

The urban dimension of the circular economy: reflections from selected case studies

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ABSTRACT

The objective of the present study is to clarify, at least in part, the emerging concept of “circular city”. To this end, a profound analysis is undertaken of the cases of three European cities, Amsterdam, Glasgow and Peterborough, which, through their strategic development plans, are engaged in the implementation of a circular economy (CE) urban model. From the three cases analysed it can be concluded that the CE plans developed are linked to a greater or lesser degree to other initiatives of a local and/or national nature. Furthermore, the need to define pilot projects to learn from them and, later, escalate and repeat them, can be observed. Similarly, the importance of a high degree of collaboration among the various economic, social and political agents which form part of the respective local economies is clear. Lastly, the article concludes that in the three circular city plans there continues to exist the need to develop an appropriate model of tracking and monitoring of the advance in the measures adopted, to evaluate the degree of success of such programmes.

Key words: Circular economy, city, urban environment, transition, sustainability, climate change.

RESUMEN

El presente estudio tiene como objetivo tratar de esclarecer, al menos en parte, el emergente concepto de “ciudad circular”. Para ello, se analizan en profundidad tres casos de ciudades europeas, Ámsterdam, Glasgow y Peterborough, que, a través de sus planes estratégicos de desarrollo, están trabajando en la implementación de un modelo de economía circular (EC) urbana. De los tres casos analizados se puede concluir que los planes de EC desarrollados tienen una vinculación en mayor o menor grado con otras iniciativas de carácter local y/o nacional. Además, se observa la necesidad de definir proyectos pilotos para aprender de ellos y, más adelante, escalarlos y replicarlos. Asimismo, queda en evidencia la importancia de un alto grado de colaboración entre los diferentes agentes económicos, sociales y políticos que forman parte de las respectivas economías locales. Por último, esta investigación concluye que en los tres planes de ciudad circular existe todavía la necesidad de desarrollar un modelo apropiado de seguimiento y monitorización del avance de las medidas adoptadas para valorar el grado de éxito de dichos programas.

Palabras clave: Economía circular, ciudad, entorno urbano, transición, sostenibilidad, cambio climático.

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1. Introduction

Faced with the current global challenges of sustainable development and the mitigation of climate change, there is an urgent need for a transition from the currently dominant linear economy towards a circular economy (CE), one which achieves a balance between human activities and the resources of our planet, bearing in mind the welfare of future generations. Although there exists no universally accepted definition of the CE (see Ghisellini et al. 2016 for a recent review of the literature), one of the most frequently cited definitions is that provided by the Ellen MacArthur Foundation (EMF, 2013a): "A circular economy is 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." This concept distinguishes between technical cycles (resources are recovered and restored and can return to the economic system as "technical nutrients") and biological cycles (resources are regenerated and can return to the ecosystem as "biological nutrients"). Furthermore, it attempts to separate global economic development from the consumption of finite resources, and could generate growth and employment and reduce environmental impacts such as CO₂ emissions (EMF, 2013).

Among the international legislative initiatives which are favouring the implementation of the CE stands out the European Union (EU) Action Plan for the Circular Economy of 2015 (EC, 2015), which defines a mandate to implement a CE in Europe that includes governmental collaboration and commitment on a national, regional and local scale, with the contribution of all interested parties. For the EU, the transition towards a CE represents an advantage, since it increases its own competitiveness and sustainability by constructing an economic system more resilient and adaptable to the shortage of material and energy resources and to financial volatility, stimulating business innovation and efficiency, and radically changing production and consumption patterns. It may also create a substantial number of jobs, favour economic growth and welfare at all levels, emphasising the local scale and, at the same time, strengthen social cohesion and integration. Furthermore, a new model of circular production and consumption may limit and/or avoid irreversible damage to the climate and to biodiversity, reducing the emission of greenhouse gases into the atmosphere (Morató et al. 2017).

The understanding of local contexts is important to develop efficient political interventions (Van Bueren y ten Heuvelhof, 2005; Geng et al., 2009), which makes it necessary to approximate the CE from an urban perspective. The implementation of the CE in cities is understood ambiguously and, although various models and frameworks of the CE have been identified, their extension is specific, they are in large part conceptual and they lack transferability to a city context (Prendeville et al., 2017). However, as stated in this recent study of circular cities, “Despite criticism of the CE concept (idealistic, not linking up to normative expectations, no social considerations) the CE has clearly been adopted as an aspirational concept by several cities”.

Bearing in mind that over 50% of the world population lives in cities (and it is foreseen that this trend will continue to increase until 66% in 2050 (UN-DESA, 2017)) and in the European Union (EU) this percentage will rise to over 70% (and the UN predicts that in 2050 it will increase to over 80%), cities play an essential role in tackling sustainability (ICLEI, 2014; Vergragt et al., 2014; Loorbach et al., 2016). Cities consume 80% of the world supply of energy and 75% of global natural resources (UNEP-DTIE, 2012). Cities, in addition to being significant contributors to climate change, also face great threats due to such change, such as floods, droughts, etc., for which their protection is fundamental (Rosenzweig et al., 2011).

To tackle sustainability, cities play an essential role, but in order to achieve a profound systemic change in socioeconomic systems, radical strategies of urban governance are necessary (Loorbach et al., 2016). The implementation of radical eco-innovations is likely to involve several actors and be affected by a wide array of barriers. Thus, a systemic perspective of socio-technological change is crucial for designing effective policy strategies to mitigate the barriers to eco-innovation (Del Río et al. 2010ab).

To achieve sustainable development and tackle climate change at the city level the involvement of the urban authorities is essential, as they possess a broad knowledge of their surroundings and autonomy in urban planning, water, waste and public transport (Erickson y Tempest, 2014). Furthermore, it is also very important that all the actors comprising a city (companies, institutions, citizens, NGOs) work in accordance with long-term objectives (Prendeville et al., 2017).

In fact, the CE is taking form at both municipal and regional level, since groups of citizens are undertaking all types of circular initiatives (RLI, 2015), which demonstrates the great interest and social commitment which exists when it comes to taking advantage of the

opportunities offered by the CE. In this case, the support of local government is fundamental to be able to broaden these initiatives.

The urban approximation to the CE is, finally, important because technical and biological "nutrients" are grouped within the city limits and can be found in quantities able to be exploited through "urban mining" (Li, 2015). Furthermore, the interested parties are geographically close by, which can aid collaboration in closing the resource circuits (Morlett, 2014).

In their recent study, Prendeville et al. (2017) define "circular city" as "a city that practices CE principles to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city." However, these authors emphasise that there exists a lack of consensus regarding what constitutes a circular city, and also the need to determine yet further the how and why of the concept of the circular city.

With the aim of helping to meet this need, underlined by the literature, the objective of the present study is to attempt to clarify, at least in part, the emerging concept of the "circular city". To this end, a profound analysis is made of three cases of European cities, Amsterdam, Glasgow and Peterborough, which, through their strategic development plans, are working to implement an urban CE model.

