, 2020b, https://www3.gobiernodecanarias.org/noticias/el-gobierno-regional-presenta-a-los-cabildos-el-borrador-del-plan-integral-de-residuos-de-canarias/.

[95] EFE, "Canarias prohibirá los plásticos de un solo uso a partir de 2021," *El Diario* (Las Palmas de Gran Canaria) 2020, https://www.eldiario.es/canariasahora/sociedad/Canarias-pionera-prohibir-plasticos-partir_0_1000550443.html.

[96] Tragastec, *Estrategia para el Plástico en Canarias. Documento de diagnóstico*, Tecnologías y Servicios Agrarios, S.A (2019), http://www.datosdelanzarote.com/Uploads/doc/Estrategia-para-el-plástico-en-Canarias-2019-20190625114346808Estrategia_para_el_plxstico_en_Canarias_Gob_CanV04.pdf.

[97] Fundación-Canarias-Recicla, *Manual de gestión de residuos en establecimientos turísticos*.

tourism stakeholders that are performing their activities on a circular way, efforts are needed to track through the use of indicators the CE impact and communicate it, through a circular label/certificate special for tourism, to the resident population, tourists and other stakeholders interested in having circular economy partners for their businesses. This will facilitate the implementation of CE practices across the tourism value chain as more companies will be more aware of the different stakeholders implementing CE, facilitating synergies between businesses of the sector.

CUSTS.01 Only niche markets for CE offerings
The preference among the tourists for new and cheap instead of second-hand, recycled, environmentally-friendly products remains a challenge. Tourists going on holiday to the Canaries spend on average 139€/day. 37% of the incoming tourists affirm that price is a key reason when deciding to go for holidays to the Canaries, being for the United Kingdom tourists (1st incoming market with 32.7% of the tourist quota) the 4th most relevant factor.[98] Tourists have a strong negative impact on the environment of the Canary Islands with their purchasing decisions. For example, when buying sun umbrellas and beach toys for their short stay they usually end up leaving them behind in beaches, hotels and airports which are then thrown away. Incentivising circular business models in beach avenues where tourists can rent sun umbrellas and other beach materials and even recollect such materials at key tourist points for its reuse and remanufacture, would drastically reduce the amount of waste generated. However, tourism businesses will need to make marketing efforts to make these remanufactured/recycled, second-hand products seem attractive, are also high-quality and affordable. Efforts on raising awareness on the importance of moving towards CE through marketing instruments will enable businesses to shape the wrong perception of consumers on these products.

Player 3 – Resident population
S.02 Society's aversion to change their current behaviour, values and attitudes
There is high resistance to change towards CE from the residents if it can have negative consequences on the tourism industry. This is because the well-being of all residents in the Canary Islands heavily depends on the well-being of tourism sector (see point 1 of the specific features in the theory). Therefore, changes towards CE that can negatively impact the tourism sector will face heavy resistance from the canarian society. The challenge for residents is therefore twofold: identifying elements to move towards CE tourism that will have a low negative impact on the tourism sector and promote those elements among their peers. Organisations within society, such as NGO's where residents can volunteer, will play an important role to tackle the challenge of the canarian's aversion to change towards a CE and to promote awareness among the population.

P.05 Insufficient integration of CE in the political agenda and weak political commitment
There is a low political commitment towards CE. Green parties promoting more sustainable tourism policies in their political agendas do not gain enough importance in elections to have a tangible impact. For example, in the Spanish general elections of November 2019 the majority of the residents in the Canary Islands granted their votes to political parties such as PSOE (28.88%) and PP (20.79%) that didn't have a 'green

[98] PROMOTUR, *Perfil del turistas que visita Islas Canarias. Reino Unido* (2019b), https://turismodeislascanarias.com/sites/default/files/promotur_reino_unido_2019.pdf.

agenda for tourism' such as the "Más País-EQUO Canarias" party and "Los Verdes" which obtained 1.57% and 0.33% votes respectively.[99] The residents have a strong power to decide on the course of their island's economic development and can influence with their votes the implementation of a more circular tourism model that favours the whole canarian society. Therefore, residents could have a great impact by promoting among their peers the importance of electing political parties, hence giving CE a more prominent role in their political agenda.

CONCLUSION

The aim of our research paper was to identify the challenges of implementing CE in the tourism sector for the specific case study of the Canary Islands. This proved to be very difficult as research on CE and tourism is still in its infancy[100] and even less has been done for CE challenges in tourism (only one article with several limitations[101]). Hence, we leveraged this gap identified in literature for this paper. After identifying 42 research papers for our body of research from the initial 1,106 papers selected, we carried out open codification of 731 CE challenges and mapped them into 3 levels with its corresponding frameworks: macroenvironmental (PESTEL framework), microenvironmental (resources, value chain, infrastructure) and organisational (Ordering Moments, Business Model Canvas, Ellen MacArthur Foundation Butterfly Diagram). These challenges were then clustered into 68 CE challenge patterns and the input from EU, Spain and Canary Islands CE Strategies was later mapped to the identified patterns.

This research article has several academic contributions. The comprehensive overview of the industry unspecific CE challenge patterns mentioned in literature can be leveraged as starting point for CE challenge studies for different industries. The chosen case study can be leveraged as a reference point for further case studies in other tourism destinations and serves as foundation for further theory development. For the professional world, this overview of challenges can help different players within the tourism sector of the Canary Islands to be aware of them and to move towards CE in a more effective and efficient way.

Finally, this paper is not free of limitations. First, due COVID-19 pandemic and time constraints, we only had the possibility to perform a systematic literature review and map the identified 68 CE challenge patterns to the EU, Spain and Canary Islands CE strategies and provide a discussion which was based on examples from our opinion. In a future research it would be interesting to change this by conducting expert-based interviews from the three different levels to really see how this can apply to the case of the Canary Islands tourism sector. Second, our focus was on social sciences, such as tourism, to identify the challenges. It would be interesting to focus on other fields such as engineering or design (or other sectors such as agriculture, construction…), therefore further research could be to combine the expertise from researches across different fields to have a shared, multidisciplinary vision of the challenges in moving towards CE. Third, the selection of the case study specific for the Canary Islands has certain limitations, as the findings in the discussion might be only applicable to certain contexts experiencing similar conditions. Hence, further research for other use cases is needed.

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[99] Resultados-de-las-elecciones-generales-en:Canarias, "Resultados de las elecciones generales en: Canarias," *ABC* 2019, https://www.abc.es/elecciones/elecciones-generales/resultados/canarias/?ref=https%3A%2F%2Fwww.google.com%2F.

[100] Vargas-Sánchez, "The unavoidable disruption of the circular economy in tourism."

[101] Sørensen, Bærenholdt, and Greve, "Circular economy tourist practices."

ANNEX

Annex 1. Macroenvironmental and Microenvironmental level challenges

Area	Challenge	MACROENVIRONMENTAL LEVEL CHALLENGES		
		Description of challenge	**Article details**	**Context of the CE strategies at EU, Spain (ESP) and Canary Islands (CN)level**
Political	P.01 Missing adaptation and alignment of policies to local contexts	There is a lack of harmonisation between the policies applied at a supranational/governmental and local level. The regional policies are not adapted to the local contexts and the sustainability goals of cities are sometimes in conflict with national priorities. "Regional policies not calibrated to local contexts" (p.7).[41]	# Articles of 42 total: 5 Article IDs: 12,13,26, 38,41	**EU:** They propose to adapt the CE solutions to outermost regions and islands, "due to their dependence on resource imports, high waste generation fuelled by tourism, and waste exports" (p.19). Also, to cooperate with national authorities to ensure that sustainability requirements are applied as accorded for EU market products. **ESP:** Inter-ministerial and inter-territorial cooperation for efficient implementation of CE adapted to local context is cited as a challenge. **CN:** They are working on the formulation of regional strategies for CE to adapt the EU and ESP CE strategies.
	P.02 Lack of international alignment and collaboration regarding policies and agreements	There is a lack of global consensus when it comes to waste management and trade of looped materials. Economic blocks, countries and municipalities do not fully align on policies favouring a circular economy. "There are a lot of different countries, so you need a high level of consensus and that is not easy" (p.266).[7]	# Articles of 42 total: 4 Article IDs: 38,32,8,7	**EU:** They will support Member States in waste management policy reforms by enabling them to make the best use of EU funds through high-level exchanges on the circular economy and waste. EU will focus on establishing a smooth-running internal market for secondary raw materials by supporting "cross-border initiatives for cooperation to harmonise national end-of-waste and by-product criteria" (p.17). Furthermore, "to support a global shift to a circular economy, the Commission will propose a Global Circular Economy Alliance to identify knowledge and governance gaps in advancing a global circular economy and take forward partnership initiatives" (p.22). **CN:** The EU can provide guidance on the degree of development of the CE's in the outermost regions and help by supporting platforms/networks between the outermost regions to share knowledge and exchange information and experience.
	P.03 Inefficient governmental structures	The bureaucracy blocks company's application of sustainability policies and legislations. There is a lack of decentralization of decision-making and lack authority to effect change. "Cities lack the institutional capacity to deliver looping actions across resource types" (p.11).[12]	# Articles of 42 total:10 Article IDs: 41,37,24, 22,27,12, 19,15,26, 2	**ESP:** To reduce the administrative boundaries, Spain wants to create synergies that will facilitate the implementation of CE, by promoting the creation of appropriate channels to facilitate the exchange of information and coordination with public administrations, economic and social actors and the scientific community. **CN:** They want to create a CE platform in the Canary Islands to engage all key stakeholders.

