Methodological Framework for the Implementation Of Circular Economy in Urban Systems

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Abstract

Urban areas are hubs for innovation, economic activity and growth that hugely influence the development of our society, making those areas important drivers in the global transition towards circular economy. Although global policies are necessary to set the general ambition, local interventions are crucial to realize it. This paper presents a methodological framework aimed at facilitating the understanding and application of circular economy strategies in urban systems, that being a single city, or urban regions. The framework is conceived as a flexible structure that contains a network of potential decisions, describing

different convergence and divergence points, and that is meant as a supporting tool for future urban circular economy implementation initiatives.
After a literature review and an analysis of specific case studies on urban circular economy implementation, a four-phased methodology is proposed where the territory is explored in order to identify and select initiatives in the areas with greatest potential for circular economy. Actions needed to implement the selected initiatives are finally summarized in a roadmap. Each phase contains recommendations of different tasks to complete and available tools for achieving the expected results. Different approaches to adopt in the application of this methodology are discussed as well, such as production-based vs. consumption-based, and top-down vs. bottom-up. Special emphasis is put on the importance of involving local agents, in order to obtain specific and validated proposals that are adapted to the reality of the territory and the concerns of the stakeholders.
Through these comprehensive guidelines, the ultimate goal of this methodology is to help urban systems to foster circular economy principles, and therefore reaffirm their role in addressing and managing global sustainability issues.

Keywords: Circular Economy, Urban Transition, Urban System, Stakeholder Engagement, Environmental Management, Local Intervention.

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1. Introduction

According to the United Nations, more than 50% of the world's population has lived in urban areas since 2007 and it is estimated that by 2050 this proportion will have grown up to more than 70% (United Nations, 2013). As a consequence of urbanization, human activity is mostly concentrated in and around cities, making them the origin of many of the current sustainability issues, such as greenhouse gas (GHG) emissions (Nevens et al., 2013). Considering that more than 80% of global GDP is generated in urban areas (World Bank, 2018) they could also drive sustainable growth by promoting innovation and increasing productivity.

The global economic system where cities are embedded –based on the take-make-dispose model that represents the traditional linear economy– faces multiple issues, derived from the pressure that the combination of population growth, urbanization and industrial development has put on nature's resources. The circular economy (CE) offers an alternative that would tackle current environmental challenges and "*(…) aims to rely on renewable energy; minimizes, tracks, and eliminates the use of toxic chemicals; and eradicates waste through careful design*" (Ellen MacArthur Foundation, 2013). The desired goal of the CE is to design production and consumption models that have a positive impact on the environment and encourage global sustainable development.

The CE concept has been gaining popularity over the past decade, sparking the interest of both academia and practitioners. Scientific papers have mainly focused on the conceptualization of the CE, trying to define its main characteristics and how they counteract the negative impacts of the traditional economic system. Studies point out the existence of many different CE definitions, without a commonly accepted one (Merli et al., 2018). They also state that CE research is still vague and needs critical analysis (Korhonen et al., 2018).

Looking at CE implementation level, both practice and theory have mainly focused on products and companies, dealing with topics such as extending the lifespan of products by sustainable design (Bakker et al., 2014), implementing circular business models in service companies, or the role of product-service systems in the CE (Tukker, 2015). This means that implementation is mainly addressing the micro-level, leaving larger scales widely unexplored. There are papers that present an overview of CE strategies in different scopes and from different perspectives, such as policy interventions at different levels (Kalioujny et al., 2016; Su et al., 2013), CE principles in certain industries (Lieder and Rashid, 2016), or analysis of general current and historical CE implementation (Kalmykova et al., 2017; Winans et al., 2017). The same approach is observed for urban CE implementation where Prendeville et al., (2016) describe the progress of various European cities in the implementation of CE strategies and Wang et al., (2018) do the same for Chinese cities.

This reveals that the main focus of academia is to analyze the progress of the transition towards a CE, by describing the strategies implemented so far and identifying potential improvements, while the proposal and development of circular strategies, is still discussed mainly by practitioners. Business organizations, consultancies and policy makers, such as the European Union (European Commision, 2015) or the Chinese government (Su et al., 2013), have considerably contributed to the CE discussion. In the EU, although the CE concept has been endorsed, implementation is limited so far, which is mainly attributed to cultural barriers (Kirchherr et al., 2018). “Harder” barriers are also argued to be a slowing factor for CE development, since even when circular initiatives are technically feasible, economic and market limitations can hinder their implementation (Jesus and Mendonça, 2018).

There is a new up-and-coming debate about how cities and regions should adopt CE strategies, and what constitutes a *circular city*. Given the dependency of urban areas on energy, water and material resources, cities will only heighten the issues brought by linear

economy if a paradigm change is not enforced (Lehmann, 2017). Cities could play a vital role in sustainability transitions, such as the transition towards CE, by managing local transport and waste and water systems, and offering locations for low-carbon innovations (Nevens et al., 2013). Urban systems provide the perfect metabolism for CE initiatives, given the concentration of resources, knowledge and economic activity in a limited geographical area (Seto et al., 2010). Local governments and urban planners could be the ones to lead on urban sustainability issues since they have decision-making power and extensive knowledge on the functioning of their environment (Prendeville et al., 2016). Although global policies are necessary to set the goal of transitioning towards the CE, local interventions are crucial to make the goal a reality. The CE and its effects will empower cities, allowing them to become hubs for sustainable management and decision-making. They will also empower its citizens by encouraging proactive behavior, critical thinking and a shift in consumption patterns, thought to be essential for improving CE performance (Ghisellini et al., 2016).

Every urban system has certain potential to become circular, given by its particular social, economic and environmental characteristics. CE strategies should be adapted to the reality of each context. There are reports available describing the efforts to identify said potential and develop a CE implementation strategy in specific urban systems. Examples of these reports are Circle Economy's *Circular Amsterdam* (Circle Economy et al., 2015) or *Circular Glasgow* (Circle Economy et al., 2016), which are described more in detail in section 2.2. Although these reports provide useful methodological proposals and results, the literature is lacking a comprehensive framework that could support these actions and assist urban areas in becoming more circular.

This paper aims to fill this gap by looking into the question of how can urban systems identify their CE potential and use it to develop a plan for the implementation of circular strategies. The main goal is to propose a methodological framework that provides comprehensive guidelines for developing an urban circular economy implementation plan in a certain urban system. The framework is meant to be a flexible structure that contains a network of potential

decisions, describing different convergence and divergence points, and a supporting tool for future urban circular economy implementation initiatives. Depending on the socioeconomic reality of the territory urban, systems can be a single city, a neighborhood or a district within the city, or the whole metropolitan region (see section 3.1). This methodology has the aim of allowing local authorities and agents involved in the metabolism of the area to identify an effective way of implementing CE, besides detailing different instruments and approaches available to obtain the expected results.