The rest of the document is organised as follows. The methodology employed to perform the study is described in Section 2. Section 3 presents the respective intra-case studies of three European cities which are attempting to implement the CE in their strategic urban development plans. The inter-case analysis of the cities selected is discussed in Section 4, and section 5 concludes the study.

2. Methodology

The present document employs a study methodology of descriptive cases of an illustrative nature, with the aim of being able to have real information regarding the application of CE principles in the urban field. Case study research is often used in new subjects and when an attempt is made to explore and understand, in place of quantify and confirm (Eisenhardt, 1989). Given that the experiences of cities which perform CE activities are new and emerging, case studies are considered as appropriate for research into this phenomenon (Prendeville et al., 2017). More concretely, we

decided to study multiple cases, since this increases validity and, ultimately, the generalisation of the research results (Cook y Campbell, 1976; Patton, 1990).

As demonstrated in the so-called Aalborg Charter (1994), European cities have been working on the concept of sustainability in recent decades, displaying increasing environmental commitment. More recently, and as has already been stated, the EU has strongly supported the CE, as evidenced by the Horizon 2020 strategy, oriented towards intelligent, sustainable and integrationist growth (EC, 2011), and more explicitly in the European Union (EU) Action Plan for the Circular Economy of 2015 (EC, 2015). Consequently, due to the greater relative degree of development of these initiatives opposed to other nations, selection was made for the present research of three European cities which have performed integral and concrete planning for the application of circularity precepts in their urban model.

Specifically, the cities analysed have been Amsterdam (the Netherlands), Peterborough (England) and Glasgow (Scotland), as they are considered to be those which have the most highly developed CE plans to date. These cases permit a deeper study of how it is proposed to put the CE model into practice, based on projects, policies and concrete initiatives. Once having selected the case studies, a compilation was made of all the information relative to their strategic CE plans (objectives, visions, plans, policies, programmes, initiatives, etc.), and similarly the principal data and context indicators which may have been of interest for the study. The cases have been analysed on the basis of the triangulation of data obtained from secondary information sources (Denzin, 1990).

From the information available, presentation is then made of the discussion of an intra-case and inter-case analysis (Strauss, 1987), which will subsequently permit the proposal of a series of general conclusions able to serve as a basis for more specific research in the future, facilitating the establishment of hypotheses and guides useful for an improved understanding of the CE in the urban environment.

3. Case studies

This section presents the respective intra-case studies of three European cities which are attempting to implement the CE in their strategic urban development plans. Concretely, the cases analysed are those of Amsterdam, Glasgow and

Peterborough and, in each of them, a summary is made of the principal characteristics of each of their plans and their implementation.

3.1. Case 1: Amsterdam

Motivation

When developing the “Circular Amsterdam” plan (Circle Economy et al., 2016), which defines the vision and the agenda for the development of the CE model for the city of Amsterdam and its metropolitan area, observation can be made of diverse motivations and objectives which the above plan is intended to answer.

The first motivation is the result of a rapid increase in the world population, which is forecast to exceed 9,700 million people by 2050 (UN-DESA, 2017), and in particular the foreseeable growth of the population of Amsterdam, whose increase is estimated to be approximately 10,000 inhabitants annually¹. This situation will mean a greater demand for products and services, which will involve an increasing consumption of material and energy resources, with their consequent shortage and sharp price fluctuations. Consequently, as stated in the “Circular Amsterdam” plan, a rapid transition towards a CE is necessary, one which generates opportunities for the innovation and export of new productive models less intensive in resources, and also the reduction of dependence upon their import. In short, the intention is to achieve a higher quality of life for the inhabitants of Amsterdam, in a sustainable way.

Secondly, there appears the commitment of Amsterdam to the implementation of a CE, as defined in its sustainability agenda, adopted in March 2015². For this reason Amsterdam wishes to undertake a real transition, for which it has been considered necessary to perform a diagnostic which helps to understand the current situation of its productive model and facilitates the elaboration of a plan to achieve such a transition.

Finally, as explained in the “Circular Amsterdam” plan, this commitment to the CE model is not exclusive to the government of the city, but instead both its citizens and its businesses demonstrate great interest, expectation and initiative with regard to the evolution of its productive model. Thus, one of the objectives for which this agenda has been developed is that of establishing a surrounding which favours the exploitation of

¹ <http://population.city/> (retrieved June 2017).

² <https://www.amsterdam.nl/bestuur-organisatie/organisatie/ruimte-economie/ruimte-duurzaamheid/making-amsterdam/sustainability/> (retrieved June 2017).

that individual energy and efforts, generating synergies and achieving better results when it comes to implementing the new economic model.

Fundamental components of the plan

As described in the “Circular Amsterdam”, plan, work has been performed in accordance with the following principles of the CE³:

1. All the materials form part of an **infinite technical or biological cycle**.
2. All **the energy used comes from renewable sources of generation**.
3. The **resources are used for the generation of value**, whether economic or another type.
4. A **modular and flexible design of products and their production chain** increases the adaptability of the systems.
5. The new model of production, distribution and consumption facilitates the **transition from the “possession of products” to the “use of services”**.
6. The logistics systems facilitate the transition towards a more regional service, which possesses **greater capacities of inverse logistics**.
7. **Human activity contributes positively** to the ecosystems and the recovery of “natural capital”.

As a result, on the basis of these principles, diverse action plans are proposed; these aim, for the year 2025, to reduce the import of materials by 30%, to create 3,600 new jobs, an increase in economic benefits of 480 million euros, an annual reduction of 400 kilotons of CO₂ and the creation of 140 new startups.

Action scheme

The “Circular Amsterdam” plan has been developed as a result of the collaboration among the city of Amsterdam, Circle Economy (an organisation with its headquarters in the Netherlands, whose mission is the acceleration of a real implementation of the CE in cities), TNO (a consultancy which performs studies and research, using the scientific method in a wide range of economic sectors) and Fabric (an engineering and design

³ https://www.amsterdameconomicboard.com/app/uploads/2017/02/Engels_Board_Roadmap_Circular-Economy.pdf (retrieved June 2017).

studio). For the development of the plan, the “Circular Scan” methodology was used; as described in the “Circular Amsterdam” plan, this consists of the following phases:

