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Spatial Analysis of Leading Circular Economy and Living Lab Cities

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Abstract

This study presents the preliminary results of the “*Cities as Living Labs — Increasing the impact of investment in the circular economy for sustainable cities*” study by Santonen et. al. (forthcoming) which is to be published in late summer 2017. From innovation system and policy development point of view, it is vital to understand the impact and added value of EU-funded projects especially in context of the complex societal challenges such as circular economy in cities. By using publically available data sources the aim of this study is to A) map cities which have elaborated and implemented urban strategies relating the circular economy either by themselves or with the help of EU-project funding and B) to describe how these cities mobilise and interact with Living Labs. As a result, a strong correlation with urban strategy and EU-project activities was detected. Also, a weak correlation between Living Lab maturity and EU-project funding as well as Living Lab maturity and Urban strategy activities were detected. The TOP 10 cities executing urban strategy in circular economy, acting as a forum for EU-projects or having Living Lab activities is presented, which revealed that city of Barcelona was by far the leading city in Europe.

Keywords: Circular Economy, Living Lab, EU-funding, Urban strategy, Spatial analysis, Geographical mapping

1 Introduction

Innovations are vital to European competitiveness and therefore the EU is investing significantly in research and innovation through various funding instruments such as Framework Programme for Research and Innovation. From innovation system and policy development point of view, it is vital to understand the impact and added value of these investments especially in context of the complex societal challenges such as circular economy in cities. Circular economy promotes the idea that waste-output from a one actor can function as a valuable input to another actor e.g. in terms of raw material or energy and lead to environmental benefits by reducing intake of virgin material and/or reduced emissions (Graedel and Allenby, 1995). By definition circular economy therefore promotes resource minimisation and the adoption of cleaner technologies (Andersen, 2007) while maintaining the value of products, materials and resources in the economy for as long as possible and minimizing waste generation (European Commission 2015). The ultimate goal in circular economy is to generate economic growth without environmental pressure.

According to European Network of Living Labs (ENoLL), LLs are open innovation ecosystem based on a systematic user co-creation approach that integrates public and private research and innovation activities in communities, placing citizens at the centre of innovation. In this study LLs are considered as early markets for innovative products and services by consisting of advanced, risk-resilient consumers, innovative public/private procurement with open innovation dynamics. Furthermore, from an EU-level perspective, LLs existing in various locations across Europe offers a different social, legal, and cultural settings to explore and test innovative solutions in variable environments.

The number of LL have been steadily growing since the launch of the ENoLL about ten years ago. Historically there have been nearly 400 official recognised LLs across the world and currently there are 170 active Living Lab members in ENoLL. However, compared to traditional innovation research themes such as product, process, market or organizational innovation derived from Schumpeter (1934) typology, the maturity and evolution of LLs research is still in infancy. Many LL studies have more or less grounded on single or combination of few case studies which is typical approach when a particular research stream is still evolving strongly. Studies such Schuurman et. al (2016) are welcome exceptions since they are exploring the value of a LL approach for SMEs by comparing 27 projects. However, all these projects were conducted by single LL, which do not fully recognize the heterogeneous social, legal, and cultural conditions which are existing across Europe. Furthermore, the studies focusing on the impact of LLs at the city level are rare. Few pioneering studies are existing such as a comparative case study of three Asian and two European cities by Hu et al. (2016) and a snapshot of five case studies how the Urban Living Lab (ULL) concept was operationalised in urban governance for sustainability and low carbon cities (Voytenko et al. 2016). As a result, it is argued that there is a significant research gap relating (comparative) studies which are evaluating LL approaches and impact at European level. Therefore, the aim of this study is to A) map cities which have elaborated and implemented urban strategies relating the circular economy by using publically available data sources and B) to describe how the cities mobilise and interact with Living Labs.

2 What is Circular Economy?

Recently Ghisellini, et al. (2016) conducted an extensive review of the circular economy literature in order to define the main features and perspectives of circular economy including the origins, basic principles, advantages and disadvantages, modelling and implementation at the different levels (micro, meso and macro) worldwide. According to their study following observations were made:

- Circular economy roots are mainly being derived from ecological and environmental economics and industrial ecology.
- Both top-down national political objectives and bottom-up environmental and waste management policies have been applied.
- The implementation of circular economy is still in the early stages, but important results have been achieved in some sectors (especially in waste management). However, activities still mainly focus on recycle rather than reuse.
- Transition towards circular economy requires the involvement and capacity of all actors of the society to create suitable collaboration and exchange patterns
- Circular economy implies to A) the adoption of cleaner production patterns at company level in a way that an economic return on investment is gained to motivate companies and investors; B) increasing producers and consumers responsibility and awareness, C) using wherever possible the renewable technologies and materials and D) the adoption of suitable, clear and stable policies and tools.