	P.04 Lack of adequate CE support by the government such as incentives/ funding, trainings and legislation	Lack of CE support by the government in form of few financial incentives, trainings, CE policies (such as for public procurement). "The lack of funding opportunities likely relates to the unclear market demand for CBMs" (p.6).[4]	# Articles of 42 total:16 Article IDs: 27,22,41, 34,33,3,1, 37,12,40, 23,5,7,16, 4,17	**EU:** They will use cohesion policy funds and EU financing instruments, the Just Transition Mechanism and urban initiatives to support the CE transition at regional level. The EU will also enable circularity by facilitating industrial symbiosis through the development of an industry-led reporting and certification system. **ESP:** They will give funding priority to those loan applications for industrial competitiveness that incorporate in their production processes a reduction in the raw materials used, to those which incorporate eco-design criteria that allow for the final recovery of the product, etc. "The promotion and financing of R+D+I activities and projects in public-private collaboration, considering the joint development of research and technological development projects of high impact and strategic nature in the field of the circular economy" (p.58). **CN:** They will support recycling, repair and reuse companies. They will also support sharing economy companies that promote the exchange of products, reuse of second-hand products or collaborative consumption. They will introduce financial incentives for the recycling and reuse of by-products and waste.
	P.05 Insufficient integration of CE in the political agenda and weak political commitment	The silo-mentality within governments hinders the implementation of circular economy. Lack of strong policy maker's commitment and support for sustainability issues. There is a lack of integrated approach for policy-making and deficient institutional frameworks. Energy-saving and pollution reduction conflicts with GDP due to limited attention by national and regional governments. "Lack of political initiatives supporting CE tourism innovation" (p.3).[18]	# Articles of 42 total:13 Article IDs: 41,42,37, 40,17,12, 19,8,30,1, 5,18,11	**ESP:** They propose the implication of all Ministries in order to facilitate the progressive introduction of the CE model in each of their areas of political action. Thus, promoting its effective incorporation into the spectrum of the private sector (businesses, workers and consumers) that each ministry regulates or conditions with its policies. **CN:** They consider it crucial to have long-term political commitment and a stable political environment in order to advance towards CE.
Economic	E.01 Tax system favours linear economy and does not support CE	Tax systems are not aligned with CE (e.g. high taxes on waste, lack of taxation of labour rather than raw materials…). This unfavourable tax environment leads companies to avoid the implementation of CE, although they are willing to do so. "Existing taxation systems, policies as well incentives, are not aligned with the adoption of the CE paradigm" (p.7403).[9]	# Articles of 42 total: 7 Article IDs: 41,17,9,8, 4,42, 22	**EU:** To favour a more CE like taxation system they "will continue to encourage the broader application of well-designed economic instruments, such as environmental taxation, including landfill and incineration taxes, and enable Member States to use value added tax (VAT) rates to promote circular economy activities that target final consumers, notably repair services" (p.21).

	E.02 Low economic development makes CE implementation at scale difficult	Poor economic development makes recycling practices difficult as there is lacking infrastructure in place and different priorities. A higher environmental culture is usually linked to higher economic development. "More wealthy regions are able to dedicate more resources to innovation in circularity" (p.7).[38]	# Articles of 42 total: 2 Article IDs: 2,38	
Social	S.01 Low level of awareness on the need for a more sustainable economy	Consumers are not aware about the importance of CE, which makes it difficult to adopt sustainable practices. Consumers don't see the urgency of changing their habits for the benefit of the environment, society and the economy. Also, the awareness among logistic companies and producers is still too limited to trigger a large-scale shift towards a CE. "Need to raise awareness on the impact of 'habitual choices' on environmental, social, political and cultural system" (p.2201).[13]	# Articles of 42 total:16 Article IDs: 1,38,5,12, 13,14,17, 20,22,26, 36,37,40, 41,23,7	**EU:** Through trainings, guidance and the spread of good practices they will enable citizens to become more aware on CE. **ESP:** They are planning on carrying out awareness and information campaigns on the Spanish CE strategy and on household waste separation. **CN:** In their strategy they mention the importance of co-creating short and long-term measures and actions with citizens and strategic actors that can be implemented through a combination of top-down processes and bottom-up processes, where civil society, aware of the challenges and objectives to be achieved, becomes more involved in the implementation of the measures and actions.
	S.02 Society's aversion to change their current behaviour, values and attitudes	There is a rigidity in consumer behaviour towards change in their habits. The existing values, norms and lifestyles may hinder the implementation of a CE, as there is little or no willingness to change their behaviour and consumption patterns, Customers usually question the quality, health and safety of reused and remanufactured products, and tend to have the wrong perceptions on them. Hence, this lack of willingness to buy used products forces the remanufacturers to not go for refurbishing/remanufacturing. "Lack of customer interest in the environment" (p.1055).[3]	# Articles of 42 total:15 Article IDs: 32,41,33, 30,14,12,3, 1,8,19,38, 11,20,18, 25	**ESP:** They are well aware that consumers play a crucial role in the transition towards CE. According to them, it will only be possible through the collaboration, participation and involvement of society as a whole, especially consumers and citizens, due to their purchase decisions and their waste management behaviour. **CN:** They identify the importance of changing the consumption and lifestyle patterns amongst the canarian society at all levels: individual, family and business.
	S.03 Missing enablement of the people towards CE	There is a lack of understanding of CE among many players in society, due to education deficiency on CE. Waste topic is not included sufficiently in school curricula, hindering the enablement of children to take more circular actions. Low rates of recycling in society are related to a lack of proper education on environmental issues. "Lack of availability of environmental management programs and facilities both under governmental bodies and at academic institutions" (p.10).[17]	# Articles of 42 total: 7 Article IDs: 2,6,8,11, 31,41, 17	**EU:** They plan "investment in education and training systems, lifelong learning, and social innovation will be promoted under the European Social Fund Plus" (p.19). **ESP**: They will design tools to promote awareness on the dangers and inefficiencies of the linear model, as well as the benefits and opportunities associated with the transition to a CE. These tools aim to improve training and learning, both for citizens and companies, on several techniques and good practices that will drive the CE in Spain. **CN:** In order for their strategy to be sustainable in time, they claim that there needs to be a cultural change in people that will come through environmental education and training and training of workers and entrepreneurs on CE principles.

	S.04 Low acceptance to lack of ownership	Consumers still want to have ownership over their products, making it difficult to control the circularity of these. The attachment to physical products causes resistance on both sides (company-consumer) and a significant effort is needed to break traditional relationships. The possible loss of intangible values such as sense of control and self-esteem hinders the willingness of consumers to renounce to ownership, as property and material consumption is deeply embedded in society. "The message of a circular economy may come across as 'what you have is only temporarily yours', thus not conveying the same values as are currently associated with property" (p.13).[36] "The change in the ownership of physical elements in the systems is linked to the transformation of roles. In sustainable PSSs, mainly user- and result-oriented ones, businesses and clients make a shift from producers and consumers of products, respectively, to being providers and users of a function" (p.4).[35]	# Articles of 42 total: 7 Article IDs: 36,20,1,39, 35,9,10	**EU:** The Commission is aware of society's low acceptance to lack of ownership and therefore proposes as part of their sustainable product policy legislative initiative, to incentivise "product-as-a-service or other models where producers keep the ownership of the product or the responsibility for its performance throughout its lifecycle" (p.7).
	S.05 Conflicting interests with CE	Implementing a CE can prove to be very challenging as there are certain issues that impede this transition, such as hygiene and safety issues. Furthermore, it is not always possible to be a more environmentally-friendly consumer as the system is not ready yet for this transition; making it more difficult or expensive to be "circular" than staying "linear". "Vested interests incurred against greener economies" (p.24).[28]	# Articles of 42 total: 3 Article IDs: 20,28,36	**EU:** They want to reduce conflicting interests by ensuring consumer CE rights: "new horizontal material rights for consumers for instance as regards availability of spare parts or access to repair and, in the case of ICT and electronics, to upgrading services" (p.8).
Technological	T.01 Existing technologies are not adapted to CE	Technology for CE is not available at scale at a cost-effective level. There is current limited proof for CE technology. There are many technological limitations for the tracking of recycled materials, due to the increasing complexity of products, which make the effective and efficient recovery and reuse of products and components a massive challenge. "Lack of adequate technologies used in landfilling and incineration activities cause huge irrevocable environment losses" (p.11).[17]	# Articles of 42 total:12 Article IDs: 42,37,41, 30,22,6,38, 1,8,14,33, 17	**EU:** "The Commission will enable greater circularity in industry by promoting the use of digital technologies for tracking, tracing and mapping of resources" (p.9). **ESP:** They want to promote technological development and innovation in public procurement initiatives in CE by encouraging collaboration between public administrations and innovative agents. **CN:** They will promote innovation and research in different subjects related to CE for the development of specific technological solutions adapted to the Canary Islands.

