Pop-Machina

Mapping the circular maker movement: from a literature review to a circular maker passport

D2.1 Mapping the maker community ecosystem and the urban metabolism processes

Julie Metta and Kris Bachus
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Abstract

The Pop-Machina project is an EU-funded research project aiming to explore how the maker movement can contribute to cities' transition to the circular economy. This report provides a response to Task 2.1. Based on an intensive bibliometric review and experts and practitioners interviews, the deliverable draws a collection of definitions to characterise the circular maker movement. A set of original tools, including a decision tree, a taxonomy, indicators and maps of the circular maker movement are developed to delineate the circular maker movement, with a focus on the Pop-Machina seven pilot cities. Eventually, pilot story-boards present the current status of the circular maker movement in the city, with the disclosure of the circular maker passports, characterising the movement in each pilot.

This report constitutes Deliverable 2.1, for Work Package 2 of the Pop-Machina project.

Deliverable number + title	**D2.1 Mapping of maker community ecosystem and urban metabolism processes**
Prepared by	Julie Metta & Kris Bachus 1 – *KU Leuven* julie.metta@kuleuven.be
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Main authors	Julie Metta & Kris Bachus
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1	Dec. 2019	**First developed draft (developed structure of the report and Sections 3, 4 and 5), reviewed by WP2 partners**	**JM, KB**	
2	Feb. 2020	**Full report in bullet points, reviewed by KB**	**JM, KB**	
3	June 2020	**Report submitted to reviewers**	**JM, KB**	
4	June 2020	**Reviewers gave comments**	**BG, EA**	
5	June 2020	**Final draft submitted to coordination team**	**JM, KB**	

Acknowledgements

Contents

Executive summary

In recent years, urban maker movement initiatives with a link to circular economy, including fablabs, repair cafés, makerspaces, and maker fairs have grown and become more and more visible in many cities in Europe. These initiatives and the people behind it are often referred to as the (circular) maker movement. However, although maker practices have grown significantly, there is only little systematic knowledge on their nature and characteristics. This report aims to fill the knowledge gap on the maker movement in three ways.

First, the report provides the reader with a set of definitions and a conceptual framework of the maker movement and concomitant initiatives based on a bibliometric analysis supplement with interviews of experts. Second, the authors developed tools to map and describe the maker movement by developing a typology of maker movement initiatives. And third, the developed tools were implemented in the seven pilot cities[1] of the Pop-Machina project, to make an inventory of maker movement initiatives (MMI), using geographical maps.

This report fills a gap in the literature by designing the first conceptual framework of the maker movement. A desktop research, including a bibliometric analysis, and interviews allow the establishment of a set of definitions of the maker movement and associated concepts. The maker movement initiative (MMI) flowchart is a decision tree, which can be applied to a specific initiative to test its compliance with the definition of an MMI and to determine whether an urban initiative should be considered part of the (circular) maker movement.

Secondly, a taxonomy of MMI distinguishes the initiatives between four characteristics: type of stakeholders involved, stakeholder visions, interactions between stakeholders, and stakeholder strategies. The taxonomy is supplemented with the development of four indicators that allow assessment and comparison of maker movement initiatives and their urban ecosystems between cities: density of the MMI, circularity of the city, inclusiveness of the local economy, and sector distribution of the local economy. The taxonomy and the maker movement ecosystem indicators provide the basis for the inventory of MMI which is presented in the third part.

The third part of the report is the design and implementation of an inventory of maker movement initiatives in the seven Pop-Machina pilot cities: Istanbul, Kaunas, Leuven, Piraeus, Thessaloniki, Santander, and Venlo. Initiators of MMI were intensively surveyed, allowing the mapping of an hundred MMI spread over the seven pilot cities of Pop-Machina. The survey created based on the taxonomy and for the purpose of the report, is openly available online.

The data of this survey is used in three ways. First, the authors created a database of MMI, making the initiatives and their full description openly available online. Second, the data is presented using geographical maps of the seven cities showing the spatial distribution of MMIs. The maps will be made dynamic, and integrated in the online open-source Pop-Machina Platform that will be developed in a next phase of the project. Both the database and the maps are intended for updating on a continuous basis, with the possibility to add initiatives, but also to add other European cities to dynamically inventory all the MMI that are active in Europe. As such, the mapping could be the first step towards a comprehensive database and map of maker movement initiatives throughout Europe.

Third, several additional analyses were carried out on an aggregated (city) level, allowing us to explore the commonalities between the seven urban city maker movements and between maker and

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1 The seven pilot cities of Pop-Machina are: Istanbul, Kaunas, Leuven, Piraeus, Thessaloniki, Santander, and Venlo.

circular strategies. The results are presented in so-called circular maker passports and circular maker storyboards, both at the city level.