1. **Mapping of the flow of materials and the generation of value:** with the objective of having available a complete vision of the situation of the economic model of Amsterdam from a circular point of view, a great number of data analyses were performed at local and national level, in addition to those proceeding from *ad hoc* surveys. These analyses have facilitated the understanding of the flow of resources, both natural and human and economic, and similarly of the environmental impact of the diverse economic and productive processes. Additionally, these analyses have permitted the discovery of diverse opportunities for the creation of value in the application of measures based on circularity.
2. **Evaluation and creation of value chains:** taking as base the results of the analyses performed in phase 1 described previously, a study was made of the “value chains” which connect the different economic sectors of Amsterdam. This second phase determined those value chains on which a greater impact could be made, following the application of measures based on the principles of the CE. Next, a ranking was obtained which positioned the distinct value changes on the basis of indicators of environmental impact, economic importance, value preservation and transition potential. Finally, selection was made of two value chains upon which an action plan was to be made: that of construction and that of the recycling of organic waste.
3. **Definition of the vision:** having selected the value chains to be worked upon, the vision of each of them was defined. This vision represents an ideal description of each of them from the CE point of view. The visions developed were shared and tested with different interest groups in Amsterdam society, to evaluate their suitability and redefine them, as necessary.
4. **Project selection and definition of action plans:** this last phase defined a concrete series of projects for each of the value chains, such that it was possible to achieve the objective of converting them into circular chains in the future. To do this, evaluation was made of those projects in which both public and research institutions, and also local firms, entrepreneurs and citizens, were able to work

jointly, managing to generate value, reduce the emission of CO₂, reduce the consumption of resources and generate employment.

Concrete actions proposed

As stated in previous sections, the “Circular Amsterdam” plan defines two value chains upon which there has been developed a specific plan for the implementation of measures which facilitate the attainment of a circular vision of these chains. By way of summary:

1. **Construction value chain:** the ideal vision of the construction value chain from a circular point of view would require that buildings are designed and constructed according to a model in which materials have a longer useful life and are easier to substitute and reuse when they are replaced. To be able to achieve this circular vision, different strategies have been defined, materialised in an action plan and possessing several concrete and quantifiable objectives. These strategies are:
 - **Intelligent design:** this means constructing buildings with a design which facilitates their adaptation faced with a change in their use, and also favouring the re-use of materials. This strategy will be based on concrete actions, such as modular and flexible design, the employment of new technologies in construction, such as 3D printing, the incorporation of biological materials and the development of experimental construction areas. The implementation of this strategy is intended to create an economic value of 12 million euros, generate 100 jobs and reduce annual CO₂ emissions by 300,000 tons.
 - **Dismantling and separation:** the principal idea is to demolish and dismantle buildings which are irrecoverable in an intelligent fashion, separating the materials which are of use for future productive processes. Furthermore, it is proposed to include this demolition phase in the life cycle of a building, to be added to construction plans as well as the usual ones of design, construction and maintenance. Thanks to the development of these projects, the “Circular Amsterdam” plan foresees the generation of an economic value of 25 million euros, the generation of 200 new jobs and the reduction of CO₂ emissions by 100,000 tons.

- **High-value recycling:** the construction sector is directly responsible for the generation of 40% of waste in Amsterdam (CBS, 2014). Currently, a large part of this waste is reused in low-value productive processes and it is intended to establish initiatives which favour its use in other types of processes. On the one hand, proposals have been made for the development of spaces or factories prepared for the recycling of high-value materials proceeding from construction. Other examples are the recovery of materials from urban paving and street furniture, and similarly the restoring of old buildings which can be adapted to new uses, through the use of recycled materials. According to the working team of the “Circular Amsterdam” plan, this new philosophy of material re-use will generate an economic value of 23 million euros, lead to 200 new jobs, save 200,000 tons in materials and reduce CO₂ emissions by 75,000 tons annually.
- **“Marketplace” and resource bank:** to complete the value chain of construction from a circular point of view, it would be necessary to create an easily accessible repository, where identification is made of the available materials proceeding from the dismantling and demolishing of old buildings with the use of recycled materials. This line of work would consist of the creation of an “online shop” through which materials would be distributed, and a warehouse or resource bank to store available materials. This initiative is expected to generate 25 million euros of economic value and 200 new jobs, and reduce CO₂ emissions by 25,000 tons

2. **Recycling of high-value organic waste:** the ideal vision proposed for this value chain assumes that the organic waste generated in Amsterdam is used intelligently and generates the greatest possible value. Furthermore, the supply chain will be shorter, boosting trade with local suppliers. To be able to achieve this circular chain, four strategies are proposed and presented below in a summary fashion:

- **Central biological refinery:** this strategic line aims to convert Amsterdam into a hub of biological materials recycled on a worldwide scale, exploiting their logistic and commercial potential in the global

economy. To do this, it will be necessary to achieve levels of recycling of organic material sufficient to satisfy worldwide demand and, above all, that the recycling process generates quality materials efficiently. Thanks to this initiative, it is predicted that an economic value of 30 million euros will be generated as well as 400 new jobs, the consumption of materials will fall by 25,000 tons and CO₂ emissions by 100,000 tons, in annual terms.

- **Separation of waste and inverse logistics:** in this case, the idea is to establish an efficient and productive process of domestic waste separation. For this, it would be possible to have available differentiated containers where waste could be deposited separately. Such containers would have sensors indicating the composition of the waste deposited, and also their quantity, such that their subsequent processing would be simpler. Furthermore, the possibility is proposed that certain agents, such as home food delivery persons, could act as waste recoverers, exploiting their return trip following a delivery. Through the development of these strategies, the working team of the “Circular Amsterdam” plan believes that economic returns of 30 million euros and 200 new jobs could be generated, the use of materials reduced by 300,000 tons and CO₂ emissions reduced by 100.000 tons annually.
- **Organic material flows:** another of the working lines is the development of an organic materials management chain which maximises the value of their use. Currently, a large percentage of waste from food is recycled in low-value processes; the idea would be to be able to determine a different use for each type of waste on the basis of its potential. For example, it is proposed to use foods which are in good condition for their food use, but have been damaged or have a disagreeable appearance, in the development of protein complements or their use as biomass in public spaces. The idea is that these actions produce an economic value of 30 million euros and 150 new jobs, the reduction of 500.000 tons of materials and a decrease in the emission of 100,000 tons of CO₂ annually.
- **Nutrient recovery:** the last of the strategic lines proposed to achieve the circular vision of the organic material recycling chain is the recovery of

nutrients from human biological waste. This waste contains a large quantity of high value nutrients which have not been absorbed by the human body and which, originally, have been incorporated into the productive process via very costly processes and imports. This waste can be used for the generation of compost, manure, and fertilizer and for the generation of other elements such as bio-gas. This initiative is expected to generate 30 million euros of economic value, 450 new jobs, reduce the use of materials by 75,000 tons and decrease annual emissions of CO₂, by 25,000 tons.

Current situation of the programme

Having analysed the current situation of the economy of Amsterdam from a circular point of view and identified the value chains on which to focus, there have been defined, as described in the previous section, four strategic lines of activity for each of these chains, such that the circular vision established in each case can be achieved. Next, concrete projects have been identified to undertake within each of the lines of work, evaluating them and prioritising them based on indicators of potential, ease of implementation, environmental benefits and capacity for contribution to the model of circularity.