Environment	EN.01 Natural resources need costly and/or time-consuming treatment to be leveraged for CE	Natural resources are limited and its appropriate extraction and 'take-back' to the environment is crucial, but as they get contaminated and degraded, their ability to be introduced in the circular system is more complex and costlier. Thus, this makes it less attractive in the short-term for governments to invest in changing their linear approaches.	# Articles of 42 total: 2 Article IDs: 12,14	**CN:** They consider in their strategy as a barrier that it some outermost regions (such as they Canary Islands) suffer from problems related to soil and water quality, as well as, waste management problems, which hinder the transition to a CE.
	EN.02 Geographical circumstances restrict applicability of CE solutions	Due to the geographical circumstances, the ability to implement certain circular economy procedures may be hampered. "The difference between geographical circumstances affects metabolic flows and applicability of solutions" (p.7).[38]	# Articles of 42 total: 2 Article IDs: 38,14	**CN:** Due to the special geographic conditions from the Canary Islands drinking water is very scarce. Most of the water consumed in households and businesses comes from desalination plants, which in turn are powered by non-renewable energy making the production of drinking water unsustainable. To change this, the energy needs to come from renewable sources that aren't fully adapted and implemented to make it possible in CE way.
Legal	L.01 Lacking international and national legislation/regulation agreements and joined supportive frameworks for CE	The misalignments in EU- wide chemicals, product and waste legislation hamper efforts to recycle and re-use products. There is a lack of vision and consensus from governments for CE and a lack of coordination of regulations at EU, national, regional and local level in the field of sustainability. No joined-up supportive framework as the legislation at an international level remains sector specific (e.g., the Water Framework Directive, Waste Framework Directive) rather than integrative. "The need for harmonized legislation between EU Member States" (p.52).[34]	# Articles of 42 total: 5 Article IDs: 39,42,34, 15,12	**EU:** The EU is moving forward in international supportive frameworks for CE as they are establishing further measures to ensure that the EU benefits from "a well-functioning internal market for high quality secondary raw materials" (p.17). The Commission will also "support the effective and efficient application of the new sustainable product framework" by stepping up efforts, "in cooperation with national authorities, on enforcement of applicable sustainability requirements for products placed on the EU market, in particular through concerted inspections and market surveillance actions" (p.7). With the CE Action Plan they want to minimise the burdens on citizens and business while ensuring an efficient and effective regulatory framework. **ESP:** The ECOLABEL, established by the EU, is a very important step in the common agreement of certain environmental standards that are also applied at a national level to encourage the business sector to incorporate environmental policies into their production systems. The Ministry of Agriculture and Fishing, Food and Environment (MAPAMA) will continue to promote the use of the eco-labelled products in public procurement.

	L.02 Legislation not adapted to efficiently regulate CE	Existing obstructing and inconsistent laws and regulations hamper circular practices. Service providers cannot legally retain ownership of a sold product which makes it difficult to implement CE. Existing laws in waste management in some systems do not fit CE concepts. There is a lack of supporting government legislation with inadequately defined multi-level regulatory frameworks favouring linear processes. Legislation hinders Circular Business Models, e.g. legislation on sales of waste materials and on cross border movement of products for reuse. "Competition legislation inhibits collaboration between companies" (p.7).[37]	# Articles of 42 total:15 Article IDs: 12,7,30,33, 10,40,4,1, 26,42,22, 41,8, 24,37	**EU:** They are aware that the European waste laws need to be continuously improved to be adapted to the CE. Thus, the are going to undergo revision of EU legislation on packaging, hazardous substances in electronic equipment, batteries, end-of-life vehicles to hinder the generation of waste and foster safer and cleaner waste streams, as well as to escalate the recycled content and ensure its high quality. **ESP:** They consider adopting a strategic fiscal policy focused on specific (environmental) taxes to encourage certain CE practices as it will incentivise consumers, producers and private investors to move away from linear economy practices. **CN:** They mention lack of consistency in the canarian regulation as a challenge to implement CE.
	L.03 Insufficient implementation of CE regulations	There is a lack of regulatory pressures. CE laws are not strong enough; there is no existing tool to analyse the effectiveness of the proposed rules and laws. Most laws are posed with personal opinion rather than technical expertise. There is an inadequate, complex and fragmented legal system. "Governments and local authorities' responsibilities are not clear on the implementation of CE" (p.9).[17]	# Articles of 42 total: 3 Article IDs: 1,6,17	**EU:** The EU mentions that "there is no comprehensive set of requirements to ensure that all products placed on the EU market become increasingly sustainable and stand the test of circularity" (p.6). Therefore, they want to make sustainable business models, products and services the norm with the help of a sustainable product policy framework, minimising the production of waste at the source and encouraging a change in consumption patterns. "The core of this legislative initiative will be to widen the Ecodesign Directive beyond energy-related products so as to make the Ecodesign framework applicable to the broadest possible range of products and make it deliver on circularity" (p.6). **ESP:** There is yet no effective technical regulation on buildings that favours greater circularity of materials and products used in construction, as the current requirements limit their reuse. Thus, they are going to analyse the technical building regulations, to identify the existence of possible barriers hindering the latter, to incorporate aspects related to sustainability. **CN:** They analysed that there needs to be an effective enforcement of regulations on dumping and separate collection, including regulations on sanctions.
Area	**Challenge**	**MICROENVIRONMENTAL LEVEL CHALLENGES**		
		Description of challenge (insert two citations for each paragraph)	**Article details**	**Context of the CE strategies at EU, Spain (ESP) and Canary Islands (CN)level**

Resources	R.01 Lack of experts on CE to hire and CE training offerings	There is not enough qualified workforce on CE. There is a lack of interest and understanding to apply CE across value chains. There is a need for training and education on CE. There is no official training available for employees in repair/refurbish and no guidelines for third party repair companies. "Lack of qualified personnel in environmental management" (p.164).[16]	# Articles of 42 total: 5 Article IDs: 3,16,17,23,4	**EU:** They will "support capacity building with guidance, training and dissemination of good practices and encouraging public buyers to take part in a "Public Buyers for Climate and Environment" initiative, which will facilitate exchanges among buyers committed to Green Public Procurement implementation" (p.8). They want also to support the training of experts on CE practices "through the Skills Agenda, the forthcoming Action Plan for Social Economy, the Pact for Skills and the European Social Fund Plus" (p.27). **ESP:** They have incorporated various education, employment and training actions (informative videos, informative documents, etc). They will implement active labour market policies to adapt the current skills of workers to the new demands of the labour market. **CN:** They consider necessary the promotion of professional training in the field of CE due to a lack of human capital.
	R.02 CBMs have greater financial risks than linear business models	CBMs have greater financial risks than linear business models, which makes them less attractive for investors and finance institutions. Lack of public investment and banks are not willing to finance CE ventures because it is too risky and there are complex processes to apply for additional funding to develop innovative solutions. "Financial assessment, accounting and return on investment (ROI) based on linear concepts of rapid returns–Circular business models not seen as profitable or generating split returns" (p.7).[42]	# Articles of 42 total: 5 Article IDs: 5,4,12,41,42	**ESP:** Will use economic stimuli (in the form of grants, loans, subsidies, etc) aimed at providing financial support to private initiatives willing to adopt CE business models.
	R.03 Cheaper price for virgin materials whereas environmentally friendly and looped materials are more expensive	The low virgin price of virgin, finite materials creates unfair competition towards those using secondary materials which are more expensive. This makes it less profitable for companies to start working with looped materials (e.g. reused/recycled). "[…] consumers are often more focused on price rather than on the product's entire lifecycle" (p.296).[1] In virgin materials, the external costs (monetized environmental and social costs) of production are not completely included in the price. The logistics costs that are charged in the value chain are lower than the real costs, stimulating path-dependent behaviour of all players, as finite resources are not given a true price impeding the costs to be passed onto the whole value chain.	# Articles of 42 total: 8 Article IDs: 7,19,12,42,1,17,37,36	**EU:** "Creating a well-functioning EU market for secondary raw materials. Secondary raw materials face a number of challenges in competing with primary raw materials for reasons not only related to their safety, but also to their performance, availability and cost. A number of actions foreseen in this Plan, notably introducing requirements for recycled content in products, will contribute to preventing a mismatch between supply and demand of secondary raw materials and ensure the smooth expansion of the recycling sector in the EU" (p.17).

	R.04 Lack of efficient market to source available and high-quality CE resources	There is limited availability and quality of recycling materials due to technological limitations for recycling, product design and other processes. It is difficult to supply recycled/reused/refurbished products as there is limited demand for looped products. Lack of standardization on refurbishment products leads to a reduced quality. "Lack of market for recycled materials (e.g. glass, polymers)" (p.34)[22] and "original spare parts are difficult or impossible to attain or have to be transported over long distances" (p.10).[4]	# Articles of 42 total: 11 Article IDs: 39,22,4,41, 1,12,7,10, 37,31,23	**EU:** They are very well aware of this challenge therefore they will introduce several measures to "ensure that the EU has a well-functioning internal market for high quality secondary raw materials" (p.5). They are also going to take actions "on product design, quality and safety of secondary materials and enhancing their markets will contribute to making "recycled in the EU" a benchmark for qualitative secondary materials" (p.18).
	R.05 Lack of proof of solid CE theory, concepts, methods, measurements and role models (especially business models)	There is lack of data and indicators to measure (long-term) benefits of CE activities. Lack of clear, reliable standards to asses CE processes, activities, materials, leading to lack of public awareness and lack of demand for sustainable products. There is absence of perceived need to move towards CE "many companies do not see how lifecycle thinking can be applied to their specific operations – or even the benefits of doing so. Many potential users are unaware of how life-cycle approaches can aid in decision making" (p.20).[29] There is limited awareness of successful CE business models in resource management and planning projects, as well as lack of successful business models to implement CE in supply chain. "Knowledge development in the field of circular business models is still in its infancy" (p.14).[36]	# Articles of 42 total:19 Article IDs: 7,31,10,14, 15,4,11,37, 1,41,36,12, 22,40,6,5, 29,9,34	**EU:** They recognize in their action plan that there is "no comprehensive set of requirements to ensure that all products placed on the EU market become increasingly sustainable and stand the test of circularity" (p.6). However, "the single market provides a critical mass enabling the EU to set global standards in product sustainability and to influence product design and value chain management worldwide" (p.6), which is crucial for the implementation of CE. They will also set "a common European Dataspace for Smart Circular Applications with data on value chains and product information" (p.7) to support the effective and efficient application of the new sustainable product framework. **ESP:** They seek to promote the use of common, transparent and accessible indicators that allow you monitor the CE. Their starting point will be the identification of the existing indicators in the circular economy or similar ones in the different autonomous communities, as well as the leveraging proposals that are being worked on at a national, European and global level. They also seek a responsible consumption model, based on transparency of information on the characteristics of goods and services, their duration and energy efficiency, through the use of certain measures such as the use of the eco-label. **CN:** They propose the creation of indicators or statistical systems that will monitor the progress in CE at regional level. Also, they consider the collection and sharing of disaggregated statistical data on waste important for its use in the business sector.