This report describes the drivers of the makers and of their communities, and their needs to further develop their circular activities are discerned. The inventory of good practices are the level of Pop-Machina showcases the potential contributions of the maker movement to the circular economy. The work will contribute to the upscaling and the development of further circular maker initiatives among cities with different contexts in Europe.

List of abbreviations and acronyms

CE	Circular Economy
CMM	Circular Maker Movement
DIY	Do It Yourself
D2.1	Deliverable 2.1
EU	European Union
KPI	Key Performance Indicator
MMI	Maker Movement Initiative
MSW	Municipal Solid Waste
NGO	Non-Governmental Organisation
SME	Small And Medium Enterprises
STEM	Science Technique Engineering Mathematics
UNFCC	United Nations Framework Convention on Climate Change
US	United States of America
WP	Work Package

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1. Introduction

1.1 The Pop-Machina project

By 2050, more than 80% of Europeans will live in cities (WEF & PwC, 2018). Urban areas are the most important hubs for the European economic development, but also for resource consumption and for waste generation. In the coming decades, cities will face new challenges such as climate change, pollution, and scarcity of resources. To adapt to these challenges, cities will need to be innovative.

The circular economy and the maker movement are two recent concepts, but their implementation is driving the future of European cities. While the maker movement may have strong potential to advance the circular economy, it suffers from insufficient accessibility due to lack of skills, infrastructure, tools, and methods for engagement. Pop-Machina, a H2020 project funded by the European Union, is developing new innovative solutions to address these challenges, thus promoting the circular maker movement (CMM) in European urban areas. Pop-Machina aspires to disclose the ability of the circular maker ecosystems for the sustainable development of urban areas (Bachus & Metta, 2020).

Figure 1.   Aims of Pop-Machina project
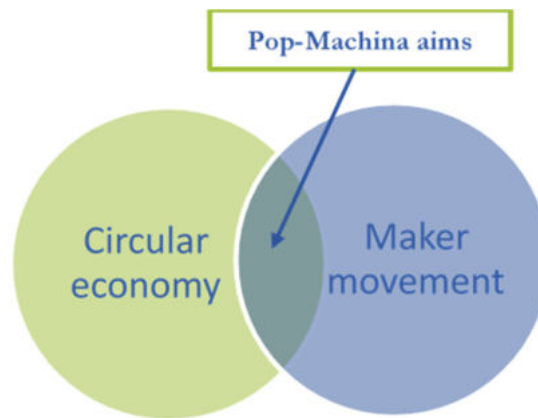
Pop-Machina is designing methodologies for building, engaging, and supporting CMM communities in urban areas. The project aims to demonstrate the power and potential of the maker movement and collaborative production for the European circular economy. Empowered cities will be able to generate a circular maker movement, enacting a more resilient and adaptive ecosystem able to tackle socio-economic and environmental challenges.

1.2 Work package 2

To reach its goals, the Pop-Machina project is divided in work packages (WP). WP2 provides an understanding of the concepts and the underlying framework of Pop-Machina, to appropriately align

the scope and methodology of the consortium actions. WP2 delineates the ecosystem characteristics of the seven pilot cities (namely, Istanbul in Turkey, Kaunas in Lithuania, Leuven in Belgium, Piraeus and Thessaloniki in Greece, Santander in Spain and Venlo in the Netherlands). The tasks enable a standardised collaboration framework for the different stakeholders of the circular maker movement. The package facilitates the generation of circular innovations with a positive socio-economic impact in urban areas.

The results of this second WP are key for the project, beyond the framing of scope and role, the results will motivate the tasks of WP3 through the development of methodologies to support circular maker communities. The tasks of WP4 will also build on WP2's results to establish the collaborative production tools.

Figure 2. **PERT Chart showing the interdependencies of Pop-Machina's work plan components (Figure 12 of Pop-Machina's grant agreement)**
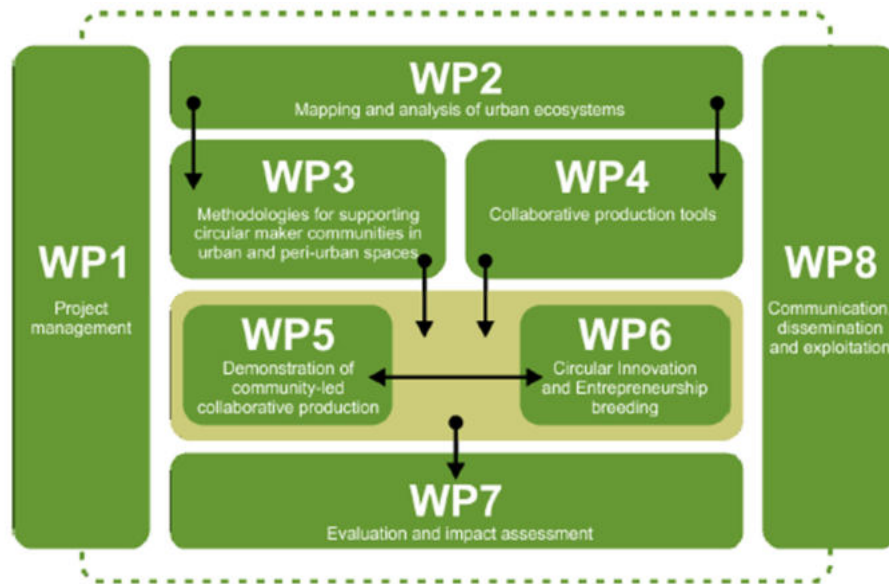
1.3 Objectives of deliverable 2.1