2. Methodology

This section describes the methodology followed in order to set up the methodological framework for CE implementation in urban systems. The methodology of this paper combines a theoretical and practical approach including a literature review, a case study analysis and a focus group with local authorities, as can be observed in Figure 1.

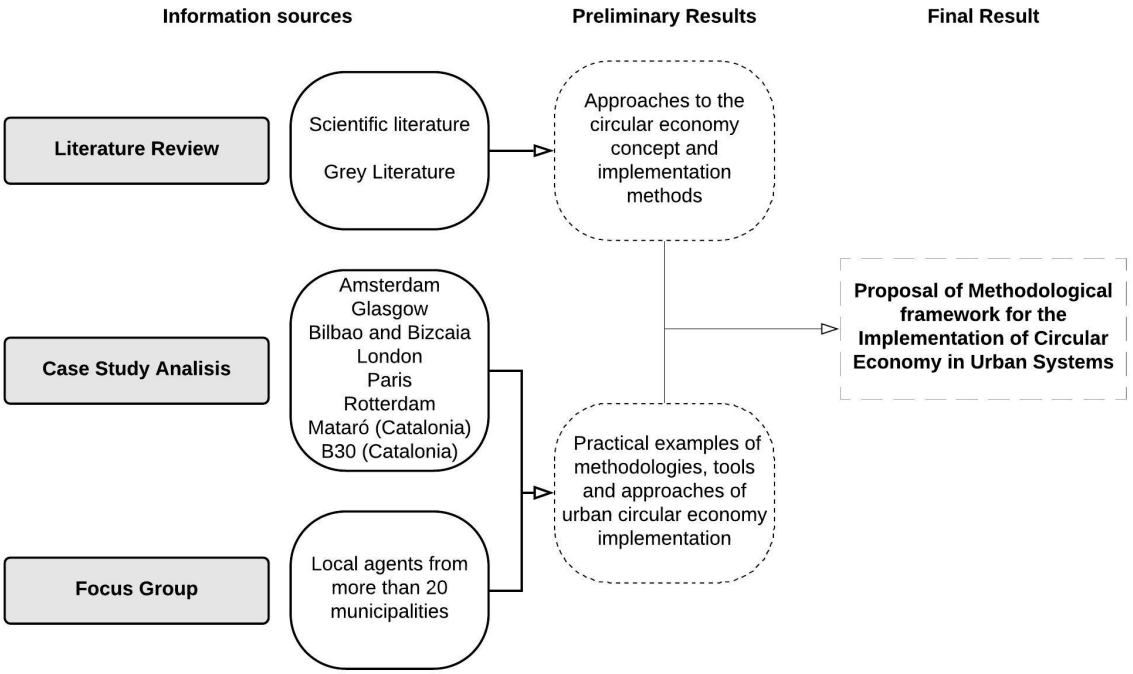

Figure 1: Research Methodology

2.1 Literature Review

The first step is a search in scientific literature databases, e.g. Scopus and Science Direct, using keywords such as *circular economy, implementation strategies, circular cities or urban transitions.* The results obtained are classified according to whether they focus on conceptualization or implementation of CE, or whether they refer to CE in urban systems. The aim is to get an overview of the approaches adopted in the discussion about urban CE, determining if there are studies about CE implementation strategies and methodology proposals for urban systems.

Grey literature is also reviewed, focusing on documents that deal with the application of CE principles or strategies in a territory, including strategic plans and current legislation. Reports carried out by public or private organizations, about the CE concept and its characteristics, are also reviewed. The necessary resources are obtained from a general online search and

from consulting the websites of the leading organizations in CE research, implementation and policy development.

In both cases, some of the questions to be answered by the literature review are:

- How much of a conceptual framework concerning circular economy has been developed by academia?
- What is the level, e.g. micro-, meso- or macro-level, of circular economy implementation that has been discussed the most?
- What is the perspective that academia has focused on the most in terms of circular economy implementation? E.g. Policy, production processes or technical solutions.
- Are there papers that propose implementation strategies for the circular economy from a theoretical point of view?
- Is the role of cities in the circular economy discussed in academic literature?
- Are cities in Europe incorporating circular economy in their policy?
- Is the EU talking about circular economy in their strategies?
- How is the concept of circular economy discussed from a practitioner's point of view?

2.2 Case Study Analysis

Several existing projects that deal with CE implementation in urban systems are analyzed in order to acquire an overview of the methodologies used in each case. These projects are identified from a combination of a general online search and the authors existing knowledge of this kind of initiatives, since they actively participate in some of them. The cases are selected to represent different types of urban systems, scale wise, as well as different social, economic and environmental characteristics. The aim is to extract the main aspects of their methodology in terms of data gathering methods, tools or approaches used, and differences

that can be discussed and can enrich the methodological framework presented later in this paper. This is done by combining an extensive review of the selected cases (Table 1), with the authors' experience in the promotion of CE at the local level. A brief description of the projects considered for the analysis is provided next.

The Dutch organization Circle Economy started an initiative called Circle Cities where, applying their own methodology known as City Scan, they perform studies in different European cities in order to figure out the opportunities available for implementing circular strategies and propose an action plan (Circle Economy et al., 2018, 2016, 2015). London and Paris, have also included CE in their plans, defining their vision of how CE can be adopted in the area (Bio by Deloitte et al., 2016; LWARB, 2017, 2015). Rotterdam has developed a roadmap that intends to enable the city to become "the European centre of the circular economy"(Gemeente Rotterdam, 2016). Other projects in Catalonia (Northeast Spain), are the ones in "Àmbit B30" (an association of private and public institutions from 23 municipalities located in the industrial area surrounding the beltway B30.), and the city of Mataró. Although the reports are not published yet due to the fact that these are still ongoing projects, the authors are actively involved in their development and have already gathered some knowledge from the results available so far.