Albeit, many dimensions for circular economy can be defined and identified, in this study a circular economy in cities is argued to cover one or several of the three following dimensions:

1. **Sustainable use of resources, natural and cultural capital** (e.g. waste management, urban mining, up- and re-cycling, new business models) (Dalhammar, 2016),
2. **Circular mobility** (i.e. offering more choices of mobility and promoting vehicles which can be shared, electrified, autonomous, multi-modal and looped) since transportation is a major contributor to climate change but efforts at reducing emissions in this sector has been challenging (Cruz and Katz-Gerro, 2016) and
3. **Resource efficient buildings and urban spaces**, since buildings causes 40% of Europe's energy consumption and globally it varies from 16 to 50% of total worldwide energy consumption (Pombo, Rivela and Neila 2016).

3 Research methodology

3.1 Unit of analysis – Selecting cities

In 2012, the OECD and the European Commission published a new definition of a city (Dijkstra and Poelman, 2012). This new definition is based on the presence of an 'urban centre', a new spatial concept which is purely based on population size and density instead of functions, funding or feudal history which can lead to problems when conducting cross-country comparison. To qualify as an 'urban centre', city must have a density of more than 1.500 inhabitants per sq km and more than 50.000 inhabitants. However, this study mainly focuses only on European cities having over 100.000 inhabitants (N=517), but the sample can include also cities less than 100.000 inhabitants in urban area since by some data sources a city is defined by administrative border instead of urban centre. A city selection was conducted according to following rules:

- 1) City has an **official urban strategy** with objectives to achieve one or several of the prior defined three dimensions of a circular economy,
- 2) Sample **cities represent different size** in terms of population and follows the population categorisation of Eurostat [i.e. A) cities having 100.000-250.000

- inhabitants, B) having 250.000-1 million inhabitants, C) having 1 to 3 million inhabitants, and D) cities larger than 3 million inhabitants],
- 3) The **geographical location** of the cities includes cities in Central Europe, Western Europe, Eastern Europe, Southern Europe and Northern Europe. Unfortunately, there are several different approaches to define European sub-regions and therefore a country can belong to a different sub-region depending on a classification schema. As a result, various country grouping does not fully match. The county classification used in this study is presented in Appendix 1: Geographical classification of Countries.

3.2 Data collection and construction of measures

Data sources were classified into following three categories: 1) EU-funding, 2) Urban strategy, and 3) Living Labs.

EU-funding: CORDIS database was used to identify all the relevant FP7 and Horizon 2020 projects which thematically focused on various circular economy and/or Living Lab themes. Seasoned EU official executed the search by using circular economy and Living Labs related keywords. In all this search resulted 137 FP7 and Horizon projects. Next the participants profiles, objective descriptions from Cordis database were analysed to acquire for more detailed information about the project as well as the project's websites (N=101) when they were still available. As a result of this analysis in a project, a city could have following different roles which was defined as a reference to a project: 1) beneficiary, 2) lighthouse city, 3) follower city, 4) benchmark city, 5) observer city, 6) demonstration city, 7) case study city or 8) pilot city.

Urban strategy: The following web services which are known to focus on urban strategies or circular economy were evaluated in order to detect the maturity of urban strategy in city: Covenant of Mayors for Climate and Energy, Sustainable Cities Platform, Urban Innovative Actions (UIA), The European Green Capital Award, The European Green Leaf, European Innovation Partnership on Smart Cities and Communities Market Place, The Circular Europe Network, The Reference Framework for Sustainable Cities (RFSC), The European Capital of Innovation Award (iCapital), The Open & Agile Smart Cities initiative (OASC), The Ellen MacArthur Foundation, ICLEI - Local Governments for Sustainability, Eltis, C40 Cities Climate Leadership Group and EUROCITIES. Depending on the data source the following approaches were utilized to define an Urban Strategy measure: A) a city has a membership or signatory profile (or is a member of initiative) or B) is present in a case study or project, which was listed in the given data source website. Furthermore, if city had participated on multiple activities (e.g. in multiple projects or cases) each activity resulted one point. Then all the points were summed up which was used as an indicator of urban strategy intensity.

Living Labs: The list of ENoLL's effective members were used identify LL locations and their thematic areas. The Living Lab age in years, the number of different Living Labs and different thematic areas were used as indicators to measure the Living Lab maturity in a city. Furthermore, FP7 and Horizon 2020 projects having clear Living Lab focus, were also identified from CORDIS database in order to evaluate the LL and circular economy related EU-project ratio.