In the last decade, there has been an increasing number of citizen-driven initiatives to make a better tomorrow, among them the maker movement. The following questions arise from the study of these maker initiatives:
- what differentiates these initiatives from other?
- where do they meet?
- what are the topics of interest?
- do they contribute to the circular economy?

The deliverable 2.1 (D2.1) provides answers to these questions by reporting on the circular maker community ecosystem in Europe with a particular focus on the seven pilot cities. The four above questions are answered with the provision of:
- a set of definitions and a taxonomy of the maker movement;
- a geographical analysis which includes the production of maps;
- a keyword analysis;
- analyses of the commonalities between the pilot cities and between maker and circular strategies.

This deliverable introduces a conceptual framework for the maker movement and highlights the scope for Pop-Machina with a set of definitions. For this deliverable, beyond the set of definitions, the partners developed a database and a taxonomy of the circular maker movement initiatives. The commonalities between stakeholders in the circular economy and stakeholders in the maker movement are delineated through a mapping exercise. The goal of the mapping exercise is to identify the stakeholders in the maker movement and the circular maker communities. The circular maker ecosystems characteristics are depicted through a detailed taxonomy to fully define and understand the maker movement. The taxonomy also features the social framework of the key stakeholders of the maker movement, capturing their roles and interactions. Indicators are developed to measure key aspects of the circular maker movement such as making, circularity but also inclusion and sectoral indicators. The database and passports were built from a survey, and represented in a multi-layered map, as is described in Sections 4 and 5. The tools created were brought together to generate a circular maker movement passport to create a city profile for each of the seven pilot cities. The circular maker good practices in each city are illustrated as storyboards. The storyboards discern the drivers of the makers and of their communities, and their needs to further develop their circular activities.

This deliverable examines the development of circular maker movement initiatives. The mapping exercise focuses on the maker movement and their features to achieve circularity. The scope includes the supply chain of making and the immediate ecosystem of the maker movement, in order to map the peculiarity of the circular maker movement. The maps illustrate the state of the art of circular maker movement initiatives and their ecosystem and provide an inventory of circular maker solutions. This study enables a better understanding of their patterns and allows the replication and the development of further circular maker initiatives among cities with different contexts in Europe.

1.4   Methods

For the purpose of this report, a set of analytical tools was implemented to investigate the contexts of the circular and maker initiatives in Europe with a focus on the seven Pop-Machina pilot cities. First, an extensive bibliometric review of the literature was conducted, supplemented with cross citation and desktop research. To have a better understanding of the particularities of the circular maker movement, bottom-up strategies were applied. European experts and practitioners of the circular and maker movement were interviewed to obtain insights from the ecosystem itself. The details of the 18 interviews can be found in 0. They were complemented by results from the 49 interviews of maker stakeholders conducted for the H2020 project MAKE-IT (Unterfrauner et al., 2018; Voigt et al., 2017). A stakeholder and local value chain analysis was performed at city level through a survey.

The literature and the interviews enable the common set of definitions for EU and the Pop-Machina Project. The stakeholder and value chain analysis extended the understanding of the dynamics between the different stakeholders and illustrated the potential opportunities for collaborative production to drive circular activity. The tools were gathered to generate an inventory of good practices and solutions of circular maker initiatives.

Note: the terms in this report underlined in grey contain a link to the definition available in appendix 1.

2. Bibliometric review of the maker movement

To better understand the strategies used by the maker movement to encompass circular economy, it is important to analyse the literature on both the circular economy and the maker movement. While the former has been extensively reviewed (Aguilar-Hernandez et al., 2018; J. Kirchherr et al., 2017; Prieto-Sandoval et al., 2018), little review of the current literature on the maker movement has been published. A bibliometric review was conducted to identify patterns in the literature on the maker movement. This review collects cases study and examples of solutions of collaborative production.

To map the maker movement, it is pertinent to capture its specificities. The literature review provides a good tool for this analysis. Indeed, academic literature depicts the trends of the main strategies, visions and scopes of the maker movement through different dimensions such as time and geography.