	R.06 Accurate and reliable information is not available along SC making it difficult to implement looping actions	Lack of reliable and accurate information on CE hinders public awareness and makes it is difficult to reuse, remanufacture and recycle products. Furthermore, there is asymmetric information available regarding materials and tracking in SC towards recycling. The necessary data to adopt CE principles is not available at the needed level (e.g. geographic) and along the value chain, "reducing the assessment of CE impacts, decision making and the validation of environmental impact" (p.7).[42] "The value that waste can have with an adequate treatment (separation, reuse or recovery) is unknown" (p.5).[2]	# Articles of 42 total:11 Article IDs: 1,22,27,17, 30,40,2,7, 42,29,5	**EU:** Wants to implement information systems to detect the presence of hazardous substances. They will also set "a common European Dataspace for Smart Circular Applications with data on value chains and product information" (p.7) to support the effective and efficient application of the new sustainable product framework. **ESP:** The Ministry of Agriculture and Fishing, Food and Environment (MAPAMA) will develop different platforms and computer tools, with the aim of monitoring waste prevention and management. They can be used by the agents involved in the consumption, production and recycling chain.
	R.07 Information exchange regarding CE along the supply chain is not always possible	Information exchange between different stakeholders regarding CE along the supply chain is not always possible due to the confidential nature of the information and lack of trust, which limit the spread of knowledge, the transparency and average improvement of the system. "CE requires a close collaboration and information exchange among the different tiers of the supply chain, which may not be achieved especially within global configurations. This can be due to several reasons such as competition among supply chain tiers, information sensitivity, IT system integration, poor planning of activities, etc" (p.7405).[9]	# Articles of 42 total: 5 Article IDs: 9,37,36,12, 10	**EU:** They will set "a common European Dataspace for Smart Circular Applications with data on value chains and product information" (p.7) to support the effective and efficient application of the new sustainable product framework. The Commission will consider the regulation of product information through digitalisation in the form of digital passports, tagging and watermarks. This can facilitate the exchange of information on CE along the supply chain. **CN:** They want to put in place a CE platform for the Canary Islands that can bring together all they key players and citizens involved. Furthermore, they want to ensure access to information, public participation and environmental justice. In this way, the future strategy for the circular economy will respect the principles of transparency and inclusiveness in its development and objectives.
Value Chain	VC.01 Misaligned profits, incentive systems and pressures along value chain making CE adoption unattractive	There are misaligned returns and/or incentives for investments into CE across the value chain, diminishing the willingness to change or collaborate. The lack of mutual benefits due to misaligned profit sharing along supply chain hinders collaboration and circular business model adoption. If there is no large-scale trigger towards CE coming from production, distribution and selling industries, the logistics industry will not consider it necessary to change the way of doing business. "The whole supply chain needs are not included. Many developed nations outsource their products to low wage nations, which brings products as well as waste generation. However, there is no such specificity on circular economy dealing with the focus on sub suppliers" (p.298).[1]	# Articles of 42 total:10 Article IDs: 42,10,12,3 3,32,36,34, 41,31,1	**EU:** They mention in their action plan that "the linear pattern of "take-make-use-dispose" does not provide producers with sufficient incentives to make their products more circular" (p.6). They also want to strengthen the capacity of EU to take more responsibility for its waste and revise rules on waste shipments. "The global market for waste is undergoing considerable changes. In the past decade, millions of tonnes of European waste has been exported to non-EU countries, often without sufficient consideration of proper waste treatment[…] Recent import restriction introduced by some third countries have exposed the overdependence of the EU on foreign waste treatment, but they have also mobilised the recycling industry to increase its capacity and add value to waste in the EU" (p.18).

	V.02 Complex and costly to adapt the value chain to reverse logistics	The exchange of materials is limited by the capacity of reverse logistics. The reverse logistics organisation and stability prevents companies from implementing circular business models. "The quality, access and attractiveness of recovered products and materials" (p.7)[42] remains challenging. "Extending the supply chain to include remanufacturing, recycling, repair and refurbishing creates an additional level of complexity, leading to potentially negative impacts in quality, cost, and delivery times" (p.22).[22]	# Articles of 42 total: 8 Article IDs: 22,32,37, 10,31,39, 42,40	**EU:** The EU wants to "set global standards in product sustainability and to influence product design and value chain management worldwide" (p.6). **ESP:** Their strategy recognizes that not all sectors have the same potential to adapt to a circular production, consumption and reuse model. According to them, they are still far away from being able to establish a global circular model even if many sectors have already begun to incorporate recycling practices which reduce the demand for new raw materials and help to alleviate the ecological deficit.
	V.03 Lack of willingness and trust to collaborate across the value chain	Network collaboration across the value chain (VC) to facilitate the implementation of CE all along remains very complex. It is very difficult to find and create the appropriate, trustworthy networks (especially from supply chain) necessary for circularity. "From a supply perspective, a major challenge seems to be the absence of "green" suppliers for specific inputs that the SME needs in the production process of a product or a service. According to the SMEs, in most cases markets for these inputs are absent or insufficiently developed in the supply chain. Also, some SMEs report difficulties in implementing a green solution since they are locked in at the bottom of the supply chain or they are part of global supply chains sectors with correlated high environmental impact" (p.10).[27] It is complicated to have a strong commitment towards the implementation of CE and to get the entire industry onboard, as not all e.g. packaging component manufacturers, packaging equipment users, material producers, waste recovery facilities have same interests. "Involves actors from across society and creation of suitable collaboration and exchange patterns" (p.1033)[31] and "CBM is based on collaboration, and that requires trust between parties" (p.5).[10]	# Articles of 42 total:14 Article IDs: 4,33,27,35, 12,40,7,21, 10,14,31, 36,22,1	**EU:** They will "support capacity building with guidance, training and dissemination of good practices and encouraging public buyers to take part in a "Public Buyers for Climate and Environment" initiative, which will facilitate exchanges among buyers committed to Green Public Procurement implementation" (p.8). Furthermore, they want to empower consumers and make CE more economically viable: "the Commission will propose a revision of EU consumer law to ensure that consumers receive trustworthy and relevant information on products at the point of sale, including on their lifespan and on the availability of repair services, spare parts and repair manuals. The Commission will also consider further strengthening consumer protection against green washing and premature obsolescence, setting minimum requirements for sustainability labels/logos and for information tools" (p.8). **ESP:** They have identified 'lack of trust from the operators' as a main barrier in by-products. Therefore, the Ministry of Agriculture and Fishing, Food and Environment (MAPAMA) will prepare the corresponding ministerial orders that will provide guidance on under which circumstances by-products can be used with all the safeguards for human health and the environment. Hence, operators will have a greater certainty and fair competitive conditions. **CN:** To facilitate network collaboration across the value chain, they are willing to create a CE platform which will bring together all key players and citizens. They also propose to organise workshops on the CE to promote cooperation between different organizations and the dissemination of specialized information.

	V.04 Dependency on other companies following a linear economy system hinders the transition towards CE of individual firms	Globalisation contributes to greater interdependency between different companies and value chains, with global supply chains that find it difficult to change their operating business models towards CE but can't fully implement it, due to the lock-in effect, as it is incompatible with the existing linear operations and development targets. "Changes in the leading industries are complex: a company that wants to start working circularly may be dependent on other (supplying) companies and the pace at which this start operating circularly" (p.12).[36]	# Articles of 42 total:10 Article IDs: 31,36,42,7, 12,4,28,40, 1,41	**EU:** They will facilitate the transition towards CE by introducing mandatory requirements that will increase the sustainability of goods and services. To smooth this transition, they consider the "possibility to introduce requirements linked to environmental and social aspects along the value chain, from production through use to end of life, […] including in the context of WTO rules" (p.7). They also want to enable companies to become more circular by facilitating industrial symbiosis. **ESP:** In their strategy they recognise that the transition towards a CE will only be possible if the whole society and all economic sectors (manufacturing, production, distribution and waste management) are involved and collaborate.
Infrastructure	I.01Information collection processes and information sharing platforms not in place/ not efficient enough	Important concerns on data privacy and data security hinder the collection of end-of-life products and hinder the sharing of information along different levels of the supply chain due to competition issues, information sensitivity, etc. Lack of knowledge and internal procedures for collecting and managing the right data, e.g. life cycle data. Furthermore, there is inconsistent external and internal data as well as traceability issues that can impede the adoption of CE. "Difficult communication between knowledge-transfer actors with social science and engineering or design background" (p.7)[38] and the need for the "creation of a consistent database for performance comparison between cities" (p.328)[8] are challenges that hamper CE implementation among others.	# Articles of 42 total: 9 Article IDs: 9,29,12,8, 5,25,38,1, 17	**EU:** They will set "a common European Dataspace for Smart Circular Applications with data on value chains and product information" (p.7) to support the effective and efficient application of the new sustainable product framework. This will contribute to improve data collection. **ESP:** They propose to improve the information available on good practices for individuals, businesses and society as a whole, to boost the CE from a corporate social responsibility perspective. In their strategy they mention constant cooperation and collaboration between the public and private sector as a means to support and facilitate the flows of information and good practices between researches, public administrations, businesses, industries as well as all organisations committed to sustainable development and CE principles. **CN:** They identify a lack of available information and lack of up-to-date statistical data in the Canary Islands. They emphasise the importance to improve the collection of relevant data that would provide a reliable information base for future policy formulation and fund designation.