When elaborating the present study, performance is being made of the plans defined for each of those pilot projects as well as communicating to the different interest groups the small achievements made through newsletters and periodical publications⁴. There currently exist some concrete examples of projects developed in the city of Amsterdam, such as that undertaken by the Schiphol airport, which has been collaborating with Philips Lighting in the supply of "lighting as a service" in its buildings in the terminal. Philips owns and maintains the 3,700 LED installations of high energetic efficiency in the terminals, while the airport pays simply for the electricity it uses. A similar project is Park 20/20, the first business park to be created in accordance with the design principles of "cradle to cradle", with buildings that can be dismantled for their recycling and reuse. And, finally, there is the ABN AMOR Circular Pavilion, to be inaugurated this year in the Amsterdam district of Zuidas. Located immediately opposite the headquarters of the bank, this pavilion of easily dismantled wood and glass aims to be an icon of the sustainable efforts of the institution. It will be an inspiring meeting point for clients and employees, and similarly for neighbours and visitors interested in the CE.

⁴ <https://www.amsterdam.nl/wonen-leefomgeving/duurzaam-amsterdam/nieuwsbriefduurzaam/>, (retrieved June 2017)

In early 2017 the Economic Board of the city and 179 companies, local authorities, knowledge institutes and other actors from civil society signed a Raw Materials Agreement intended to accelerate the transition from the city to a CE by closing the value chains in the food sector and those of biomass, manufactures, construction and consumption goods (AMS, 2017).

Next steps

As the following steps within the “Circular Amsterdam”, plan, the working party established a series of recommendations which would favour the achievement of the objectives established. Firstly, it was proposed to establish a tracking control panel which would help to monitor the situation of the action plan at all times and to establish new measures if necessary. Elsewhere, it was also proposed to compare the level of development of the CE model of Amsterdam and its implementation with that of other cities working in the same line. As commented on above, the objectives established are aimed at obtaining certain rapid results which animate Amsterdam society to continue with the implementation of the CE model. Moreover, the strategic objectives are foreseen for the medium and long term, and thus work will continue on the development of the plans established.

3.2. Case 2: Glasgow

Motivation

As can be extracted from the “Circular Glasgow”⁵ strategic plan, which captures the vision and the action plan to boost the CE in the city of Glasgow, there exist different motivations behind the implementation of this plan.

Firstly, it can be observed that the current productive model may experience difficulties in the future, due to the use of certain increasingly limited resources, and also to greater demand produced by world population growth which, according to data from the World Bank, is approximately 1.2% at the worldwide scale and close to 1% in the United Kingdom⁶. Given this context, it has been estimated that the CE represents an opportunity to improve the quality of life, as it stimulates the development of new productive models and innovations which reduce the consumption of resources and the

⁵ <http://www.glasgowchamberofcommerce.com/policy-projects/projects/world-class-city/circular-glasgow/> (retrieved June 2017)

⁶ <http://datos.bancomundial.org/indicador/SP.POP.GROW> (retrieved June 2017)

dependence of an economy, which could be that of Glasgow, on imports. Furthermore, the “Circular Glasgow” plan considers that these new techniques will mean a competitive advantage with regard to other economies and will generate business opportunities for their export to other markets.

Moreover, Glasgow has been recognised as one of the United Kingdom cities which has best been capable of recovering from the economic recession, and has the opportunity to enjoy a more productive and sustainable economy, this last being one of the fundamental objectives on the strategic agenda of the city of Glasgow.

Another of the motivations for the development of the “Circular Glasgow” plan is the availability of tangible elements which help to convince local businesses of the medium- and long-term advantages of the implantation of a CE model, since their collaboration is essential to achieve effective implementation.

Lastly, this plan will help to meet the strategic objectives established by Scotland in its “Zero Waste Scotland” plan; this proposes, among other questions, the reduction by 25% of the current waste of food before 2025. To achieve this, Scotland has invested 18 million pounds in launching an investment fund to support local businesses which collaborate in the creation of a more circular economy⁷.

Fundamental components of the plan

As stated in the previous section, the “Circular Glasgow” plan is closely linked to the “Zero Waste Scotland” initiative. In both cases, account has been taken of the following components on which to base their action plans⁸:

- **Design:** the replacement of the productive model by one based on eco-innovation, utilising regenerative materials and modular design techniques, in order to obtain products which are more durable and easier to dismantle and repair, which would require design with a lower degree of waste.
- **Maintenance and repair:** the lengthening of the life cycle of products, promoting their maintenance and repair, such that they maintain the original characteristics of use as long as possible. This could involve manufacturers maintaining the ownership of their products, offering re-use and maintenance services.

⁷ <http://www.zerowastescotland.org.uk/circular-economy/investment-fund> (retrieved June 2017)

⁸ <http://www.zerowastescotland.org.uk/circular-economy/definition> (retrieved June 2017)

- **Remanufacturing and reutilization:** the re-use of products after the finalisation of their “first life”, through their redesign and/or adaptation for different subsequent uses.
- **Recycling:** the separation of the different parts and components of products when their re-use is no longer possible, such that they can serve as materials for new fabrications.

Taking these principles as a basis, the “Circular Glasgow” plan defines the strategic objectives on which to work to develop its model of the CE. In this way, by 2023 it is expected to save 100,000 tons of CO₂, reduce waste by 5,000 tons and avoid the use of 15,000 tons of primary resources in productive processes, jointly generating an economic benefit of 50 million pounds.

Action plan

The “Circular Glasgow” plan is the result of the collaboration between the Glasgow Chamber of Commerce and the Circle Economy organisation (a social enterprise with its headquarters in the Netherlands), and has the support of Zero Waste Scotland and the Glasgow City Council. The plan designed comprises four principal phases:

1. The first phase attempts to answer the question “Where should a circular economy be started?” To do this, it was decided to analyse the ten principal productive sectors, at both economic and political level. This analysis aimed to identify the potential of each of them to adopt the circularity model and, taking those results into consideration, define those priority sectors for the definition of a tangible action plan. Following this analysis, it was considered that the sectors in which the plan was to be centred should be those of education, manufacturing and health, which employ approximately 30% of the productive force of Glasgow and have a joint economic value which represents 27% of the total.
2. During the second phase of the “Circular Glasgow” plan, an analysis was made of the impacts of each of these sectors on the environment, such that the most important aspects could be identified. As the result of this analysis a flow map was generated of the principal primary resources used in the productive processes of the sectors selected. In this way, a map was established of each of the sectors in which representation was made of how and to what extent each of

the materials (energy, water, biomass, chemicals and minerals) are transformed into residues of different types following the process of production.

As a complement to this information, a map was developed to spatially represent the location of each of the sectors analysed on the map of Glasgow, thereby facilitating the understanding of the best locations for the implementation of circular innovations, the opportunities for local collaboration and resource sharing, as well as the potential for escalating pilot projects in the future.