The sections below report some[2] of the results carried out from the systematic literature review, analysing the main concepts, principles, and determinants of the maker movement as depicted in the literature. This review assisted the creation of three main outputs:

A set of definitions:
- a taxonomy of the maker movement;
- a knowledge map of the maker movement.

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2 Further results obtained from this review are used throughout the report to support the theoretical frameworks developed.

Figure 3.   **Bibliometric analysis method**
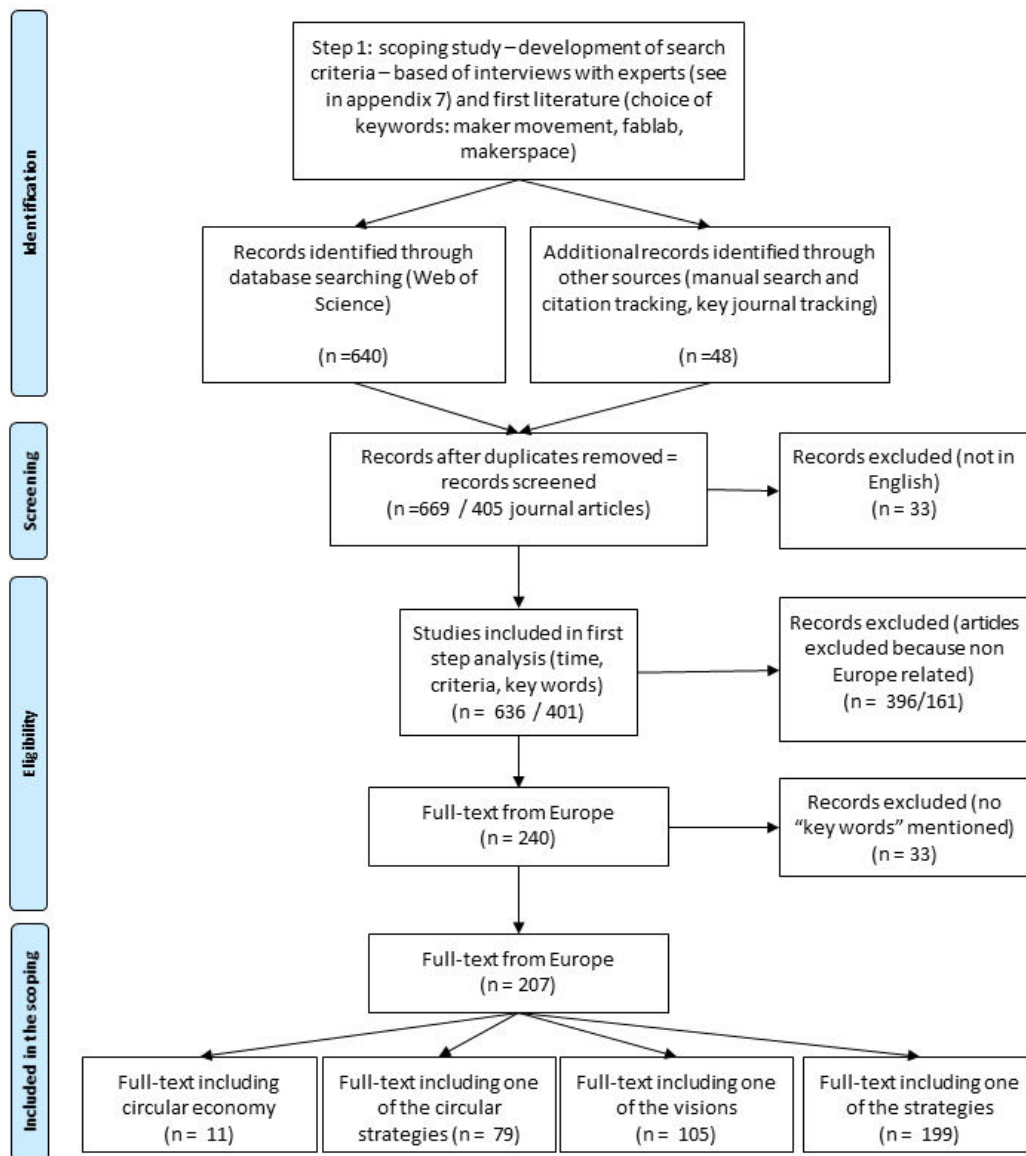
2.1   Method

As shown in Figure 3, a bibliometric analysis was conducted following the methodology of Liberati et al. (2009). The words used for the scoping were chosen based on interviews with makers and on a first literature screening. The terms used for the scoping are: maker movement, fablab, makerspaces, hackerspaces, collaborative economy. The databases screened are Scopus, Web of Science and Google Scholar.[3] As indicated by Figure 3, in the second line on the left-hand box, additional references were added such as reports, cross-references and documents provided by interviewees.