	I.02 Inefficient waste management/recycling systems, practices and infrastructures	Lack of economies of scale in waste treatment/recycling hinders the implementation of appropriate infrastructure necessary for CE, as "it is prohibitively costly for individual organisations to invest in smart enabling technologies for waste management" (p.19).[6] Furthermore, some regions cannot reach economies of scale, as there is not enough amount of waste and also due to the geographic conditions, such as islands with certain conditions that limit their possibilities as isolated environments "the bulk density of the roasted material makes it difficult to transport and store it from an economic point of view" (p.4).[2] Not all regions have the necessary waste containers in public spaces for appropriate waste separation and "points for separated waste collection frequently becoming wasted areas (illegally dumped litter near the separate collection bins)" (p.8).[41] Non-integrated poor waste infrastructure and long distances between waste generation and treatment. "Dual waste system (households/ industrial) hinders waste management optimization" (p.7).[41] Many of the areas performing landfilling and incineration activities lack adequate technologies. It is difficult to clearly allocate responsibilities on waste management.	# Articles of 42 total:14 Article IDs: 6,34,23,2, 24,33,12,41,17,39,8, 14,5,13	**EU:** They will establish rules for the safe recycling of plastic materials, other than PET, that have been in contact with food. To facilitate separate collection of packaging waste at source, they want to establish an EU-wide harmonised model. **ESP:** The Ministry of Agriculture and Fishing, Food and Environment (MAPAMA) will develop different platforms and computer tools, with the aim of monitoring waste prevention and management. They can be used by the agents involved in the consumption, production and recycling chain. Furthermore, they want to implement an electronic waste information system to improve the transparency and traceability of waste, to increase the harmonisation of shipments and to facilitate the control of waste movements carried out by economic operators within Spain. This system will be accompanied by a module on transboundary shipments with third countries, which will facilitate the communication with the Tax Agency, the Civil Guard and the Autonomous Communities. **CN:** Millions of tourists arriving every year to the Canary Islands increase exponentially the amounts of waste generated aggravating the already complex waste management situation of the islands. To help manage it in the most effective and efficient way, there is already an Integral Waste Plan for the Canary Islands in place (PIRCAN 2020-2026).
	I.03 Difficult to implement CE spatial planning and transportation infrastructure	Lack of spatial planning mechanisms following CE rules and difficulties to manage complex urban systems. "Tension between urban planning and facilitating the kind of experimentation that CE calls for (how to manage the changing economy and the changing structure in a built form)" (p.2200).[13] The socio-technical lock-in hinders the implementation of CE, "even if there is willingness amongst institutions providing urban infrastructure and services to adopt circular design or integrated approaches, it is practically difficult to alter these infrastructural systems due to the capital cost and disruption generated by such a radical transformation" (p.10).[12]	# Articles of 42 total: 3 Article IDs: 12,14,13	**ESP:** They want to implement an electronic waste information system to improve the transparency and traceability of waste, to increase the harmonisation of shipments and to facilitate the control of waste movements carried out by economic operators within Spain. This system will be accompanied by a module on transboundary shipments with third countries, which will facilitate the communication with the Tax Agency, the Civil Guard and the Autonomous Communities. **CN:** The double insularity of the islands hinders the effective and efficient application of CE. Furthermore, they consider that moving towards a more circular transport sector involves several sectors including the optimisation of logistics services, transport infrastructures and the transport of passengers and goods.

For the strategy/vision, structure and cultural/management blocks nothing has been identified in the EU, Spain and Canary Islands CE strategies, as these challenges are most likely to be in company CE strategies rather than on a supranational. national and regional level.

Annex II. Organisational challenges – Ordering Moments St. Gallen Management Model

Area	Challenge	Description of challenge (insert two citations for each paragraph)	Article details
Strategy	STRAT.01 Shareholder interests not aligned with CE, lack of CE vision	Dealing with a trade-off on whether to have short-term profitability or long- term sustainability. As CE usually involves high short-term costs and low short-term economic benefits instead of low short-term costs and high short-term benefits from a linear economy. "Focus on short-term returns on investment" (p.1033)[31] and "missing the strategic relevance of sustainable development" (p.1033).[31] CE approaches are not always seen profitable (e.g. high requirements for pollution reduction and energy saving), and insufficient ROI, which makes it harder to attract investment. This lack of investment power challenges the implementation of CE. Also, there is a lack of holistic thinking and a multistakeholder approach. There is a high focus on individual company interests and a lack of CE vision. Businesses face important amounts of sunk value and sunk cost that have already been invested in suppliers, real capital and human capital making it very difficult to transform their approach towards CE.	# Articles of 42 total:19 Article IDs: 1,26,28,5, 12,14,6,19,23,11, 39, 37,31,24,3,9, 22,33,15
	STRAT.02 Lack of transparency, forecast ability and difficult decision making	There is lack of end to end visibility and forecast ability hindering the implementation of CE. The challenge of validation not being achievable until further sales makes CE adoption riskier. Both poor forecast ability and difficult validation make decision making more challenging to implement CE in the most efficient and effective way. Businesses aren't certain that demand or input prices will not go back to past levels and there is uncertain return. "The business cannot be sure what new technologies and business environments will emerge such that if it tries to change too fast now, it will miss a better investment opportunity in the future" (p.19).[28]	# Articles of 42 total:6 Article IDs: 28,39,10, 35,1, 30
Structures	STR.01 Missing organisational abilities and structure for CE	Depending on how the organisation is structured, it will enable or hinder the implementation of CE in their business model. Lack of organisational capabilities which are necessary to implement circular practices across the organisations several functions. "Often, life-cycle practitioners are functionally a part of a company's environment, safety, and health division – separated or disconnected from the process design and product development departments. Thus, the knowledge of the life-cycle practitioners is not shared with developers, and the developers may not be aware of how life-cycle thinking can be integrated into design and development" (p.20).[29]	# Articles of 42 total:3 Article IDs: 1,29,33
	STR.02 Incentive systems misaligned with CE	The incentive systems are not adapted to CE: "Traditional incentive structures and performance metrics are inappropriate to support new business models" (p.10).[4]	# Articles of 42 total:4 Article IDs: 4,25,11,36
Culture	CULT.01 Lack of managerial commitment and leadership towards CE	From top down, managerial commitment and weak leadership towards CE are major challenges, which are argued by time constraints and reliance on business leaders to make the CE transition. From bottom up, heavy organizational hierarchies prevent bottom-up experimenting. "Lack of leadership commitment" (p.20).[6]	# Articles of 42 total:11 Article IDs: 1,6,24,41, 28,27,29,4,40,31,8
	CULT.02 Resistance to changes towards CE and conflict with the existing culture	Not all organizations are willing to change their business models to make them more or fully circular due to internal resistance to risk among managers and shareholders, rigidity in business routines and different preferences (preferences for incremental over radical innovation). The aversion to risk is a common resistance challenge towards the adoption of CE due to costly implementations. The hesitant company culture with predominant linear mindset encourages resistance to change towards CE. The prevailing structures in many industries, known as 'linear lock-in' act as a barrier to the implementation of CE. "Conflict of interest within companies" (p.2).[33] The already settled company culture conflicts with CE adoption due to again risk aversion, and the poor internal cooperation difficult it too. The silo thinking in the business's culture reduces the organization's efficiency.	# Articles of 42 total:15 Article IDs: 31,25,10, 24,33,30, 35,42,4,7, 9,12,40, 27,26

Annex III. Organisational challenges – Business Model Canvas

Area	Challenge	Description of challenge (insert two citations for each paragraph)	Article details	Context of the CE strategies at EU, Spain (ESP) and Canary Islands (CN)level
Customer segments	CUSTS.01 Only niche markets for CE offerings	The majority of consumers are not willing to buy environmentally-friendly products, remanufactured/recycled, second-hand products due to their own preferences and/or their lack of knowledge on the origins of the product and the on impacts their consumer behaviour can have on the well-being of all. There is still limited acceptance of products as services (e.g. lease agreements). "Used products are often considered more or less inferior, an idea that is strongly supported by marketing of new products. This preference limits the potential of organizing local collection and exchange of goods" (p.13).[6]	# Articles of 42 total:12 Article IDs: 5,17,36,1, 4,32,31,41, 6,42,10,35	**EU:** They want to promote consumer participation on CE by ensuring the provision of "high-quality, functional and safe products, which are efficient and affordable, last longer and are designed for reuse, repair, and high-quality recycling" (p. 5). **ESP:** To open the market for CE offerings, Spain, through the Ministry of Agriculture and Fishing, Food and Environment (MAPAMA), wants to boost the free circulation of secondary raw materials.
	CUSTS.02 Low willingness to pay for CE offerings	Consumers are not always willing to pay a plus for environmentally friendly products as price is a very decisive factor when tacking the final purchase decision. Circular products may be characterised by high selling price, due to enhanced quality (durability) or upgradability, thus constituting a barrier for the customer. It is important to increase the visibility of the benefits of the products to be able to argue for higher prices. "From a demand perspective, a major challenge underlined by the majority of SMEs is the need to create a business case for customers in order to buy a green product or to use a green service[…]the need to provide accurate figures and additional evidence of benefits related to green goods and services, the need to convince potential customers that the circular economy approach is the way forward, and the misperception of customers that green products and services are of lower quality than traditional goods and services" (p.10).[27]	# Articles of 42 total: 5 Article IDs: 9,41,18, 16,27	**EU:** "Empowering consumers and providing them with cost-saving opportunities is a key building block of the sustainable product policy framework. To enhance the participation of consumers in the circular economy, the Commission will propose a revision of EU consumer law to ensure that consumers receive trustworthy and relevant information on products at the point of sale, including on their lifespan and on the availability of repair services, spare parts and repair manuals. The Commission will also consider further strengthening consumer protection against green washing and premature obsolescence, setting minimum requirements for sustainability labels/logos and for information tools" (p.8).
	CUSTS.03 Short-term fashion and technology trends	Due to the rapid technological changes, there is a demand for frequent design innovations that hinder the remanufacture and reuse of products, causing CE products to have less competitive advantage in the market. Also, long-life designed products are unable to respond to fashion changes and other trends, which can cause consumers to take 'worse' decisions from a circular perspective. "Changing fashion trends can be a challenge for long-life products" (p.10).[4]	# Articles of 42 total: 6 Article IDs: 4,39,9,10, 32,36	**EU:** They wants to address fast fashion challenges and drive new circular business models in the textile industry through the "EU Strategy for Textiles". "The strategy will aim at strengthening industrial competitiveness and innovation in the sector, boosting the EU market for sustainable and circular textiles, including the market for textile reuse. […] This will be achieved by a comprehensive set of measures, including: increasing transparency through international cooperation" (p.13).