3. As a result of the study described above, the food and drink subsector was identified as that having greatest potential for the development of circular innovation projects, since it uses over 51% of the resources jointly consumed by the three strategic sectors (education, manufacturing and health). The analysis of the food and drink sector includes nine concrete circular strategies, scalable and with the potential to optimise the flow of resources in the productive process (GCC, 2016). For their definition, special attention was paid to inter-company benefits, collaborative work and the capacity of each of those strategies to generate a significant impact.
4. Finally, definition was made of the concrete action plan to be developed, which includes four of the nine circular strategies identified (GCC, 2016). For their selection, the project team analysed in each case the potential for success and the capacity to generate innovation in Glasgow. In this way were selected strategies easy to implement, comprehensible for a greater number of persons and with the possibility of showing positive results in the short term.

Concrete actions proposed

The “Circular Glasgow” plans includes four tangible projects oriented to the food and drink sector, which were developed as pilot projects. These projects will serve to inspire and motivate other businesses to initiate innovative circular projects. As principal characteristics of all of them can be observed the presence of different economic agents, which must work in a coordinated way and which will obtain tangible benefits following the application of the strategies proposed.

The four projects selected are:

1. **Heat recovery:** the project consists of the exploitation of the residual heat generated in bakers, principally in the baking process (which accounts for 70-

80% of the energy consumed in a bakers, and 10% of this energy is currently wasted), for other processes such as the heating of other areas, water heating, etc. In this case, it is necessary to involve different agents, such as bakers themselves, thermal equipment installation companies and, finally, entities from the energy sector which could finance the significant investment to be made.

2. **Aquaponics:** in this case, the project is intended to make restaurants generate part of the fish, vegetables and aromatic herbs they use in their cooking. This is achieved through a process which makes efficient use of the water employed in the fish growth tanks, to water and fertilise the cultivation of vegetables and herbs, achieving a 90% saving of water in the process in comparison with traditional agriculture. To put the project into practice there would be necessary the participation of restaurants, the availability of adequate space to install the tanks and cultivations, suppliers of fish food, installation of the lighting systems necessary for the process and the aquaponics technology which permits the use of water from the tank for the watering of the cultivation.
3. **From bread to beer:** this is an innovative technology which permits the use of unsold bread in place of the barley necessary for the production of beer. Using this technology, it is possible to reduce the waste of food, at the same time as reducing by over one third the resources necessary for the elaboration of beer.
4. **High-value cascade:** returning to the interaction between bakers and beer companies, a project has been designed whereby could be used the grains of waste from the productive process of beer for the making of bread and other elements such as cakes and pastries. Furthermore, these grains could be used to cultivate mushrooms which would be turned into compost to complete the circle of the process. This project would replace 50% of the flour necessary for the making of bread and reduce, in turn, the waste generated in the production of beer. Its implementation would require the collaboration of beer companies, bakers and, furthermore, firms from the restaurant sector which would take responsibility for distributing the product.

Current situation of the programme

Currently, the initiatives defined in the action plan are being implemented, with the collaboration of local entities from diverse sectors. For example, with regard to the

project “From bread to beer”, the local company Jaw Brew has commercialised a beer produced with bread from the excess production of local bakers.

In mid-2017 a new phase of the “Circular Glasgow” plan was initiated, which will consist of the direct participation of CE experts who, using a diagnostic tool developed by the Circular Economy, will help companies to understand to what degree their current practices meet the objectives of the circular city. This tool examines seven key areas which affect the circularity of all businesses:

- Prioritization of the sources of renewable resources.
- Preservation and extension of what is currently done.
- Use of waste as a resource.
- Design for the future.
- Collaboration to create joint value.
- Reflection on the business model.
- Incorporation of digital technology.

In addition, Glasgow companies will have access to the investment fund for the CE and the support service for circular firms, developed by Zero Waste Scotland⁹.

It should be underlined that the “Circular Glasgow” plan, jointly with “Zero Waste Scotland” and the Glasgow City Council, were recognised during the World Economic Forum held in January 2017 in the city of Davos, with the AB InBev prize, which recognises governments, regions and cities which apply the principles of CE¹⁰.

Next steps

The following phase of the “Circular Glasgow” plan will consist of finalising the implementation of the four pilot projects selected. Once this phase has been completed, these examples will be used as models of inspiration for future projects and to make Glasgow businesses aware of the benefits which can be derived from the evolution towards a model of the CE, both for them and for the society and economy of Glasgow. Meanwhile, the lessons learnt in the development of the projects will be shared.

⁹ <https://progrss.com/sustainability/20170330/glasgow-city-circular-initiative/> (retrieved July 2017)

¹⁰ <http://www.glasgowlive.co.uk/news/glasgow-news/award-win-glasgows-pioneering-project-12461326>;
<https://thecirculars.org/> (retrieved June 2017)

3.3. Case 3: Peterborough

The CE model proposed by Peterborough is integrated within its local strategic plan, which proposes diverse challenges whose principal objective is that of achieving an intelligent and sustainable city.

For the proposal of this model, the authorities of Peterborough observed that the natural resources utilised to meet the needs of the world population are increasingly scarce and, on the other hand, over half of the world population live in urban nuclei (UN DESA, 2013), and thus the active role which must be adopted by cities, their firms and their citizens is increasingly important when defining a sustainable economic and social model. The current situation is worsening due to the large quantity of valuable materials we discard as waste following their consumption and which, due to the lack of efficient management processes for that waste, become elements which degrade the environment.

Taking this into consideration, Peterborough has accepted the challenge of becoming the first circular city in the United Kingdom, a city which manages its resources in an efficient and sustainable way, to the benefit of the environment and future generations. This model of circular city will require¹¹:

- The achievement of a more competitive economy.
- Greater productivity of resources.
- The creation of stronger social ties.
- The development of the abilities of local businesses and citizens.
- The reduction of waste.
- The exploitation of new opportunities for local businesses.

Fundamental components of the plan

As observed in the circular city plan defined by Peterborough, as part of its local strategic plan, its model is based on the following principles:

1. **Reflection:** its idea is to reflect upon resources, taking into account that they are not only materials and products, but that economic and human capital also exist. Given this principle, it is aimed to discuss the current productive model in the

¹¹ <http://www.futurepeterborough.com/circular-city/> (retrieved June 2017)

search for a more economically viable model, as well as sustainable solutions for the products and services which form part of the economy.