The screening shows that the literature on the maker movement is not very extensive. Only 669 scientific documents were found and among them only 401 journal articles. Nevertheless, it is interesting to highlight patterns from this recent literature.

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3   The complete list of references used for the bibliometric analysis is available upon request.

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2.2 Patterns in the literature

The following section highlights the key features and patterns of the maker movement based on the literature review on the maker movement.

Figure 4.   Timeline of the publications on the maker movement
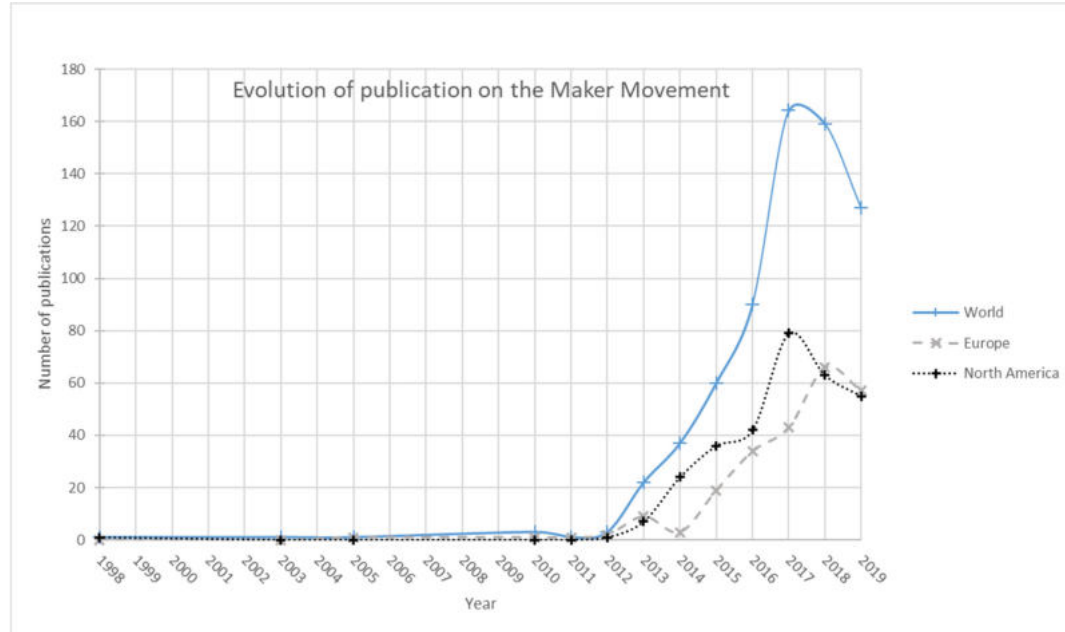
Note: The locations where reported based on the location of the authors' university and on the research case study.

2.2.1 Time spread: a 22 year old phenomenon which started growing at age 14

The first document found mentioning the maker movement was published in 1998 but the real interest for the maker movement starts in 2013, as illustrated in Figure 4. The interest for the maker movement in the academic literature appears with the creation of the first fablab in 2001.[4] Following the trend later in Europe, the first makerspaces open in mid and late 2000's. The first magazine dedicated to the maker movement is published in 2005. The concept of the maker movement is mentioned for the first time in the UNFCCC congress in Lima in 2011, followed by a rise of academic publications on the topic. The surge in European publications coincides with the expansion of interest from European governments. Similarly, there was a peak of interest for the maker movement, especially in North America, following the speech of President Obama and the first Maker Faire at the White House in July 2016.[5] Academic research on the topic of the maker movement seems to be partially driven by political interest.

This first result shows a clear need for policy stakeholders to mention and support the maker movement to allow further research to be conducted in this domain.

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4 ('Fablab', 2020).
5 (Making the maker movement | Whitehouse.Gov, n.d.).

2.2.2 Demographic spread: the literature on the maker movement is spread worldwide but mainly developed in Europe and North America

While there are publications from 66 different countries, European and North American publications together represented more than 83% of the publications on the maker movement (see Figure 5).

The literature on the maker movement started simultaneously in North America and Europe and while the North American literature was bigger, there is a shift since 2018, when Europeans started publishing more papers on the maker movement than North Americans. This shift may correspond to a surge of the maker movement in the political scene, with European governments' calls offering subsidies for maker movement initiatives and thus an increase in makerspaces in Europe.