Table 1: Summary of selected case studies

Selected Case	Location	Reference
"Circular Amsterdam: A vision and action agenda for the city and the metropolitan area"	Amsterdam, North Holland, The Netherlands	(Circle Economy et al., 2015)
"Circular Glasgow: A vision and action plan for the city of Glasgow"	Glasgow, Scotland, UK	(Circle Economy et al., 2016)

“Circular Glasgow: A vision and action plan for the city of Glasgow”	Bilbao and Bizcaia, Basque Country, Spain	(Circle Economy et al., 2018a)
“London, the Circular Economy Capital: Towards a circular economy - context and opportunities” “London, the Circular Economy Capital: Towards a circular economy - context and opportunities”	London, England, UK	(LWARB, 2017, 2015)
“White Paper on the Circular Economy of Greater Paris”	Paris, France	(Bio by Deloitte et al., 2016)
“Roadmap, Circular Economy Rotterdam”	Rotterdam, South Holland, The Netherlands	(Gemeente Rotterdam, 2016)
“Circular Economy Strategy and Vision for Àmbit B30”	Àmbit B30, Catalonia, Spain	(Xarxa de Ciutats i Pobles cap ala Sostenibilitat; Diputació de Barcelona; Fundacio Fórum Ambiental, 2019)
“Promotion Plan for Local Circular Economy in Mataró”	Mataró, Catalonia, Spain	(Xarxa de Ciutats i Pobles cap ala Sostenibilitat; Diputació de Barcelona; Fundacio Fórum Ambiental, 2019)

2.3 Focus Group

The experiences learned from a focus group on CE at local scale are also taken into account. The focus group gathered more than 50 public local agents of economic development and sustainability from more than 20 municipalities in Catalonia, NE Spain. The agents were part of the CE working group from the Network of Towns and Cities towards Sustainability. It is an association committed towards sustainable development created in 1997 and joined by 290 local organizations from Catalonia, Spain. The working group met in 8 occasions between April 2017 and February 2019, celebrating full-morning workshops that were structured around the lessons learned from their local CE experiences, as well as the barriers and opportunities perceived. The main topics covered and discussed during the sessions were (not exhaustive list): what do local agents understand when they refer to

circular economy, what are the potential benefits, what is the role of municipalities, the private sector and the citizenship in promoting CE, what methodological frameworks do exist when promoting CE, what did or did not work in their own municipalities when facing this challenge, and what are the needs and barriers towards circular economy. Most of the sessions and discussions were based on real case studies from the workshop participants. This experience resulted in the elaboration of a guide aimed at promoting the CE concept and providing practical recommendations for local agents (Xarxa de Ciutats i Pobles cap ala Sostenibilitat et al., 2018). The diversity in CE experiences is represented in an additional document elaborated to illustrate and promote the role of local agents in the implementation of circular strategies (Xarxa de Ciutats i Pobles cap ala Sostenibilitat et al., 2019).

3. Results and Discussion

It was raised earlier in this paper the issue of how can urban systems be assisted in identifying their CE potential and use it to develop an implementation plan for circular strategies. In hopes to provide some insights, a methodological framework aimed at doing that is proposed here. Knowledge gathered from the literature combined with the case study analysis and authors' experience in CE initiatives, have allowed the identification of a recommended CE implementation structure for urban systems, as well as a selection of aspects and variables to take into consideration.

The proposed framework includes four implementation phases, which are summarized in Figure 2.

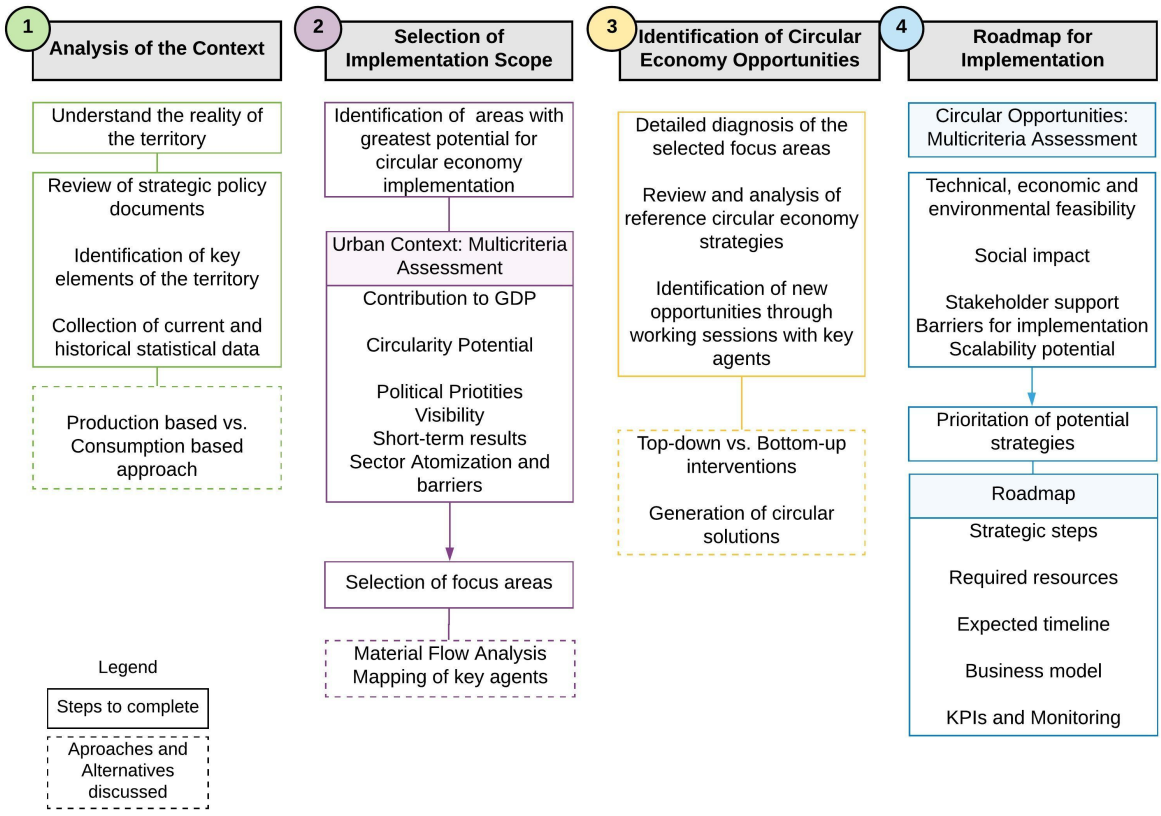

Figure 2: Summary of the phases included in the methodology

Phases 1 and 2 represent the initial exploration of the urban system (sections 3.2. and 3.3), highlighting areas with more potential for CE. Phases 3 and 4 (sections 3.4 and 3.5) are aimed at identifying specific projects for CE and developing a roadmap for their implementation. Each phase includes the recommended tasks to complete, and discusses key issues that should be addressed. The intention is to develop a methodological framework that could be adapted to different geographical scales, e.g., small town, district within a city or very populated metropolitan area, or different economic, social and environmental characteristics. A number of aspects to consider before the start of Phase 1 are described in the following section.