2. **Redesign:** this means evolving the productive model in such a way as to increase the life cycle of products and make it simpler to improve, repair, separate and reuse them.
3. **Redefinition, re-use and sharing:** as observed in Peterborough's circular economy plan, current consumers are used to utilizing products and services for a short period of time and for a single use. The products which some dispose of could be of use to others, through a model of donations or of sale as second-hand articles.
4. **Repair:** in this case, the principle of repair proposes the analysis of the different possibilities and processes of repair of an article before its discarding. The CE model, therefore, aims to stimulate the idea of repair instead of that of discarding, among producers and consumers.
5. **Remanufacturing:** this principle involves the utilization of certain valuable components of products which have reached the end of their life cycle for the elaboration of new products. Furthermore, this model would favour the use of products as a service, instead of their purchase.
6. **Recycling:** once products and their components can no longer be repaired or reutilized for the fabrication of new products, the time has come to recycle them.
7. **Recovery:** all products and components have a residual value which it is important to recover. As an example of this, Peterborough has developed an energy recovery unit, which recovers 90% of household waste of the city for the generation of electrical energy. This system currently supplies over 15,000 households.

Action scheme

In 2012, Peterborough obtained the second position in a competition organised by "Innovate UK", which had as prize 3 million pounds for the testing, development and implementation of new concepts and ideas which connected individuals, places, spaces and services in a more intelligent way, creating a more sustainable city in which to live and work. From this exercise emerged, in 2012, the pilot programme "Peterborough DNA", concentrated on growth, innovation, capacities and sustainability. This

programme provided the bases for the development of intelligent projects giving rise to innovative solutions to the challenges of the city. This project was the fruit of collaboration between the Peterborough City Council and “Opportunity Peterborough”, an organisation for the economic development of the city.

Thanks to the development of this pilot project there has emerged “Future Peterborough”, an initiative with concrete objectives and which responds to the commitment of the city to conserve its natural capital and convert itself into an intelligent city, always through a CE model. As can be seen, it consists of a comprehensive approach which will be moulded in a strategic local plan that will tackle the principal challenges in consonance with citizens, businesses and other local interest groups.

The development of the 2016 local strategic plan for the city of Peterborough was initiated in 2016 and consists of 7 phases which will extend until February 2018. In the initial phases of the development of the plan different interest groups (citizens, businesses, institutions, etc.) have been consulted regarding their points of view and proposals. Next, the plan will be transferred to the competent authorities for its approval and implementation.

The objective is for the local strategic plan to be aligned with the strategic priorities of the city¹²:

- To generate growth, regeneration and economic development.
- To improve educational achievements and the skills developed.
- To safeguard groups at risk.
- To implement the environmental capital agenda.
- To support culture and leisure in Peterborough (Vivacity).
- To maintain all communities safe, healthy and cohesive.
- To achieve the best health and welfare for the city.

¹² <http://consult.peterborough.gov.uk/portal/planning/peterborough/lp16/pd/plp4pd?pointId=s1437641924077#section-s1437641924077> (retrieved June 2017)

Consequently, taking these strategic priorities into consideration an action plan was developed to serve to reach the vision of Peterborough in 2050. The principal objectives dealt with in that plan are¹³:

- **Zero carbon emissions:** to be able to achieve a net level of nil carbon emissions, via a system of sustainable and efficient production and consumption.
- **Sustainable water:** to drastically reduce the consumption of water in the local ambit and establish water management measures which are efficient and respect the environment.
- **Use of the land and wildlife:** to favour the development of natural areas where wildlife is respected and can be visited and enjoyed by local citizens.
- **Sustainable materials:** as far as possible, all the materials used in productive processes must be sustainable and of local origin.
- **Sustainable and local foods:** to encourage the consumption of local food and drink, to improve sustainability levels.
- **Zero waste:** to establish adequate procedures and infrastructure to reduce to the minimum the waste generated in the city.
- **Sustainable transport:** by 2050, 90% of transport must take place in vehicles which produce zero emissions.
- **Culture and heritage:** to be recognised by its visitors for its culture and social heritage.
- **Equity and the local economy:** to develop an equitable economic model based principally on innovative and environmental businesses.
- **Health and welfare:** to achieve a city in which citizens live longer in an agreeable and respectful way.

Concrete actions proposed

The Peterborough City Council has placed at the disposition of the different interest groups a web platform where they can share the private projects which take into account some of the principles on which their CE model is based. In this way, the intention is for

¹³ <https://www.peterborough.gov.uk/upload/www.peterborough.gov.uk/council/campaigns/EnvironmentActionPlan-PCC-May2017.pdf?inline=true> (retrieved June 2017)

businesses, citizens and/or institutions themselves to participate proactively in this initiative. By way of summary, these are the currently identified projects subscribed to the circular city model. In addition, other projects linked to the “Future Peterborough” plan can be found:

- **Smart Fengate:** This is a collaborative economic project in which local SMEs participate, with the aim of constructing a viable and sustainable economic model. Many local companies in Peterborough work in isolation, without being conscious of the benefits produced by the collaborative economy. The “Fengate business cluster” is an industrial area of Peterborough where a series of systems are being developed to help to provide shared solutions and to improve the efficiency of their resources.

At first, a group of twelve local companies started to work jointly with the “Future Peterborough” initiative for the creation of the “Share Peterborough” platform. This platform permits maximisation of the exchange of second-hand materials, products and services.

- **Care Zone:** this is a training project based on innovative methods of furniture recycling and the development of skills for a greater employability of the persons receiving it. This project is being developed by the Kingsgate Community Church of Peterborough and aims to:
 - Aid families in crisis and provide them with access to furniture, clothes and other household goods, all of them being emergency articles of good quality. These articles are procured by donations.
 - To improve the degree of employability of persons at risk of social exclusion and suffering very long periods of unemployment, by improving their technical capacities, autonomy and personal self-confidence.
 - To offer opportunities of volunteer work to the citizens of Peterborough so that they can make a valuable contribution to their community.
 - To reduce the scrapping of furniture by motivating the community to give these articles a second life through persons needing them.
 - To collaborate with local businesses to facilitate the incorporation of persons at risk of social exclusion and to improve their skills.

- **Upskilling & upcycling:** in addition to its work helping families in complicated situations, Care Zone has developed furniture recovery workshops in which these citizens can develop technical abilities of use for their incorporation into working life. Care Zone collaborates with a great number of local institutions and, furthermore, has reached an agreement with IKEA to obtain material useful for such workshops and which otherwise would have been discarded. These materials are recycled and reused in the creation of furniture which, subsequently, is donated to needy families. In addition, the participants receive training regarding recovery which will be of great use to them in the recovery of old furniture which they may have at home. This project is linked to the principles of: Reflect, Redefine, Reuse, Recycle and Share.

Current situation of the programme

As has been described throughout the analysis of the case, the circular city model of Peterborough forms part of a wider conceptual framework. It is for this reason that the working team formed by the Peterborough City Council and “Opportunity Peterborough”, continue working on a more complete definition of the specific plan for the development of the circular city. Here, the experience which is being developed with the “Smart Fengate” project is serving as the inspiration and motor for change. Peterborough has over 200 organizations involved in the circular city project and the Share Peterborough platform, launched in December 2016, currently has over 100 members.