In term of languages, Table 1 shows that English is prominent and covers 95% of the publications. Based on the results of the interviews,[6] English is also the common language in the maker movement. This result can be explained by the multidisciplinary of the maker movement stakeholders but also by the open knowledge platforms used among the communities. First, the maker movement communities welcome citizens from all over the world with different cultures and languages. English being increasingly the most common language, it easily became the language of communication among the maker stakeholders. Second, the citizens' part of the movement has a strong willingness to learn and expand their knowledge, English including. A third explanation is the fact that academic publications are predominantly in English, regardless of the topic. Last but not least, to benefit from the extensive open and free software and tools, makers have a strong incentive to communicate in English to allow the broader audience to benefit from the shared resources.

Figure 5. Spatial repartition of the publications on the maker movement

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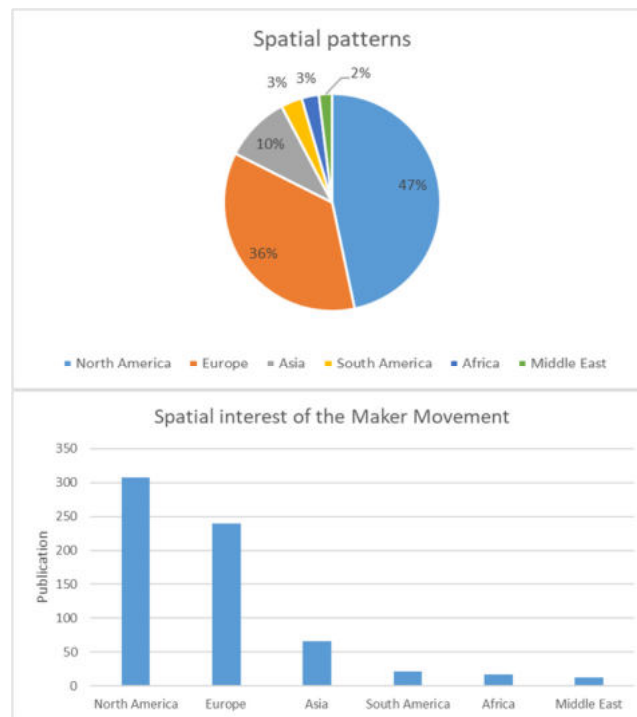
Table 1. **Extent of publication languages**

English	Spanish	French	German	Italian	Turkish	Portuguese	Croatian
636	18	3	6	2	1	2	1
95.1%	2.7%	0.4%	0.9%	0.3%	0.1%	0.3%	0.1%

2.3 Keywords

Thanks to the literature and the keyword analysis the main visions and strategies of the maker movement were identified.

The analysis of the top 66 words appearing as recurrent in the literature, and reported in Table 2, already highlights a lexicon related to the learning, the sciences, the society, the creation (production and innovation) and the environment. Some subcategories of material, community and creativity also emerged.

The results of the keyword analysis are developed in Section 4. Further details of this keyword analysis can be found in the appendix 2.

Table 2. **Details of the results from the keywords analysis**

Word	Rank	Word	Rank	Word	Rank
Maker*	2	Problem	28	Maker*space*	55
Use*	3	Sustainability*	30	Prosumer	56
Space	4	Business	31	Engineer*	57
Study*	5	Network	32	Reuse/redistribute	57
Design	6	Connect	33	Solution*	57
Student	7	Innovative	33	Regeneration	60
Maker movement	9	Develop*	35	Redesign	51
Product*	10	Local	36	Education*	62
Science*	11	Environment*	37	Entrepreneur*	62
Digital	12	Initiative	37	Maintain	63
School	13	Society	37	Stakeholder*	64
Project	14	Urban	40	Urban development	65
Knowledge	15	Understand*	41	Activity*	66
Fabrication	16	Learn*	42	Collaboration*	66
Model	17	Circular	43	Community*	66
Process	17	Citizen	43	Consumption*	66
City*	19	Group*	43	Creation*	66
Social*	20	Tool*	43	Distribution*	66
Information	21	Grassroots	47	Inclusion*	66
Public	22	Waste	48	Library*	66
Concept	23	Fab*lab*	49	Manufacture*	66
Culture	23	Plastic	50	Recycle*	66
Value	23	Supply chain	51	Reduce*	66
Academic	25	Capital	52	Refurbish	66
Economy*	26	Government	52	Share*	66
Future	27	Skill*	53	Solve*	66
Opportunity*	28	Resource	54	Technology*	66

Note: The * holds for words including their derivatives, e.g., use*= use, user, users, using, usage. The first ranked word was removed because not pertinent for the analysis.

3. Defining the maker movement, the circular economy, and the circular maker movement

One of the key outputs of this deliverable is the development of a conceptual framework for the maker movement. To highlight the scope for Pop-Machina, a set of definitions was outlined. After detailing the method used, the following sections present the three main concepts of maker, circular and circular maker movement. Lastly, the implications of the circular maker movement on the global value chain is ascertained.