Channels	CH.01 Challenge to establish and control CE compatible channels	A lack of channel control is proven to be challenging when companies try to apply circular business models. "Both corporations and entrepreneurs face a lack of channel control" (p.22).[22]	# Articles of 42 total: 4 Article IDs: 10,11,22,39	
Customer relationships	CUSTR.01 Difficulty in efficiently branding CE offerings and low status of looped offerings	CE looped products are not perceived as equally good as new products. Also, inadequate branding of looped offerings affects the purchasing behaviour of consumers. "Low status of products from recycled materials and repaired, reused, refurbished or remanufactured products" (p.10).[4]	# Articles of 42 total: 5 Article IDs: 9,32,4,22, 39	**CN:** They propose the creation of the brand *"Canarian Circular Economy"* for companies that adhere to the principles of the CE.
	CUSTR.02 Careless customer behaviour regarding offering without having ownership	When customers lack the values related to ownership, they are more careless when it comes to leasing, renting and pooling. They are still not fully into product service systems (PSS) due to resistance to change and property values, which makes it challenging for businesses to adopt this environmentally-friendly principle. "Servitised BMs may lead to careless behaviour in product use and conservation by the users, since they no longer feel responsible for the product correct conservation. This may reduce the product duration or generate legal issues between the supplier and the user" (p.7407).[9]	# Articles of 42 total: 2 Article IDs: 9,10	
Value Propositions	VP.01 Challenging to create efficient CE value proposition designs for complex offerings	There is limited focus on achieving circularity when it comes to product design. There are many design challenges to durable reuse and recovery products. The product complexity also hinders Life Cycle Assessments. There is a lack of sufficient guidelines towards product design that enable circularity. "The difficulties related to the use of tools available to support the design of sustainable PSSs" (p.4)[35] is also a challenge to implement CE.	# Articles of 42 total:10 Article IDs: 19,7,11,1, 39,22,4,35, 21,37	**ESP:** They are going to promote new product design systems, oriented to satisfy the demand while considering product life extension, reparability and obsolescence reduction. **EU:** The EU wants to "set global standards in product sustainability and to influence product design and value chain management worldwide" (p.6)
	VP.02 CE offerings often inferior to linear economy offerings	The CE offering are perceived to have inferior quality, performance, worse customer demand fit, etc. When it comes to redesigning of circular products it is difficult to maintain the same quality level as before. "Worse performance of the services" (p.924).[20]	# Articles of 42 total: 3 Article IDs: 33,11,20	**EU:** The EU wants to ensure that CE offerings are "high-quality, functional and safe products, which are efficient and affordable, last longer and are designed for reuse, repair, and high-quality recycling" (p. 5).

Key Partners	KP.01 Difficulties in finding suitable CE partners and building solid relationships with them	A multi-stakeholder approach is necessary to facilitate the circularity throughout the whole value chain, which has been proven to be very complex when it comes to dealing with the appropriate partners that follow CE principles. Businesses lack the support and long-term cooperation from their key partners. "Companies who decide to move towards CE often experience difficulty in finding appropriate supply chain partners, with appropriate skills and a CE approach" (p.7404).[9]	# Articles of 42 total: 8 Article IDs: 9,17,41,28, 21,33,31,22	**EU:** Their CE Action plan wants facilitate businesses to be able to find CE partners by ensuring "a well-functioning internal market for high quality secondary raw materials" (p.17).
	KP.02 High dependencies on partners represents a higher risk	The high dependency on other partners to produce/manufacture risks the accomplishment of full circularity in the business. Procurement and sourcing are the starting points of a CE and these prove difficult to deliver in terms of circularity due to changed interdependencies and responsibilities and longer lifespans of products with longer contracts too. "Partners work closely and increase dependency on each other which is considered a risk that must be controlled" (p.5).[10]	# Articles of 42 total: 2 Article IDs: 10,36	
	KP.03 Lack of stakeholder cooperation	Not all stakeholders are willing to cooperate to implement effectively and efficiently CE in their businesses. There is resistance to cooperate due to large interests in status quo, hindering the implementation of CE along supply chains and value chains. "Lack of network support and partners" (p.91).[40]	# Articles of 42 total: 7 Article IDs: 6,8,41,37, 24,22,40	
Key Resources	KR.01 Lack of CE related technical resources and know-how	Companies lack adequate technologies to be able to adopt innovative CE practices. "Need for technical and technological know-how and expertise" (p.2).[33]	# Articles of 42 total: 9 Article IDs: 16,3,33,40, 4,5, 30,42,8	**EU:** "The Commission will enable greater circularity in industry by promoting the use of digital technologies for tracking, tracing and mapping of resources" (p.9). **CN:** They identified the current need to boost technology transfer in the Canary Islands.
	KR.02 Lack of financial resources to invest in CE	Businesses, such as SME's, lack the sufficient financial resources to invest in CE. The need for large capital requirements and the lack of internal resources such as time and workers to investigate possible opportunities to become more circular. "Many organizations have difficulty in securing financial resources for improving waste management" (p.12).[6]	# Articles of 42 total: 8 Article IDs: 3,16,22,6, 4,30,24,40	**ESP**: Will use economic stimuli (in the form of grants, loans, subsidies, etc) aimed at providing financial support to private initiatives willing to adopt CE business models.

	KR.03 Lack of CE skilled Human Resources within the company	Lack of professionals with the necessary skills in CE practices that can help the company change their current linear business model towards a circular business model. "Skills shortage to manage the radical innovations needed to transition towards a sustainable, circular economy, for which knowledge often needs to be sourced from outside the organisation" (p.1033).[31]	# Articles of 42 total: 5 Article IDs: 31,4,27, 5,11	**CN:** The strategy analysed a lack of human capital. There is a lack of technical knowledge to facilitate development, provide sustainable and innovative solutions, including the design and production of value-added products. Furthermore, they consider necessary the promotion of professional training in the field of CE.
	KR.04 Lack of capacity to reinvent the company and its operations for a more CE like model	Not all businesses have the capacity to reinvent their current business model towards the principles of CE and for example integrate them into their design process such as product life cycle assessment. They simply don't have the knowledge to understand the benefits of CE and apply it. If elements such as cross-sectoral knowledge development and knowledge dissemination and innovation on CE are not present, it can impede the transition to a CE. "Companies' supply chain position may limit opportunities to adopt CBMs" (p.10)[4] and "the transition to a circular economy requires knowledge development, knowledge dissemination and innovation. If these elements are insufficiently present, this may impede the transition. In general, knowledge development with regard to the issue of circular economy is characterized by fragmentation in the organization of it and an insufficient focus on cross-sectoral knowledge development" (p.14).[36]	# Articles of 42 total:10 Article IDs: 35,4,6,8, 36,40, 26,3, 29,41	
	KR.05 Difficult to protect knowhow and intellectual property in CE models	Not every business can adopt CE models due to intellectual property reasons. The challenge relies on the lack of embracement from manufactures of open markets, e.g. reuse and remanufacturing markets. Reusing and remanufacturing products may require skilled workforce to hack them, to digitally unlock them and to reverse engineer them. This can require access to proprietary tools that manufactures are not always willing to share. This means access to replacement parts, diagnostic codes and circuit schematics which manufacturers thoroughly seek to protect. "IP and know-how access […] activities (e.g. remanufacturing) accomplished by a third party (independent from a manufacturer) may lead to a loss of control by the manufacturer of the Intellectual Property (IP) embedded in the products" (p.7401).[9]	# Articles of 42 total: 2 Article IDs: 9,36	**EU:** The Commission will consider the regulation of product information through digitalisation in the form of digital passports, tagging and watermarks. This can facilitate the reuse and repair of products by other companies without manufacturers fearing intellectual property loss.