3.1 Preparing the Ground

Applying this methodology can be a complex process that requires the collaboration of many different agents, such as companies, social groups or the public sector at different levels, as well as the coordination of different working methods, such as interviews or workshops. Starting by defining the objectives and creating a shared vision for what the initiative aims to achieve can encourage these collaborations and commit actors from different areas and with different interests (Nevens et al., 2013). The ultimate goal of the initiative, apart from CE implementation, may be addressing other local issues such as employment or re-industrialization, which can affect the project in terms of structure, partnerships and decisions.

In terms of project governance, there should mainly be two designated groups in charge of the development of this initiative, although this structure is flexible and should be adapted to the specific needs of each case. The proposal described here has been adapted from the recommendations provided by the CE guide mentioned in section 2.3 (Xarxa de Ciutats i Pobles cap ala Sostenibilitat et al., 2018), resulting from the CE focus group with local agents:

- The first group would be responsible for the technical tasks and the day-to-day progress of the project. They would be deeply involved in the development of each phase, contributing to the analysis and implementation of the results. Its members, besides having technical knowledge, could have economic or social knowledge that would provide a more transversal perspective.
- The second group would be in charge of both monitoring the progress and validating the results of each phase. Its members should have decision-making power and a broad perspective of the local economy and context. They would provide their

knowledge and insights in decisive moments of the process, facilitate the contact and collaboration with key agents, and promote the initiative to reach other types of audiences.

Something that should be emphasized here and throughout the framework, and that should be reflected in the designated groups, is the commitment to actively work with relevant and diverse agents from the territory.

The goal of the framework is to ultimately implement CE strategies in an urban system. The selected study area, in terms of geographical limits, could be delimited by established administrative boundaries, or it could represent an economic reality. This could refer to implementing CE at city level, or in other areas within or beyond the municipal administrative borders. In the first case the possibilities could be a specific neighborhood or an industrial district, while an example of the second case can be found in the project “Ámbit B30”. The latter, as explained in section 2.2, aims to implement CE in the territory surrounding an important beltway in Catalonia, which includes 23 municipalities. Selecting a specific delimited area would not exclude the possibility of working with elements, agents or resources, outside that area.

3.2 Phase 1: Analysis of the Context

The first phase of the methodology consists of performing an in-depth analysis of the political and socioeconomic context, gathering information about different key aspects of the territory. In order to successfully introduce circular strategies in the urban system, it is crucial to understand its basic characteristics, identify particular assets, and determine strengths and weaknesses. The following tasks can contribute to the achievement of these objectives:

- *Review of strategic policy documents*. This is aimed at extracting priorities, goals and targets in terms of economic development and sustainability. It is also important to identify existing experiences with CE in the area.
- *Identification of key elements of the territory*. This means identifying important assets that the territory might hold, such as valuable infrastructure, strategic geographic location or presence of relevant organizational networks.
- *Collection of current and historical statistical data*. This mainly includes the collection of economic and environmental data. The goal is to determine which activity sectors contribute more to the economy, where the employment opportunities are, what kind of waste the economy generates or what is the intensity of resource use. Any type of statistical data that is incomplete or it does not reach the level of detail desired could be complemented with information directly from public agencies or specific companies.

The following sections present a description and discussion of two indicators that could be useful for this phase, Circularity Baseline and Circularity Potential. They also acknowledge different approaches that could be explored: Production-based vs. Consumption-based.

3.2.1 Circularity Baseline

An indicator that could facilitate the understanding of the urban context is the *Circularity Baseline*. The Circularity Baseline is meant to represent the level of circularity that the territory already has, highlighting stronger and weaker areas. Although there is not a standardized method to calculate it, there is an ongoing discussion about measuring circularity, especially at the national or European level. The Ellen MacArthur Foundation describes the Circularity Baseline with a set of indicators based on resource productivity, circular activities, waste generation and energy and greenhouse gas emissions, and they apply it to Denmark as an example (Ellen MacArthur, 2015). The European Union recently

published a framework for monitoring the circular economy, in which they describe ten indicators related with production and consumption, waste management, secondary raw materials and competitiveness and innovation (European Commission, 2018). Also related with measuring sustainability, the European Union developed the Eco-Innovation Index (European Commission, 2017), which represents eco-innovation performance across the Member States. It is calculated by applying 16 indicators from five different dimensions: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency and socio-economic outcomes. The Chinese government has also been working on CE indicators, but they are mainly based on resource efficiency (Geng et al., 2012).

The issue with the aforementioned indicators is that they have been conceived to measure circularity at a national scale, which means that they would have to be adapted to fit urban systems. Wang et al., (2018) recently proposed an urban circular development index that builds on previous work to adapt the Chinese indicator system to evaluate urban CE. There is a clear lack of consensus on how to measure circularity, which means that it is an issue that remains open for discussion and should be explored further.

3.2.2 Circularity Potential

A circularity potential indicator can be calculated to make a more informed decision about which areas, e.g., economic sectors, have more potential for the application of CE strategies.

There is not a standardized definition or calculation method for the circularity potential. Circle Economy's City Scan in Bilbao and Bizcaia (Circle Economy et al., 2018) considers circularity potential as a purely quantitative indicator, which is based on waste generation, material intensity and waste value recovery. The Ellen MacArthur Foundation (2015), while initially giving a similar definition, introduces the idea of adding other variables that are not so straightforward, such as environmental impact of resource extraction and use, scarcity of

required resources or receptiveness to the CE. Following this suggestion, an example of circularity potential indicator that was developed by the authors and used in the projects of Mataró and "Àmbit B30", is described in Table 2.

The Quantitative variables in the proposed indicator (Table 2) include use of resources and waste generation. Input/output tables can be used to obtain the resource use intensity while waste generation values can be obtained from statistical sources, from the competent public agencies or directly from the companies. Both variables are considered in relative values, i.e. divided by euro generated by the sector, since the absolute value would be affected by the sector's weight in the economy. This type of environmental data leaves out other important dimensions that are not so easily quantifiable, which is why qualitative variables are also included in the proposed indicator. The sector's sensitivity to CE represents how CE can impact the sector with strategies such as reintroducing waste back in the system or providing "food" for a different system, (see Table 2). If the sector is motivated for transitioning towards CE, or if it belongs to organizational networks, the circularity potential is higher, since it would have more support and means to implement new initiatives successfully. These qualitative dimensions should rely on expert opinion and judgment.