Figure 6.   **Feedback (loop) method used to develop the set of definitions and the flowchart**
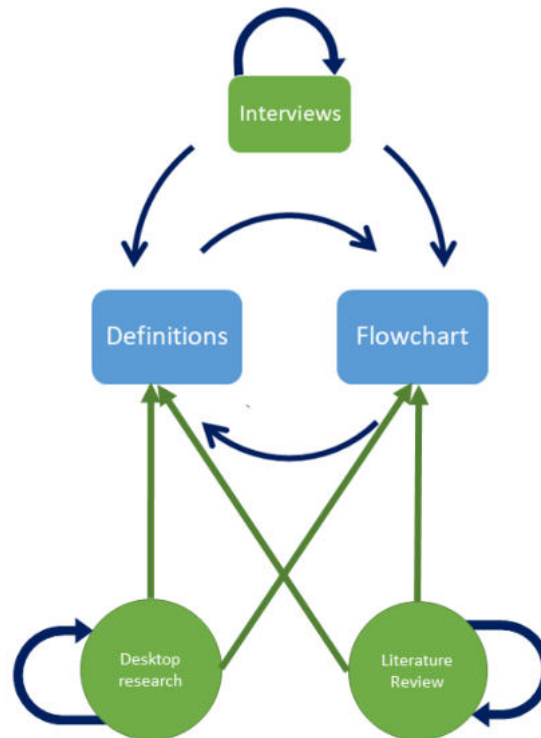
3.1   Mixed feedback loop approach

From the literature review, described in Section 2, complemented with a first round of interviews and an intensive desktop research, a first set of definitions was created. This first set was presented to the consortium and to the experts interviewed for feedback. The definitions were adjusted according to the first collection of feedbacks. Based on the literature, the desktop research, the interviews and the definitions, a flowchart (described further in Section 4) was constructed as a decision tool to identify the initiatives belonging to the circular maker movement. The flowchart and the definitions were

exposed together to comments from interviewees and from pop-Machina partners. The two instruments were adjusted based on the comments. A last round of comments allowed both the definitions and the flowchart to be presented in this deliverable in their final shape.

During this process, the interviews, desktop and literature study were continuously performed and enhanced. Indeed, the definitions, as explained below, were used to define the keywords and set strategies for data collection and validation.

The definition of the concepts presented in the following sections may not encompass all notions, characteristics and areas into which the concepts belong. However, following the method presented above, the definitions offered in this deliverable illustrate the concepts as studied for the purpose of Pop-Machina.

3.2 The maker movement

The following section defines the maker movement within the framework of Pop-Machina. The definition was built on the above-mentioned literature review as well as on a series of interviews complemented with online and offline sources.

A concise definition of the maker movement is introduced before delving into the key characteristics of the maker movement. From the definitions provided in the literature, (Anderson, 2012; Maffei, 2014; Millard et al., 2018; Unterfrauner et al., 2018; Voigt et al., 2017) an innovative and more inclusive definition was developed. While the existing literature provided four pillars of the maker movement, most of the pillars do not relate which make interconnection hard among the four pillars, the definition generated is composed of three pillars allowing any of the pillars to connect with the two other pillars.

3.2.1 Concise definition of the maker movement

The maker movement consists of a variety of stakeholders organising initiatives that are part of the **supply chain of 'making'**. The initiatives often aim at tackling social and environmental issues, they are often **grassroots,** and led by local communities.

3.2.2 Key components of the maker movement

The current consumption habits have led to two main consumer issues: the excessive production of waste and the loss of consumer skills. While previous generations of consumers were mostly skilled and abled to fix and repair their belongings, the current consumers have little knowledge on the technologies laying in their equipment.

The maker movement is reinstating the consumer in control of his belongings through the democratisation of new technologies. Most of the technologies used by the maker movement are open-source and easy to build machinery, allowing their widespread diffusion. Thanks to the open-source concept supported by and supporting the maker movement, the maker communities disseminate knowledge and skills among a broad range of domains and stakeholders. This increase in understanding of technology empowers the maker communities which illustrate robust expertise in high technologies. The maker movement enables the local production of high quality and long lasting products.

The main innovative feature of the maker movement is the accessibility and the democratisation of the tools and skills it provides to the community. The maker movement allows for mix and porosity among social classes, education backgrounds, and more broadly practitioners. The inclusivity and the seek for diversity makes this movement remarkable (Lande & Jordan, 2014, Tierny, 2015).

The maker movement is not an economic sector. While the sector of making has a long-standing history (e.g. manufacturing industries, crafts, etc.), the emergent maker movement consists of a variety of initiatives, with the following three characteristics:
- they are part of the **supply chain of 'making'**;
- their goal is generally to tackle **social and environmental issues**;
- they are often **grassroots**, **collaborative** and led by communities.