Key Activities	KA.01 Life Cycle Management of products is challenging	Companies face lack of methods for handling life cycle assessment of products and lack of understanding of the entire life cycle of products. "It is difficult for enterprises to manage product quality through the lifecycle of a product" (p.297).[1]	# Articles of 42 total: 5 Article IDs: 29,1,10,8,39	**ESP:** They want to promote the analysis of the life cycle of products and the incorporation of eco-design criteria to reduce the introduction of harmful substances in their manufacture, and to facilitate the reparability of the goods produced.
	KA.02 Complex planning and forecast uncertainties	Complex planning and forecast uncertainties make resources procurement in CE difficult. Procuring in CE is still new and limited, and there is a gap between current market availability and what it is capable of offering. "Inability to ensure resource balance" and "correct forecast of needed spare parts" (p.10).[39]	# Articles of 42 total: 5 Article IDs: 30,39,42,7,11	**EU:** "Public authorities' purchasing power represents 14% of EU GDP and can serve as a powerful driver of the demand for sustainable products. To tap into this potential, the Commission will propose minimum mandatory green public procurement (GPP) criteria and targets in sectoral legislation and phase in *compulsory reporting to monitor the uptake of Green Public Procurement (GPP)* without creating unjustified administrative burden for public buyers" (p.8).
Revenue structures	RS.01 Cannibalisation of sales due to new circular products	There is a risk of cannibalisation due to new circular products diverting sales from existing ones, which can affect the revenue streams obtained from 'linear' traditional products, thus reducing the whole future sales of the business. "Risk of cannibalization similar to fashion vulnerability hinders production of long-lasting high-quality products" (p.5).[10]	# Articles of 42 total: 5 Article IDs: 9,10,32,39,4	
	RS.02 Difficulties in establishing optimal pricing strategies	Difficulties in establishing optimal pricing strategies due to the resource cost uncertainties. "Future uncertainty created by resource price volatility" (p.6).[12]	# Articles of 42 total: 3 Article IDs: 1,12,32	
Cost structure	CS.01 CE has higher operating costs	CE has higher expenses associated with costly management, production and planning processes due to more complex practices. Together with this higher operational cost there is lack of financial support. "The cost of decontamination […] and dealing with health risks associated with recycling, reuse and recovery […] adds to operational costs. New systems don't just cost a lot they require people to accept them and change their behaviour to be effective" (p.6).[12]	# Articles of 42 total:10 Article IDs: 1,28,29,12, 30,33,37,39, 40,22	
	CS.02 Financial and operational risk remains with the company instead of going to the customer	There is a greater operational risk for the business as the costs of maintenance and repair stays with the supplier. "In traditional sales-oriented BMs, the financial risk is shifted to the user when the product is sold. Conversely, in servitised BMs, this risk remains with the supplier even after the first transaction" (p.7400).[9]	# Articles of 42 total: 2 Article IDs: 9,24	

	CS.03 Very high upfront investment costs to implement CE	Very high upfront investment costs hinder the implementation of CE practices, especially in supply chain. This high upfront investment does not pay back instantly, which blocks investment on CE practices prioritising investment on linear economy approaches as they usually have short-term economic returns. "High upfront investment costs make 'circular' products more expensive" (p.4).[19] Recycled materials are generally more expensive in CBM as in linear business models, as acquiring different looped resources and qualified personnel can be more expensive. Furthermore, the lack of capital access to face the high upfront investment costs creates lock-in effect, thus impeding businesses to engage with CE.	# Articles of 42 total:16 Article IDs: 1,7,19,37, 10,11,17,42, 30,36,5,8, 25,26,39,33	**CN:** They propose to support the creation of recycling, repair and reuse companies, as well as for the creation of collaborative companies.

Annex IV. Organisational challenges – EMF Butterfly Diagram

Area	Challenge	Description of challenge (insert two citations for each paragraph)	Article details	Context of the CE strategies at EU, Spain (ESP) and Canary Islands (CN)level
Biological cycles	BC.01 Bio-waste potential not fully exploited	There is an important loss of value from inappropriate usage of organic matter. One of these uses could be for biogas production. "Bio-waste potential is not fully used for biogas production" (p.8)[41], as it is usually taken directly to landfill or incineration instead of leveraging it for other uses such as extracting the biochemical feedstock to anaerobic digestion/composting for biogas production.	# Articles of 42 total: 2 Article IDs: 1,41	**ESP:** In their strategy they want to promote the use of forest biomass as a source of energy for heating in line with the Green Public Procurement measures. They also want to encourage the generation and efficient use of biogas by using it in transports, integrating it into the gas network, etc. They consider that progress must be made in the use of bio-waste as fertilizer products. **CN:** They consider promoting the reuse of organic waste for composting and/or biogas.
	BC.02 Challenge to safely return to biosphere	It is complicated to return the bio-waste safely to the biosphere due to the raw material volatility and the quantity uncertainty which make it difficult to dispose of it properly. The current technology is also not the appropriate one to separate materials. "New challenges to separate the bio- from the technocycle" (p.8).[37]	# Articles of 42 total: 3 Article IDs: 37,1,39	

Technical cycles	TC.01 Infinite recyclability and material circularity is not always possible	Due to the laws of thermodynamics, in particular the second law, it is not 100% possible to produce fully circular as there is an energy lost which cannot be recovered. In order for circular concepts to be successfully implemented, it is important to consider the entropy limits, as looping actions will at some point lead to unsustainable levels of resource depletion, waste generation and pollution if physical flows are not properly managed. In addition, it is not always feasible to repair and recycle products. "Infinite recyclability and material circularity is not possible, since materials lose their inherent properties over time; cycling secondary material stocks may not reduce extractive activities because of stock accumulation and growing demand" (p.4).[19]	# Articles of 42 total: 4 Article IDs: 19,28,39,8	
	TC.02 Ability to create high quality remanufacturing products	It is challenging to create high quality remanufactured products due the uncertainties in the quality of returned products and due to the disassembly operation where part of the value of the original materials is lost. "Lacking ability to deliver high quality remanufactured products […], limited availability and quality of recycled materials" (p.266).[7]	# Articles of 42 total: 4 Article IDs: 1,19,26,7	**EU:** As part of their sustainable product policy legislative initiative, "the Commission will consider establishing sustainability principles and other appropriate ways to regulate the following aspects: enabling remanufacturing and high-quality recycling" (p.6).
	TC.03 Return flow uncertainty (quality, quantity, place, time...)	There is an unpredictable and decreased quality flow of returned products which leads to difficulties in capacity and lowers the chances of achieving economies of scale. There is disruption in the collection processes due to uncertainties on time and place of returns. Also, not everyone is willing to replace their end-of-life products, resulting in the interruption of material flow, thus hindering the continuous circularity needed for CE practices. "To circulate the loops continuously, there should be a regular flow of materials so that old products and parts can be utilised in remanufacturing operations. To do this, companies make contracts with customers to limit their usage and ensure the return" (p.8).[17]	# Articles of 42 total: 6 Article IDs: 9,4,17,1, 39,10	**EU:** To facilitate the correct separation of packaging waste and harmonise separate waste collection systems, the Commission proposes the implementation of EU-wide labelling. Furthermore, "to increase uptake of recycled plastics and contribute to the more sustainable use of plastics, the Commission will propose mandatory requirements for recycled content and waste reduction measures for key products such as packaging, construction materials and vehicles, also taking into account the activities of the Circular Plastics Alliance" (p.12). They are also considering "standardisation and the use of quality management systems to assure the quality of the collected waste destined for use in products, and in particular as food contact material" (p.16). **CN:** The low recycling rates in the Canary Islands hinder the proper return of products/materials, necessary for CE.

	TC.04 Product complexity and design makes it difficult to recover value through recycling	Organizations often produce many different types of waste which complicates its treatment for value recovery. Not many products can be repaired due to their design or simply because there is a lack of repair information available. Planned obsolescence practices are also a barrier when it comes to extending the products life. As most of the products produced in a linear economy are not designed with end-of-life recycling in mind, their value recovery is very low. Furthermore, design for durability creates challenges for recycling. "The proliferation of new materials as well as the growth of product complexity increase the difficulties in managing recovering and recycle processes" (p.7402).[9] The high personalisation of products leads to a higher complexity in the disassembling of the product for its remanufacture.	# Articles of 42 total: 4 Article IDs: 9,4,22,10	**EU:** They want to ensure that all packaging in the EU is reusable or recyclable in an economically viable way by 2030. For this "the Commission will review Directive 94/62/EC27 to reinforce the mandatory essential requirements for packaging to be allowed on the EU market and consider other measures" (p.11). The Commission will present a '*Circular Electronics Initiative'* in line with the new sustainable products policy framework, establishing "regulatory measures for electronics and ICT including mobile phones, tablets and laptops under the *Ecodesign Directive* so that devices are designed for energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling" (p.10).
	TC.05 Looping actions might be less efficient than linear actions	Recycling is not always financially viable and can be very expensive compared to the linear production from raw materials. The lack of economic value in recycled, reused and remanufactured products, makes it less attractive to establish provision systems which facilitate looping actions. The geographical dispersion between the recycling collection points and the factories for recycling treatment is also challenging its financial viability. "CE would drastically increase transportation activities and costs if all the products have to be sent back to producers or specialised sites for refurbishing, remanufacturing, etc" (p.7404).[9]	# Articles of 42 total: 6 Article IDs: 9,33,1,12,2,6	**EU:** They want to ensure high economic value on reused/recycled products through standardisation and quality management systems, guaranteeing the quality of the collected waste intended for use in products. **CN:** The geographical isolation and small size territories of outermost regions, with the Canary Islands Archipelago having 40% of its land protected, limits proper waste management, due to the possibilities of installing landfills and waste treatment plants and/or recycling processes.