Another of the pillars supporting the circular city plan of Peterborough to continue working on this idea is the international recognition its proposal has been receiving. Here, Peterborough received the “Smart City 2015” prize, in the category of cities, awarded in Barcelona by the “World Smart City Congress”, thanks to its EC proposal¹⁴. Additionally, it should be underlined that Peterborough forms part of the network of circular cities of the EMF (Ellen MacArthur Foundation).

Next steps

Throughout the case study, emphasis has been placed on the omnicomprehensive character of the strategic plan of Peterborough, which is based on a circular city model. Firstly, it is predicted that in February 2018 it will be possible to launch the local strategic

¹⁴ <http://www.citiestobe.com/article/circular-economy-in-peterborough/>;
<http://www.futurepeterborough.com/2015/11/20/peterborough-wins-smart-city-year-2015/> (retrieved June 2017)

plan for its implementation and, when that moment comes, more lines of work will be developed, related to the circular city that will be Peterborough in 2050.

In order to be able to evaluate the implementation of its model of circularity, Peterborough is preparing a model with which to analyse the maturity of its programme. This model of tracking is being defined in two phases. The first of these consists of working with local businesses to create a system which can track the progress of businesses in their objective of becoming circular. Next, the model will be escalated to incorporate the approach of other citizens and other social elements, in such a way that a tracking model is obtained, one which measures the degree of implementation of the circular city model as a whole.

4. Discussion

Having undertaken an intra-case analysis of three examples of the implementation of the CE in the urban environment in section 3, the present section summarises the principal characteristics of them all, by way of introduction for their subsequent inter-case analysis (see Table 1).

Table 1 Principal characteristics of the circular projects of the three cities selected.

	Amsterdam	Glasgow	Peterborough
Motivations	<ul style="list-style-type: none"> - Increase of the world population and shortage of resources. - Conviction of institutions for a real? transition towards the CE. - Strong commitment by citizens and businesses. 	<ul style="list-style-type: none"> - Increase of the world population and shortage of resources. - Competitive advantage and new opportunities. - Elements available to convince and motivate interest groups. - Fulfil the objectives outlined in the Zero Waste Scotland plan. 	<ul style="list-style-type: none"> - Develop an intelligent and sustainable city - Increase of the world population and shortage of resources. - Need for active intervention by local governments. - Manage resources in an efficient and sustainable way.
Fundamental components of the plan	<ul style="list-style-type: none"> - Infinite technical or biological cycle. - Energy from renewable sources. - Use of resources to generate value. - Modular and flexible design. - Transition from the "possession of 	<ul style="list-style-type: none"> - Design: productive model based on eco-innovation. - Maintenance and repair: lengthen product life cycles. - Remanufacture and re-use: reutilizing products after the 	<ul style="list-style-type: none"> - Reflect: more economically viable and sustainable model. - Redesign: increase the life cycle of products. - Redefine, reuse and share: products discarded by some

	<p>products” to the “use of services”.</p> <ul style="list-style-type: none"> - More local economic model. - Human activity contributes positively to ecosystems. 	<p>finalization of their “first life”.</p> <ul style="list-style-type: none"> - Recycling: separation of the different parts and components of products when their reuse is no longer possible. 	<p>could be of use to others.</p> <ul style="list-style-type: none"> - Repair: repair processes of an article before discarding it. - Remanufacture: utilization of certain valuable components of products which have reached the end of their life cycle. - Recycling: recycle components when they cannot be reused. - Recovery: recover the residual value of components.
Outline of activity	<ul style="list-style-type: none"> - Mapping of the flow of materials and the generation of value. - Evaluation and selection of value chains. - Definition of the vision. - Project selection and definition of action plans. 	<ul style="list-style-type: none"> - Analysis and selection of sectors in which to work. - Mapping of the flow of the principal primary resources. - Selection of the subsector in which to apply the plan. - Definition of the concrete action plans to develop. 	<ul style="list-style-type: none"> - Obtaining of funds for the development of the Peterborough DNA pilot programme. - Definition of the strategic priorities of the city. - Implementation of the Future Peterborough plan. - Development of the local strategic plan.
Concrete actions proposed	<p>Value chain of construction:</p> <ul style="list-style-type: none"> - Intelligent design. - Dismantling and separation. - High-value recycling. - Marketplace and resource bank. - Recycling of high-value organic waste: central biological refinery; separation of waste and inverse logistics; organic material flows; recovery of nutrients. 	<p>Projects aimed at food and drink sector:</p> <ul style="list-style-type: none"> - Recovery of residual heat. - Aquaponics. - From bread to beer. - High-value cascade. 	<ul style="list-style-type: none"> - Smart Fengate: This is a project of economic collaboration in which local SMEs participate. Platform for the exchange of second-hand materials, products and services - Care Zone: training in technical skills for persons at risk of exclusion - Upskilling & Upcycling: recovery of second-hand furniture.
Current situation	<ul style="list-style-type: none"> - Four strategic lines of action have been defined. - Identification has been made of concrete projects to be executed within each of the lines of work, evaluating them and prioritising them based on indicators of potential, ease of 	<ul style="list-style-type: none"> - The initiatives defined in the action plan are being implemented, with the collaboration of local entities in diverse sectors. - The “Circular Glasgow” plan, jointly with “Zero Waste Scotland” and the Glasgow City Council, was recognised during 	<ul style="list-style-type: none"> - Working on the most complete definition of the specific plan for the development of the circular city. - “Smart City” prize in the year 2015, in the category of “Cities”, awarded in Barcelona by the “World Smart City Congress”,

	<p>implementation, benefits for the environment and capacity for contribution to the model of circularity.</p> <ul style="list-style-type: none"> - Execution is being made of the plans defined for each of these pilot projects, communicating to the different interest group the moderate achievements being reached through newsletters and periodic publications. 	<p>the World Economic Forum held in January 2017 in the city of Davos, with the AB InBev prize, which recognises the governments, regions and cities which apply CE principles.</p>	<p>thanks to its CE approach.</p> <ul style="list-style-type: none"> - It forms part of the network of circular cities of the EMF.
Next steps	<ul style="list-style-type: none"> - It is proposed to establish a tracking control panel which helps to monitor the situation of the action plan at all times and to establish new measures should these be necessary. - Compare the level of development of the CE model of Amsterdam and its implementation, compared to that of other cities which are working in the same line. 	<ul style="list-style-type: none"> - To finalise the implementation of the four pilot projects selected. - Once this phase has been completed, these examples will be used as models of inspiration for future projects and to make businesses aware 	<ul style="list-style-type: none"> - Finalisation and launching of the strategic plan of the city of Peterborough (February 2018). - Design and implementation of a tracking model and analysis of the degree of maturity of the circular city model.

Source: authors' compilation.

The inter-case analysis permits the emergence of a large quantity of coincident aspects.