Table 2: Example of Circularity Potential Indicator (adapted from the projects in Àmbit B30 and Mataró).

	Variable	**Description**	**Scale**
Qualitative	Sensitivity to Circular Economy.	Potential for reintroduction of waste as raw material, synergies, impact of circular economy on the sector.	High Medium Low
	Motivation for Circular economy.	How motivated is the sector in terms of applying circular economy initiatives?	
	Circular Economy experience.	Existence of circular economy (and/or sustainability) initiatives	

	Existence of organizational networks.	Does the sector actively belong to any formal or informal organizational network? (e.g., cluster, business association)	Yes/no
Quantitative	Resource use intensity	Material and energy expenses in each sector per euro generated by the sector	Monetary value spent per monetary value.
	Waste generation	Quantity of waste generated in each sector per euro generated by the sector	Quantity per monetary value.

The variables included in the circularity potential should be adapted to each specific case, depending on the characteristics of the territory and the availability of information, time and resources.

3.2.3 Production-based vs. Consumption-based Approach

Studying opportunities for the implementation of circular economy strategies can be done from either a production-based, a consumption- based, or a combined consumption-and-production based point of view.

Adopting the production-based approach would mean that the local context is analyzed by looking at the *performance* of economic sectors, which is given by employment, contribution to GDP, circularity potential, environmental impacts and other qualitative criteria. The opposite approach, consumption-based, would be to start by collecting consumption data and then determining the types of goods and services more taken up or used, respectively, in the study area selected, as well as their impacts.

The use of one approach or the other will directly affect the types of areas to be prioritized, e.g. economic sectors or material flows, in phase 2. From a production-based point of view, if a certain economic activity was not present in the city, it would never be selected as a focus

area. From a consumption-based point of view, the product or service resulting from the same economic activity could be very important for the local economy. The ideal situation would be to combine both approaches in order to ensure a more holistic intervention. The methodological framework described in this paper focuses on the production-based approach, since the availability of data facilitates its application.

The dichotomy of addressing or studying an issue from a production-based or consumption-based point of view was also observed when dealing with CO_2 emission accounting. Emissions reported by a city such as Madrid could double if the approach is shifted from production-based to consumption-based (Andrade et al., 2018).

3.3 Phase 2: Selection of Implementation Scope

The next step in the methodology has the aim of identifying in which scope there is the greatest potential for implementing CE. By narrowing the scope, priority is given to the areas of the urban ecosystem where CE initiatives would have a bigger impact. Even though there might be a wide variety of potential lines of action across the territory, aiming to manage all of them could be overwhelming and ultimately inefficient. It is important to concentrate time and resources in areas that are relevant for CE in order to obtain quality initiatives that become long lasting projects and that could eventually trigger new opportunities in other areas. The selected areas can lead by example and spread the implementation of CE to other areas.

Given the fact that the statistical data mentioned in the previous phase is classified according to the different sectors of economic activity, it is more convenient to initially evaluate the potential based on said classification. Other types of focus areas could be considered, such as different types of flows, e.g., energy, organic material or plastics. In this case, selecting a certain flow could mean indirectly focusing on economic sectors that would not have been

considered a priority with the first approach. The focus could also be an issue especially relevant for the local context, such as unemployment, air quality or water scarcity. Even a hybrid approach where different types of focus areas are selected could be useful to ensure that the reality of the urban system is represented appropriately.

Economic sectors could be prioritized based on their role in the economy and their circularity potential. The role in the economy could be given by the contribution to the GDP and employment and unemployment data. A visual representation of these indicators for the main sectors could be used to summarize the results and facilitate the interpretation of the data. One option is plotting the contribution to GDP against circularity potential, placing the points corresponding to each sector in the same diagram (Vinet and Zhedanov, 2011). A third variable, for instance employment, could be represented in the size of the points, as done in the projects Àmbit B30 and Mataró (see Figure 3).

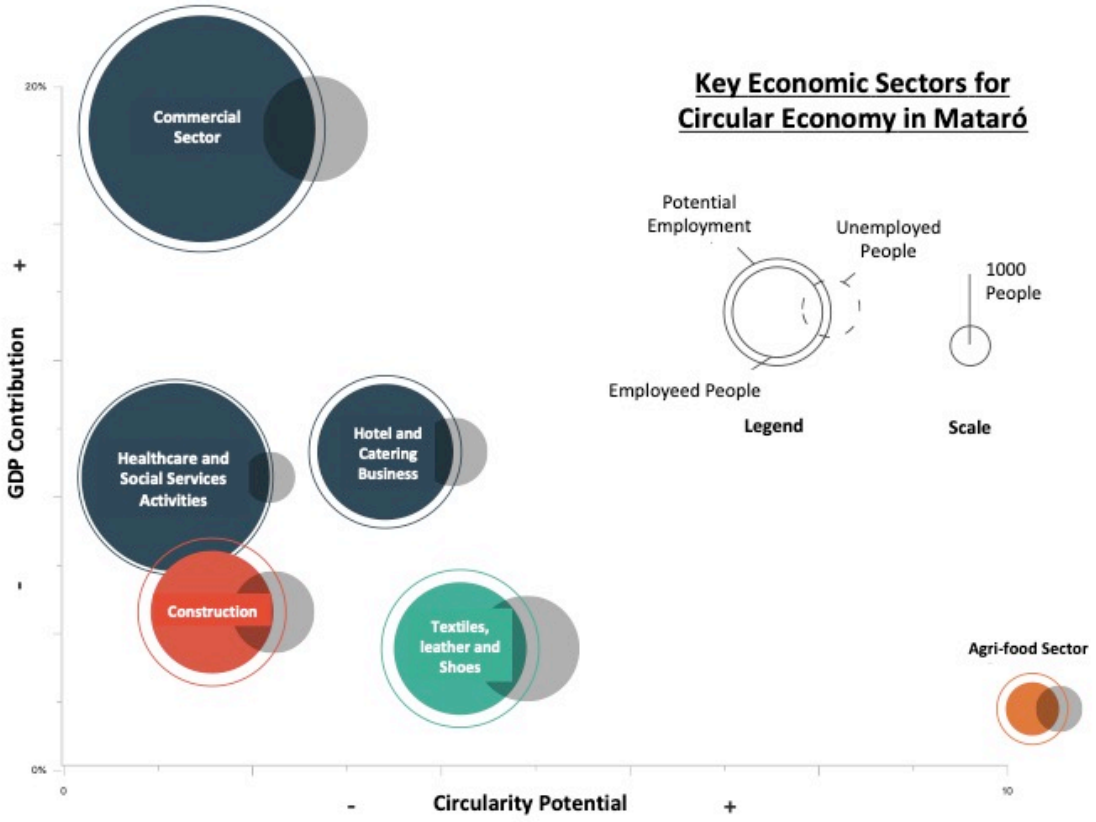

Figure 3: Example of Circularity Potential Representation for the case study in Mataró (based on Ellen MacArthur, 2015)

3.3.1 Urban Context: Multicriteria Assessment

The information collected in the previous phase can now be interpreted and assessed to make a preliminary selection of potential focus areas. The selection should be made acknowledging the trade-off between economic relevance and circularity potential. Ideally, the focus areas would be the ones who relevantly influence the economic development of the territory and where there are multiple opportunities for CE implementation.