Annex V. The CE challenge patterns identified in the 42 articles

ID Art.	Author & year	Article title	CE challenge patterns
1	Govindan & Hasanagic, 2017	A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective.	P.04, P.05, S.01, S.02, S.04, T.01, L.02, L.03, R.03, R.04, R.05, R.06, VC.01, VC.03, VC.04, I.01, STRAT.01, STRAT.02, STR.01, CULT.01, CUSTS.01, VP.01, KR.03, KA.01, RS.02, CS.01, CS.03, BC.01, BC.02, TC.02, TC.03, TC.05
2	Soria & Rodríguez-Monroy, 2019	An Efficient Waste-To-Energy Model in Isolated Environments. Case Study: La Gomera.	P.03, E.02, S.03, R.06, I.02, TC.05
3	Ormazabal et al., 2016	An Overview of the Circular Economy among SMEs in the Basque Country: A Multiple Case Study.	P.04, S.02, R.01, STRAT.01, KR.01, KR.02, KR.04
4	Guldmann & Huulgaard, 2019	Barriers to circular business model innovation: A multiple-case study.	P.04, E.01, L.02, R.01, R.02, R.04, R.05, VC.03, VC.04, STR.02, CULT.01, CULT.02, CUSTS.01, CUSTS.03, CUSTR.01, VP.01, KR.01, KR.02, KR.03, KR.04, RS.01, TC.03, TC.04
5	Zu et al., 2019	Barriers to Promoting Eco-Industrial Parks Development in China.	P.04, P.05, S.01, R.02, R.05, R.06, I.01, I.02, STRAT.01, CUSTS.01, KR.01, KR.03, CS.03
6	Zhang et al., 2019	Barriers to smart waste management for a circular economy in China.	S.03, T.01, L.03, R.05, I.02, STRAT.01, CULT.01, CUSTS.01, KP.03, KR.02, KR.04, TC.05
7	Kirchherr et al., 2018	Barriers to the Circular Economy: Evidence From the European Union (EU).	P.02, P.04, S.01, L.02, R.03, R.05, R.06, VC.03, VC.04, CULT.02, VP.01, KA.02, CS.03, TC.02
8	Pietzsch et al., 2017	Benefits, challenges and critical factors of success for Zero Waste: A systematic literature review.	P.02, P.05, E.01, S.02, S.03, T.01, L.02, I.01, I.02, CULT.01, KP.03, KR.01, KR.04, KA.01, CS.03, TC.01
9	Bressannelli et al., 2018	Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study.	E.01, S.04, R.05, R.07, I.01, STRAT.01, CULT.02, CUSTS.02, CUSTS.03, CUSTR.01, CUSTR.02, KP.01, KR.05, RS.01, CS.02, TC.03, TC.04, TC.05
10	Oghazi & Mostaghel, 2018	Circular Business Model Challenges and Lessons Learned-An Industrial Perspective.	S.04, L.02, R.04, R.05, R.07, VC.01, VC.02, VC.03, STRAT.02, CULT.02, CUSTS.01, CUSTS.03, CH.01, CUSTR.02, KP.02, KA.01, RS.01, CS.03, TC.03, TC.04
11	Reim et al., 2019	Circular Business Models for the Bio-Economy: A Review and New Directions for Future Research.	P.05, S.02, S.03, R.05, STRAT.01, STR.02, CH.01, VP.01, VP.02, KR.03, KA.02, CS.03
12	Williams, 2019	Circular Cities: Challenges to Implementing Looping Actions.	P.01, P.03, P.04, P.05, S.01, S.02, EN.01, L.01, L.02, R.02, R.03, R.04, R.05, R.07, VC.01, VC.03, VC.04, I.01, I.02, I.03, STRAT.01, CULT.02, RS.02, CS.01, TC.05
13	Bolger & Doyon, 2019	Circular cities: exploring local government strategies to facilitate a circular economy.	P.01, S.01, I.02, I.03
14	Nowakowska & Grodzicka-Kowalczyk, 2019	Circular Economy Approach in Revitalization: an opportunity for effective urban regeneration.	S.01, S.02, T.01, EN.01, EN.02, R.05, VC.03, I.02, I.03, STRAT.01
15	Mura et al., 2019	Circular economy in Italian SMEs: A multi-method study.	P.03, L.01, R.05, STRAT.01
16	Ormazabal et al., 2018	Circular Economy in Spanish SMEs: Challenges and opportunities.	P.04, R.01, CUSTS.02, KR.01, KR.02
17	Kumar et al., 2019	Circular economy in the manufacturing sector: benefits, opportunities and barriers	P.04, P.05, E.01, S.01, S.03, T.01, L.03, R.01, R.03, R.06, I.01, I.02, CUSTS.01, KP.01, CS.03, TC.03
18	Sørensen et al., 2019	Circular economy tourist practices.	P.05, S.02, CUSTS.02
19	Campbell-Johnston et al., 2019	City level circular transitions: Barriers and limits in Amsterdam, Utrecht and The Hague.	P.03, P.05, S.02, R.03, STRAT.01, VP.01, CS.03, TC.01, TC.02
20	Singh & Giacosa, 2018	Cognitive biases of consumers as barriers in transition towards circular economy.	S.01, S.02, S.04, S.05, VP.02
21	Niero et al., 2017	Combining Eco-Efficiency and Eco-Effectiveness for Continuous Loop Beverage Packaging Systems: Lessons from the	VC.03, VP.01, KP.01

		Carlsberg Circular Community.	
22	Veleva & Bodkin, 2018	Corporate-entrepreneur collaborations to advance a circular economy.	P.03, P.04, E.01, S.01, T.01, L.02, R.04, R.05, R.06, VC.02, VC.03, STRAT.01, CH.01, CUSTR.01, VP.01, KP.01, KR.02, CS.01, TC.04
23	Scarpellini et al., 2019	Definition and measurement of the circular economy's regional impact.	P.04, S.01, R.01, R.04, I.02, STRAT.01
24	Cother, 2020	Developing the circular economy in Tasmania.	P.03, L.02, R.05, I.02, STRAT.01, CULT.01, CULT.02, KP.03, KR.02, CS.02
25	De Matos & Meira de Albuquerque, 2018	Enabling Factors and Strategies for the Transition Toward a Circular Economy (CE).	S.02, I.01, STR.02, CULT.02, CS.03
26	Russel et al., 2019	Getting the ball rolling: an exploration of the drivers and barriers towards the implementation of bottom-up circular economy initiatives in Amsterdam and Rotterdam.	P.01, P.03, S.01, L.02, STRAT.01, CULT.02, KR.04, CS.03, TC.02
27	Rizos et al., 2016	Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers.	P.03, P.04, R.06, VC.03, CULT.01, CULT.02, CUSTS.02, KR.03
28	Kapsalis et al., 2019	Investigation of Ecosystem Services and Circular Economy Interactions under an Inter-organizational Framework.	S.05, VC.04, STRAT.01, STRAT.02, CULT.01, KP.01, KA.02, CS.01, TC.01
29	Baran, 2019	Life cycle approach-based methods- overview, applications and implementation barriers.	R.05, R.06, I.01, STR.01, CULT.01, KR.04, KA.01, CS.01
30	De Jesús & Medonça, 2018	Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy.	P.05, S.02, T.01, L.02, R.06, STRAT.02, CULT.02, KR.01, KR.02, CS.01, CS.03
31	Velenturf & Jopson, 2019	Making the business case for resource recovery.	S.03, R.04, R.05, VC.01, VC.02, VC.03, VC.04, STRAT.01, CULT.01, CULT.02, CUSTS.01, KP.01, KR.03
32	Hopkinson, 2018	Managing a Complex Global Circular Economy Business Model: Opportunities and Challenges.	P.02, S.02, VC.01, VC.02, CUSTS.01, CUSTS.03, CUSTR.01, RS.01, RS.02
33	Bianchini et al., 2019	Overcoming the Main Barriers of Circular Economy Implementation through a New Visualization Tool for Circular Business Models.	P.04, S.02, T.01, L.02, VC.01, VC.03, STRAT.01, STR.01, CULT.02, VP.02, KP.01, KR.01, CS.01, CS.03, TC.05
34	Kunz et al., 2018	Stakeholder Views on Extended Producer Responsibility and the Circular Economy.	P.04, L.01, R.05, VC.01, I.02
35	Hernández, 2019	Sustainable Product-Service Systems and Circular Economies.	S.04, VC.03, STRAT.02, CULT.02, CUSTS.01, VP.01, KR.04
36	Van Buren et al., 2016	Towards a Circular Economy: The Role of Dutch Logistics Industries and Governments.	S.01, S.04, S.05, R.03, R.05, R.07, VC.01, VC.03, VC.04, STR.02, CUSTS.01, CUSTS.03, KP.02, KR.04, KR.05, CS.03
37	Donato et al., 2018	Towards a more circular economy: exploring the awareness, practices, and barriers from a focal firm perspective.	P.03, P.04, P.05, S.01, T.01, L.02, R.03, R.04, R.05, R.07, VC.02, STRAT.01, VP.01, KP.03, CS.01, CS.03, BC.02
38	Dabrowski et al., 2019	Transferring Circular Economy Solutions across Differentiated Territories: Understanding and Overcoming the Barriers for Knowledge Transfer.	P.01, P.02, E.02, S.01, S.02, T.01, EN.02, I.01
39	Werning & Spinler, 2019	Transition to circular economy on firm level: Barrier identification and prioritization along the value chain.	S.04, L.01, R.04, VC.02, I.02, STRAT.01, STRAT.02, CUSTS.03, CH.01, CUSTR.01, VP.01, KA.01, KA.02, RS.01, CS.01, CS.03, BC.02, TC.01, TC.03
40	Tura et al., 2019	Unlocking circular business: A framework of barriers and drivers.	P.04, P.05, S.01, L.02, R.05, R.06, VC.02, VC.03, VC.04, CULT.01, CULT.02, KP.03, KR.01, KR.02, KR.04, CS.01
41	Obersteg et al., 2019	Urban Regions Shifting to Circular Economy: Understanding Challenges for New Ways of Governance.	P.01, P.03, P.04, P.05, E.01, S.01, S.02, S.03, T.01, L.02, R.02, R.04, R.05, VC.01, VC.04, I.02, CULT.01, CUSTS.01, CUSTS.02, KP.01, KP.03, KR.04, KA.02, BC.01
42	Brown et al., 2019	Why Do Companies Pursue Collaborative Circular Oriented Innovation?	P.05, E.01, T.01, L.01, L.02, R.02, R.03, R.06, VC.01, VC.02, VC.04, CULT.02, CUSTS.01, KR.01, KA.02, CS.03

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