Firstly, when proposing the respective CE plans, all the cases are linked in one way or another to other plans of a local and/or national character. From among these are the case of the sustainability agenda in Amsterdam (Amsterdam, 2015), which serves as a starting point for the "Circular Amsterdam" plan; the "Zero Waste Scotland" programme, whose objectives of waste reduction are positioned as one of the motivations for the approach of the "Circular Glasgow" plan; the second prize for "Innovate UK" received by Peterborough, whose economic contribution served to initiate the "Peterborough DNA" plan; or the "Future Peterborough" plan which, sustained by the local strategic plan, serves as an omnicomprehensive framework in which the vision of the circular city is developed.

Furthermore, it can be observed that in the three cases the CE model has been developed on the initiative of local governments and via collaboration between the city

council and diverse organisations from the public and private sectors. However, it is interesting to observe the different profiles of the collaborators, indicating that different capacities may be of considerable use for the development of plans of this type:

- Circle Economy (Amsterdam and Glasgow): organization with headquarters in the Netherlands, whose mission is the acceleration of a real implementation of the CE in the cities.
- TNO (Amsterdam): non-governmental organization which undertakes studies and research, using the scientific method, in a wide range of economic sectors.
- Fabric (Amsterdam): engineering and design studio/study of engineering and design.
- Glasgow Chamber of Commerce (Glasgow): organization of local businesses.
- Zero Waste Scotland (Glasgow): initiative to achieve the reduction of waste generated in Scotland.
- Opportunity Peterborough (Peterborough): local organization for the economic development of the city.

Throughout the analysis of each of the cases relative to the plans of Amsterdam, Glasgow and Peterborough, it has been possible to observe that all are to be found in a first phase of implementation, where what is important is to define, in the first place, the priorities to be tackled, and similarly the lines of work to be developed, in order to achieve the objectives decided upon. In this way, the analysis of the cases selected shows how the different plans are becoming tangible through concrete projects which do not include all the productive sectors and/or economic activities of the economy of each of the cities. Additionally, the plans have been defined with their principal strategic objectives fixed for the medium and long term (Amsterdam and Glasgow for 2025, Peterborough for 2050). In this respect, the three models make clear the difficulty of executing a transformation of this magnitude without concentrating on those measures which, initially, may present greater probabilities of success and a greater impact on the transformation of the economic model of the cities.

All the cases show the necessity of involving, proactively and enthusiastically, the different interest groups and economic agents which form part of the local economy. This is important since, as can be extracted from the cases studied, the CE requires a high degree of cooperation and coordination among the different economic agents and local businesses, which must be conscious of the benefits (both economic and of other

types) they will enjoy by effectively applying the principles of circularity. In this regard, the active participation of citizens is very important; they should establish themselves as responsible consumers who demand another type of products and services, more sustainable, intelligent and responsible. Finally, the participation of local and national administrations is fundamental; these must establish the policies and regulation necessary to favour the activation of the circular city model. In this respect, as has been stated above, it has been the local administrations which have promoted the development of the plans of the three cities analysed, showing their commitment in this regard.

It has also been observed, throughout the analysis of the cases, that all of them propose a model of application of their plans in which is shared with the community the different landmarks and achievements reached throughout the application of the strategies defined. This abounds in the importance of motivating and influencing the rest of the citizens, businesses and local institutions for a successful implementation of the established CE model. In the three cases analysed, there can be observed a high degree of recognition at local and international level of the measures adopted, through prizes and public references.

Finally, from among the similarities, there stands out the importance awarded in each one of the plans to the definition of a model of monitoring and analysis of the implementation of the respective models of the circular city.

Elsewhere, the approach and implementation model of the three plans analysed shows some differences.

Firstly, the methodology used in the cases of Amsterdam and Glasgow has been very similar, based on the “Circle City Scan” model, developed by the Circle Economy organization, which has participated in the development of both plans. This methodology gives rise to the development of some CE plans which have a strong analytical base with regard to the maps of resource flows and value chains, and similarly to the different cascades and interactions necessary to successfully develop the strategies of circularity established. However, in the case of Peterborough, the development of the plan has followed a longer process, starting in 2012 with Peterborough DNA, and has been one of self learning.

Similarly, it should be underlined that the circular city plan of Peterborough is framed within a more omnicomprehensive initiative, namely Future Peterborough, which

includes objectives of an intelligent city and of the recovery of environmental capital. In addition, this initiative is supported by the strategic plan of the city of Peterborough. Throughout the analysis, it has not been possible to demonstrate such an important alignment between the different plans established in Amsterdam and Glasgow.

Finally, in view of the cases selected, it can be concluded that the implementation of a CE model in cities is a complex process requiring a prolonged period of implementation. Furthermore, there exist different methodologies and orientations when reaching that vision of the circular city. On the other hand, it can be observed that the motivations for the implementation of this type of plans are similar, and all announce a great potential in the generation of value and opportunities for the local economy. To conclude, what is made emphatically clear in the three cases is the importance of the commitment and participation on the part of all the economic and social agents of the city, led by the local authorities, who must establish an ideal framework for the implementation of this type of initiative.

5. Conclusions

Tackling the CE from an urban perspective is interesting, and even necessary, for various reasons: 1) due to its increasing importance in terms of population density and intensity in the consumption of resources; 2) because in order to achieve a profound systemic change in socioeconomic systems towards sustainability radical strategies of urban government are necessary; 3) because such a change requires the implication of the urban authorities, as they possess a broad knowledge of their environment and autonomy in the planning of the principal resources; 4) because technical and biological "nutrients" are grouped within city limits and can be found in quantities which can be exploited through "urban mining"; 5) because interested parties are geographically close by, which can help in collaboration to close the circuits of resources.

The principal objective of the present study has been to attempt to clarify, at least in part, the emerging concept of the "circular city", through the study of three cases which have shown how different European cities are adopting the CE in their strategies to implant the CE in the urban environment.

From the intra-case and inter-case analysis of the three examples selected for the development of the present study (Amsterdam, Glasgow and Peterborough), it has been possible to extract a series of conclusions which, although they cannot be extrapolated to all the current and future plans of circular cities, can be of use to understand the principal characteristics and aspects which have been taken into account when developing the plans analysed.

From the three cases analysed it can be concluded that the CE plans developed have a greater or lesser linkage with other initiatives of a local and/or national character. Furthermore, there can be observed the need to define pilot projects to learn from them and, in the future, scale them up and replicate them. Similarly, the importance of a strong degree of collaboration among the different economic, social and political agents which form part of their respective local economies is clearly evident. Lastly, this study concludes that in the three circular city plans there still exists the need to develop an appropriate model of tracking and monitoring of the advance of the measures adopted, to evaluate the degree of success of such programmes.

We are confident that, despite its limitations, this qualitative study can serve as a basis for more specific future research, aiding the establishment of hypotheses and guides useful for a better comprehension of the CE in the urban environment.

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