Other aspects considered in the assessment could be: the priorities found in policy documents, the visibility for the general public, the potential barriers for CE implementation in the considered economic sector or the possibility of obtaining results in the short-term. Looking at sector organization, studying the number of companies that are present in the

local area would allow the determination of how atomized the sector is, which means determining if there is just one big company that controls the market or if there are a large number of small ones. In the first case there is a risk that the circular initiatives end up being tailored to one specific company instead of acknowledging the reality of the whole sector and fostering circular economy across the territory. In the second case it might be more difficult to coordinate a potential collaboration among the interested agents.

The local administration, which has the role of leading this initiative and facilitating its development, could also be selected as a focus sector. Among the competences of the local administration, a lot of opportunities of applying CE can be found. Some examples of potential influence areas are water and energy supply, waste management, mobility, green public procurement or urban planning. Focusing on the local administration could be beneficial in terms of successfully implementing circular strategies, given their essential role in policy development and decision-making. They have the means to establish a direct line of communication with the citizens, which could facilitate the process of educating them about CE and involving them in the projects to be implemented.

This multicriteria assessment results in a preliminary selection of focus areas and allows a first diagnosis of the territory. The projects in Bilbao, Àmbit B30 and Mataró resulted in the selection of three focus areas, although this number is flexible and should be adapted to each case. If the scale of the project is sufficiently wide, and in order to improve the development of the next phases, the scope of implementation could be narrowed even more, analyzing more in-depth the focus areas considered so far and determining whether there is a specific part within them that presents more potential for CE.

One method to do this could be studying the metabolism of the system through a simplified *Material Flow Analysis* (MFA). MFA is a well-established method for accounting the flows of materials leaving and entering a system, as well as their stocks (Sendra et al., 2007). It

would also be interesting to include energy flows. Another method could be mapping relevant companies, institutions or organizations for each focus area in the territory by identifying who they are and their main characteristics, such as size, created value or specific type of activity. Contacting key stakeholders, e.g., through interviews, focus groups or polls, could also be useful in order to get a better understanding of the functioning of the focus area and the parts that may be more relevant.

3.4 Phase 3: Identification of Circular Economy Opportunities

The aim of this phase is to identify available opportunities for CE implementation in the focus areas previously selected. The proposed approach is to work closely with key agents of the territory, making sure they are actively involved in the process. The importance of this approach will be discussed later in sections 3.4.1 and 3.4.2. Drawing from previous experiences in CE promotion initiatives (see section 2.2 and 2.3) the recommended tasks to perform in this phase are the following: detailed diagnosis of the selected focus area, analysis of best practices of CE related with the focus area and working sessions with key agents of the territory to identify circular opportunities.

The first step should be a detailed diagnosis of the focus area in the territory. The diagnosis would include identifying companies involved and key agents in the value chain, e.g., suppliers, distributors or marketers, studying the flow of materials, energy and waste, determining current problems or challenges, and identifying previous experience in CE or sustainability initiatives. Depending on the work done in phase 2 and the level of detail achieved, the diagnosis in phase 3 would need to be more or less complemented through questionnaires, interviews or more specific document reviews. With the results from the

diagnosis of the focus area, the content and the dynamics of the working sessions can be prepared.

The next step would consist of analyzing available CE experiences in the focus area in order to learn from best practices. Unlike the identification of experiences described in the previous step, this task should focus on reviewing reference CE initiatives that have been implemented in other territories and in the same scope, which could inspire new opportunities. A few resources are available for this purpose, such as collections of case studies (Ellen MacArthur Foundation, 2012), circular economy strategies that have been implemented worldwide in different influence areas (Circle Economy, 2018b) or examples of best practices for circular business models (Guldmann, 2016).

Once the two previous tasks are completed, the information gathered in both of them can be used to organize working sessions with key agents from the territory in order to generate potential circular solutions. These key agents could be specific companies, business associations, representatives from the public sector, social organizations or sustainability experts, among others. Group sessions would be organized, in order to exchange different perspectives and encourage dialogue among stakeholders. The initiative carried out in Paris in 2015 (see Table 1) and co-organized by several Île-de-France authorities, gathered more than 240 agents representing over 120 organizations with the purpose of tackling the CE challenges for the Greater Paris Metropolis. Different working groups were organized and assigned specific topics, such as "Fight against food waste" or "From eco-design to green construction", which resulted in the proposal of 65 circular initiatives (Bio by Deloitte et al., 2016).

This step reinforces the idea that planning authorities need to be aware of their local context in order to understand the diversity and individual nature of future challenges (Pomponi and Moncaster, 2017). They should promote inclusiveness, collaboration and participation since

those are precisely the kind of values that circular economy portrays. It is also a way of showcasing the will to obtain specific and validated proposals that go beyond theoretical potential strategies and that have been adapted to the reality of the territory and the concerns of the stakeholders.

3.4.1 Top-down vs. bottom-up Interventions

There are some studies that point out the need to use a hybrid approach that is driven by both public institutions from top-down and industry from bottom-up in order to implement CE at a large scale (Lieder and Rashid, 2016).Top-down interventions are understood as the ones promoted by institutions and related with strategy and policy decisions, i.e. environmental regulations or economic inventives, while bottom-up interventions are related with social movements and business initiatives, i.e. community-led digital platforms or sharing economy initatives (Prendeville et al., 2016).

The approach adopted in this paper leans towards top-down strategies, since it is based on diagnosis followed by strategic decisions and planning. The importance of working closely with stakeholders is highlighted as well. Their involvement could result in the aknowledgement of bottom-up strategies that were overlooked before or even trigger new ones. This aligns with the idea that policymakers should contribute to the promotion of bottom-up initiatives (Bergman et al., 2010). In this case, since the identification of CE opportunities heavily depends on the characteristics of the local area, it is essential that people who have a deep knowledge and understanding of it are included in the discussion. Without their support, the proposed circular strategies or projects could not be realized.