4 Results

4.1 FP7 and Horizon 2020 project distribution across the Europe

Over half of the FP7 and Horizon 2020 projects focusing on Circular Economy or Living Labs (N=77, 56.2 %) included a reference to a city, while for 43.8 percent of projects (N=60) a city reference could not be found. In Figure 1 the cities having 2 or more project references are mapped on the European map. The size of the blue circle is indicating the number of references (i.e. bigger the circle, more project references).



Figure 1: Cities having 2 or more project references

As a result, City of Barcelona by far was the most active city with 11 references. Furthermore, the first position of Barcelona's can be regarded even stronger since Sabadell with 3 references is only about 30 kilometres and Manresa with 2 references about 60 kilometres from Barcelona. In Figure 1 Sabadell and Manresa circles are masked below Barcelona's circle. The next best position was shared by 8 cities (Amsterdam, Berlin, Helsinki, London, Madrid, Manchester, Milan and Turin) which all had 6 projects. Third position was shared by Copenhagen, Hamburg, Ljubljana and Rome which all had 5 projects. Among the top three cities, South Europe had 5 cities (Barcelona, Madrid, Milan, Turin and Rome), North Europe 2 cities (Helsinki and Copenhagen), West Europe 3 cities (Amsterdam, London, Manchester) and Central Europe 3 cities (Berlin, Hamburg and Ljubljana). The best East European city was Sofia, which shared the 5th position with 16 other cities.

When a city reference to a project were evaluated in terms of South, North, West, East, Centre and Non-Europe countries it appeared that 21 projects (26.6 %) were executed only in one region, 27 projects (34.2 %) in two regions, 15 projects (19 %) in three regions, 10 projects (12.7 %) in four regions and 6 projects (7.6 %) in five regions. None of the project included all six regions.

4.2 Urban strategy activities

In Figure 2 the cities activity level in urban strategy (yellow colour) is mapped together with project reference activity (green colour). The similar notation as in the case of project reference was used (i.e. bigger the circle, the more activities). However, in some cases (e.g. Barcelona) the green circle (project reference) is masking the yellow urban strategy circle.

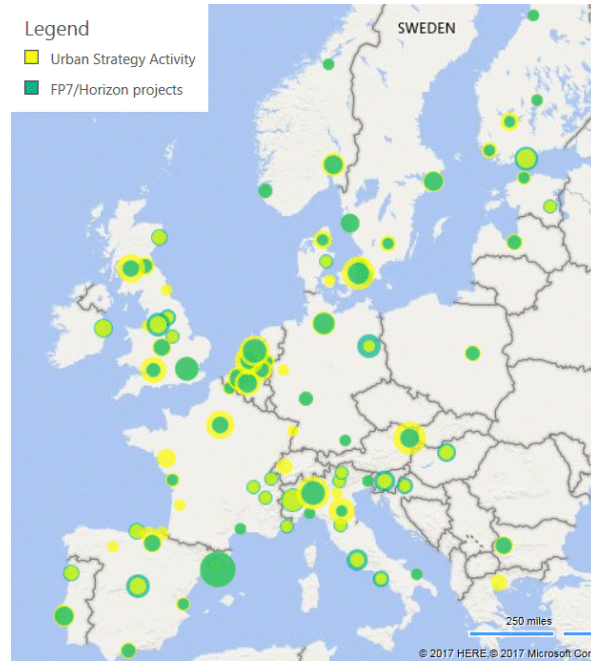


Figure 2: Top cities having active urban strategy and Cities having 2 or more project references

The visual examination of Figure 2 suggests that cities which having an active urban strategy has also acted as a forum for FP7 and Horizon projects. The correlation analysis between project reference and urban strategy measures validated this assumption and there is a clear relationship between these two measures (0.753, sig. 0.000).

4.3 Living Lab activities

In Figure 3 the most mature Living Lab (grey colour) cities are mapped together with project reference activity (red colour). The similar notation as in the prior Figures were used (i.e. bigger the circle, the more mature/active). Also in this case Barcelona's projects are masked by Living Lab maturity measure. The visual examination of Figure 3 suggests that there is a weak relation with Living Lab maturity and project references but clearly not strong as in the case of urban strategy measure and project reference. The correlation analysis between project reference and urban strategy measures validated this assumption since correlation between Living Lab maturity and project reference was 0.290 (sig. 0.000). There was also a weak correlation between urban strategy activity and Living Lab maturity (0.311, sig. 0.000).