The next section discusses how the process of identifying opportunities for the implementation of CE in the selected focus area could take place.

3.4.2 Identification of Circular Opportunities Through Stakeholder Engagement

There are many different types of engagement methods that could be used in the process of identifying circular opportunities, e.g., workshops or focus groups, depending on the kind of agents taking part in them and the time and resources available. The results from the previous work of analyzing the selected focus areas and reviewing best practices of CE strategies could be used to prepare the group sessions, ensuring their productivity and that they are geared towards the needs of the territory.

The preparation of the group sessions should start by carefully selecting who should participate, and based on that, structuring the work dynamics. The session could start by informing the attendants about the general motivation and structure of the initiative, the diagnosis of the focus area and its CE potential, and if considered necessary, a brief introduction to the CE concept and principles. In order to provide more context and stimulate the generation of ideas, a selection of the reference CE initiatives available worldwide could also be presented. Then the group discussions would take place.

Different approaches available in the literature could facilitate the identification of CE opportunities in the selected scope, structuring the process and making it more systematic. Examples of these approaches could be categorizing the initiatives under the seven key elements of the CE described by Circle Economy (Ramkumar, S., 2017), under the R-list of strategies proposed by the Netherlands Environmental Assessment Agency (Potting et al., 2017) or applying the Ellen MacArthur Foundation's ReSOLVE framework (Vinet and Zhedanov, 2011). The use of this practice could make sure that opportunities representing the different types of principles that the CE portrays are not overlooked. Knowledge provided by other fields that support some of the trends presented by CE, such as industrial ecology (Saavedra et al., 2018) could also contribute to the generation of proposals.

Once a good selection of potential strategies is collected, a preliminary discussion and evaluation of their feasibility and the actions required to realize them could be organized, in order to prepare the ground for the next phase.

3.5 Phase 4: Roadmap for Implementation

After identifying the opportunities available for CE in each focus area, said opportunities should be assessed and prioritized in order to develop a roadmap for their implementation. The following sections describe the criteria proposed to carry out the assessment and prioritization and discuss the elements that could be included in the roadmap.

3.5.1 Circular Opportunities: Multicriteria Assessment and Prioritization

The assessment can be performed based on economic, technical and environmental feasibility. The feasibility of the strategies in the three dimensions is an essential characteristic that should always be taken into account when prioritizing them. There are other aspects that play a key role as well and can complement the assessment, such as potential social impact, the level of support they have from stakeholders, their scalability potential or the estimated timeline. An analysis of potential barriers to overcome could be included, identifying them for different aspects such as economics, market behavior, regulations or social factors (Ellen MacArthur Foundation, 2015). The objectives expected to achieve with each opportunity can be indicated in order to evaluate and compare their potential impact. The information needed to fill in these parameters could be collected from the group sessions in the previous phase, hosting a final discussion where the key agents evaluate the identified circular opportunities. Those ideas would then be organized and assessed by the technical team, and complemented with additional interviews if necessary.

Based on all of these variables, the initiatives identified in phase 3 can be prioritized so that the necessary actions to realize them can be specified in a roadmap (section 3.5.2). The selected projects should be technically and economically feasible while generating a positive impact on the environment and society. They should address the needs of the focus area and be validated and supported by stakeholders. They should be visible initiatives that can motivate change and encourage the creation of new ones, as well as have the capacity to grow and eventually reach a bigger scope, generating a meaningful and lasting effect.

One of the key practices in order to achieve a circular system is closing material and resource loops (Merli et al., 2018). There is a tendency to believe that establishing *smaller* loops, i.e. local or even hyper-local loops, improves circularity. This is not necessarily true since it will depend on the specific characteristics of the local context and the before mentioned three-dimensional feasibility of the initiative. If the scale of the project is small, there is a bigger chance that the opportunities to close the loop will be outside of the scope.

3.5.2 Roadmap Development

The final result that this methodological framework aims to achieve is a strategic plan for CE implementation in the territory, which should include a roadmap of the actions that the local administration intends to carry out. The development of the roadmap could start at the end of phase 3, with the proposal of a simplified version, a preliminary sketch of the implementation requirements estimated for each circular opportunity. After the assessment and prioritization described here, in phase 4 the simplified version could be developed based on the inputs collected from a new round of interviews and working sessions specifically focused on this purpose.

The initiatives previously prioritized should be described in the roadmap, as well as what it will take to make them a reality in terms of resources, time and support from involved agents.

The strategic steps that need to be taken in order to fully implement the initiatives should be specified, along with the estimated timeline. Short-term and long-term scenarios could also be defined, with a full description of the expected development in terms of technology, consumer behavior or legal framework.

A business model for each strategy could be described as well, indicating potential value and job creation besides other financial characteristics such as required investment and expected return time. Inspiration could be drawn from the triple layer business model canvas (Joyce and Paquin, 2016) or the categorization of sustainable business model archetypes (Bocken et al., 2014). The barriers for implementation previously analyzed, (see section 3.5.1) could also be described here in order to facilitate planning how to potentially overcome them. Another very important component of the roadmap would be specifying relevant agents who have participated in the initiative and are already interested in the opportunities, while also specifying other agents whose support would be necessary to realize the selected strategies. It could even be interesting to identify potential collaborations or partnerships among particular projects and which agents should be in charge of managing them.

The necessary mechanisms for a follow-up on the implementation of the strategies presented in the roadmap could be specified, indicating whose responsibility should be, i.e., maintaining the technical team or appointing a new one just for this task, potential Key Performance Indicators (KPIs) that could be used and the appropriate time frame to do it. Monitoring the achievement of objectives and targets initially established could play a significant role, not only in the success of the strategies at hand, but also in the reputation and reliability of methodologies such as the one proposed in this paper.

Besides describing what needs to be done to implement CE in the territory, the strategic plan resulting from the application of this methodology should provide some guidance on how to trigger a bigger change. A proposal of scaling up options for each strategy could be included,

as well as potential economic, social or environmental indicators for monitoring its impact on the local context. The role of the administration goes beyond leading the initiative and facilitating the process, it should provide financial and technical support to the proposed projects. The administration emphasizes its commitment to build a trusting relationship with local agents and to enable action on sustainability issues by ensuring the success of CE implementation. As an additional step, a pilot plan for some of the prioritized strategies could be included, providing support for the kickoff and seeing out the first steps of their implementation.