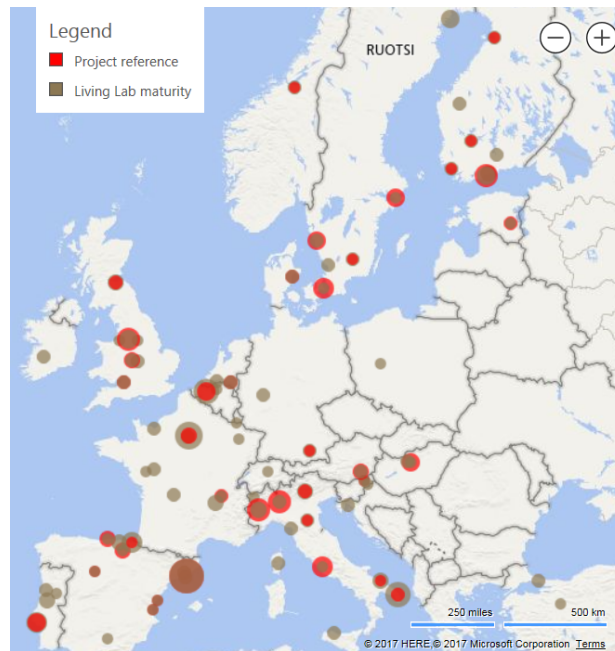


Figure 3: Most mature Living Lab cities and their EU-project references

4.3 Leading cities

In **Error! Reference source not found.** the TOP 10 cities executing urban strategy in circular economy, acting as a forum for EU-projects or having Living Lab activities are presented.

Table 1: Forerunner cities in Circular Economy

Name	Urban Strategy activity	EU-project activity	Living Lab maturity	Total
1. Barcelona (ES)	42	11	33	86
2. Paris (FR)	23	3	27	53
3. Brussels (BE)	44	4	0	48
4. Turin (IT)	25	6	14	45
5. London (UK)	35	6	0	41
6. Gent (BE)	13	4	23	40
7. Amsterdam (NL)	28	6	5	39
7. Milan (IT)	22	6	11	39
9. Lisbon (PT)	13	4	19	36
10. Gothenburg (SE)	20	4	11	35
10. Helsinki (FI)	12	6	17	35

As a result, the clear winner is Barcelona with 86 points. Furthermore, Barcelona has the highest score in Living Lab maturity (33) and EU-project activity (11) and second highest score (42) in urban strategy. After Barcelona, the close runner-ups are Paris (53 points) and Brussels (48), which however have very different profile. Paris has high living lab maturity but is not as strongly present in various web sites which highlight urban strategies. Brussels profile is just opposite to Paris and the city do not have ENoLL's effective member Living Lab. Also, the fifth ranked city London do not have any ENoLL's effective members. City of

Amsterdam is also having a bit different profile since it has only recently activated in ENoLL network. Finally, the only smaller city in the list is Gent which has about 250.000 inhabitants in the urban centre.

5 Conclusions

By using publically available data sources this study conducted a spatial analysis of European cities which have elaborated and implemented circular economy strategy either by themselves or with the help of EU-project funding. Furthermore, it was also described how these cities mobilised and interacted with ENoLL Living Labs. As a result, it was found out that cities which had implemented active urban strategy, had often also been a forum for EU-projects either as beneficiary, lighthouse city, follower city, benchmark city, observer city, demonstration city, case study city or pilot city.

However, evaluation of the urban strategy activities derived from fifteen well known websites focusing on urban strategies or circular economy did not included in-depth content analysis. Therefore, it might be also possible that these particular web forums were also used as a dissemination channel for EU-projects. If that would be the case, then the EU-funding would play even more significant role in implementing the circular economy strategies in cities. If not, then this result would reveal that the cities participating in EU-projects are also promoting circular economy with other public and private funding sources. This additional funding will then help building up the capabilities needed to gain highly competitive EU-projects where the success rate is often marginal. The underlying assumption is that the leading cities are moving forward in many frontiers while the EU-funding is helping them to increase the gap to other cities.

Most importantly there is clear gap between Eastern and other European cities. Disseminating and transferring the knowledge between the forerunners, followers and laggards appears to be challenging. Therefore, it is suggested that forthcoming Framework Programme projects would better highlight the cross European participation. In this scenario Living Labs could play a significant role, if they play their cards right. So far ENoLL Living Labs have partially missed opportunities to participate Framework Programme projects even in the circular economy projects which by definition would be the nearly a perfect match to Living Lab methodologies. The results revealed only weak correlation with Living Lab maturity and EU-project references and urban strategy activities at city level. As argued in the introduction, in best case scenario Living Labs could offer systematic methodologies for evaluating novel innovations in different social, legal, and cultural. Currently the other approaches in the market are generating a better offering for EU-projects and therefore ENoLL member's market share has remained modest. Evidently only the strongest cities such as Barcelona are sufficiently attractive while other Living Lab cities need to find new ways to enhance their offerings to EU-project consortiums as well as to cities which are actively pursuing towards circular economy.

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