The recommended elements that the roadmap should include are summarized in Figure 4.

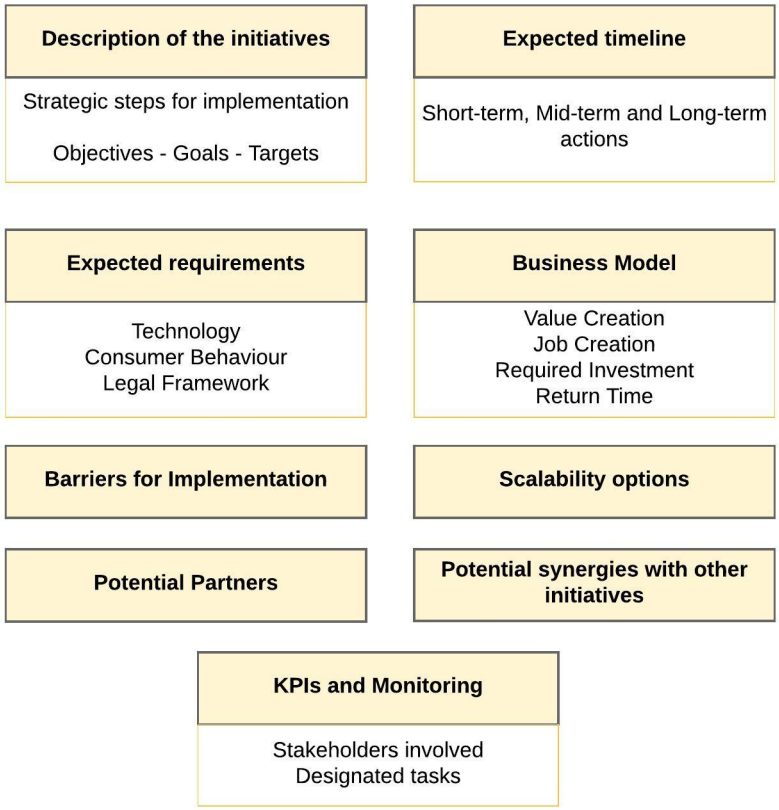

Figure 4: Recommended content for the roadmap

4. Conclusions

This paper proposes a methodological framework for urban CE implementation, addressing the issue of how can urban systems identify their CE potential and use it to define a plan to implement circular projects. Since the literature revealed a lack of consensus and guidance on how CE strategies should be applied in urban systems, the methodological framework was proposed by reviewing and analyzing the methodological structure of specific CE implementation projects in urban areas.

The methodological framework described here proposes a four-phased process aimed at developing a strategic plan to foster CE principles in a selected territory. The framework recommends the steps to follow, the data that should be collected, the criteria that could be used to make decisions and some available tools to achieve the desired results. Critical steps in the development of the initiative were also identified, which could facilitate the application of the methodology. There are certain decisions and tasks that can heavily determine the outcome, such as the approach adopted for data collection, the type of focus areas assessed and the mapping of stakeholders and relevant agents. One element that is highlighted throughout the framework, and that is a common thread among the reference case studies, is the importance of actively engaging agents from the territory, whether they are representatives from the public, social or corporate sector. In the transition towards CE, where urban systems are believed to play a key role, it is essential to encourage collaborative efforts and empower people by involving them in the development of new initiatives. Given the heterogeneity and multidimensional nature of the CE, structuring its implementation process and having the collaboration and consideration of multiple agents rooted in the methodology could potentially simplify future efforts to realize circular strategies.

Future research could focus on further exploring both the technical and management aspects of this methodological framework. On one hand, it could be useful to study more in depth how to measure the circularity potential of different activity areas in the territory, since this is a crucial element that will determine the scope in which circular opportunities are identified. The type of variables included could be discussed further, studying in detail what kinds of aspects influence the potential for CE in the social, economic and environmental dimension. This could be linked to the ongoing discussion about measuring and monitoring CE. On the other hand, the participatory process of generating potential CE initiatives could also be explored further, drawing inspiration from stakeholder engagement methods used in other sustainability issues such as climate change adaptation, and exploring the necessary collaboration component of CE.

5. Appendix A

Table 3: Literature Review

Focus	Title	Author
Discussion of Circular Economy Concept	Circular Economy: The Concept and its Limitations	(Korhonen et al., 2018a)
	How do scholars approach the circular economy? A systematic literature review	(Merli et al., 2018)
	Conceptualizing the circular economy: An analysis of 114 definitions	(Kirchherr et al., 2017)

	Circular economy as an essentially contested concept.	(Korhonen et al., 2018b)
	Towards the Circular Economy	(Ellen MacArthur Foundation, 2013)
General Circular Economy Implementation	Circular economy - From review of theories and practices to development of implementation tools.	(Kalmykova et al., 2017)
	The history and current applications of the circular economy concept	(Winans et al., 2017)
	A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems.	(Ghisellini et al., 2016)
Circular economy implementation at micro-level	Products that go round: Exploring product life extension through design	Bakker et al., 2014
	Product services for a resource-efficient and circular economy	(Tukker, 2015)
	A decoupling perspective on circular business model implementation	(Stål and Corvellec, 2018)
	Towards circular economy implementation: A comprehensive review in context of manufacturing industry	(Lieder and Rashid, 2016)
Circular economy implementation at meso-level	Smart eco-industrial parks : A circular economy implementation based on industrial metabolism	(Martín Gómez et al., 2017)

	Circular economy for the built environment : A research framework	(Pomponi and Moncaster, 2017)
Circular economy implementation at macro-level	Establishment of a strategy of circular economy increasing the well-being of society: comparison of two national policies	(Kalioujny et al., 2016)
	A review of the circular economy in China: Moving from rhetoric to implementation	(Su et al., 2013)
	Advancing to a Circular Economy : three essential ingredients for a comprehensive policy mix	(Milios, 2017)
	Delivering the Circular Economy: A Toolkit for Policymakers	(Vinet and Zhedanov, 2011)
Urban Circular Economy	Circular Cities: Mapping Six Cities in Transition	(Prendeville et al., 2016)
	Evaluation of Urban circular economy development: An empirical research of 40 cities in China	(Wang et al., 2018)
	Urban Metabolism as Framework for Circular Economy Design for Cities	(Kalmykova and Rosado, 2015)
	Cities in the Circular Economy: an Initial Exploration.	(Ellen MacArthur Foundation, 2017)
EU Policy	Closing the loop – An EU action plan for the circular economy.	(European Commission,

		2015)
	A monitoring framework for the circular economy.	(European Commission, 2018)

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