The following section describes these three components, represented in **Error! Reference source not found.**.

1) Grassroots/community-based

The maker movement is part of either the formal or the informal economy. The movement congregates a variety of **grassroots** initiatives part of the supply chain of making (Tabarés-Gutiérrez, 2016). The initiatives mostly aim at tackling local – **social, economic or environmental issues.** The initiatives can be nurtured by institutions (top-down approach) and being **grassroots** (bottom-up approach). The **grassroots** processes are mainly generated to enhance local communities and to connect people (Boni et al., 2019). The initiatives are often **collaborative.** Makers share knowledge, tools, and materials and collaborate for and during projects. This collaboration typically takes shape within virtual or substantial, informal or formal communities.

Figure 7.   The maker movement key components
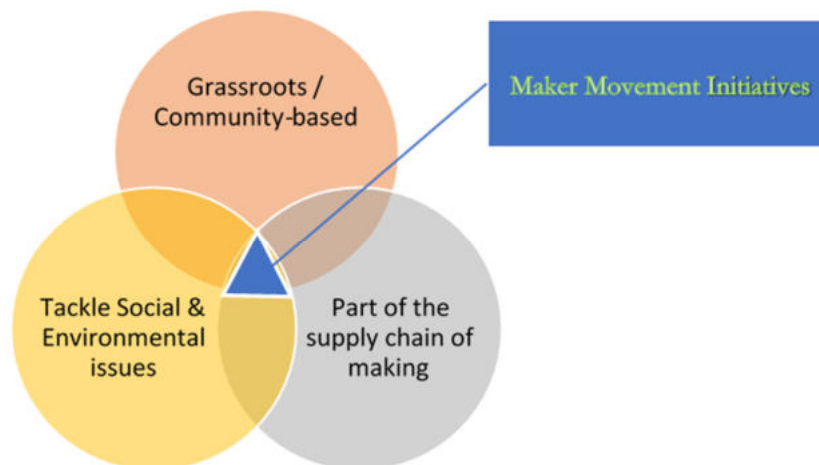
The maker movement communities are the foundation of the movement. These communities enhance the open (and often free) distribution of knowledge, tools, facilities, infrastructure, methods and ideas. The maker movement values the individual's ability to be both a creator and a consumer. The goal is to build supportive communities levering skills and capabilities of each member of the community. Alternatives are provided to individuals to access tools, facilities, methods and education, which would otherwise be inaccessible or unaffordable. The movement tends to democratise tasks and skills, and to aim at **social inclusion**.

2) Social and environmental issues

The maker movement community often strives to raise awareness and equity in a social, economic and environmental context. The goal is generally to tackle **social and environmental issues** not addressed by current markets and regulations.

Social and environmental issues affect (often negatively) citizen when no governmental and market decision are taken. The movement is widely fuelled by the critical belief that those **social and environmental issues,** such as the lack of green energy, can be tackled locally. The maker movement tends to organise itself to find more suitable alternatives to treat these issues. The maker movement initiatives often promote sustainable and innovative solutions for the city of tomorrow. The initiatives mostly enable **urban regeneration** and consolidate the regenerative capacity of cities. Most of the initiatives have as common purpose to contribute to the improvement of cities and society, sometimes by providing alternative views on the economy and society.

3)   Part of **the supply chain of making**

The maker movement puts strong emphasis on the creation process. The movement is organised around the act of making. While some makers take visible action, through the process of making, to solve **social and environmental issues**, other carry out more conceptual activities. Every maker initiative is part of the **supply chain of making** (as in manufacturing). The **supply chain** involves both the mental reflexion and the tangible expression of making. The maker movement tends to connect the formation of mental objects (ideas, concepts, etc.) to the substantial act of making tangible products (Tabarés-Gutiérrez, 2016). The cerebral concept of making is as much emphasised as the material product (Ratto, 2011). Maker movement initiatives embody new ways of both thinking and constructing, turning the consumer into a **prosumer.**

3.3   The circular economy

In the past ten years, numerous studies on and definitions of the circular economy have been published.[7] Summarising, the circular economy is an economic system that aims to add value to products and supply chains while minimising the use of raw and virgin materials and the production of waste and pollution of all kinds in a sustainable way. The circular economy uses strategies such as redesign, repurposing, reuse, repair, refurbishment, remanufacturing, recycling, as a way to improve the productivity of resources all along the value chain to reduce resource extraction and consumption. It aims to keep and increase material value to derive more value and extend product life, while decoupling the economy through a functional economy. (Alaerts et al. 2019; Charter n.d.[3]; García-Barragán, Eyckmans, and Rousseau 2019; Kirchherr et al. 2017a; Stahel 2016; Ellen MacArthur Foundation, n.d.[3]) The deposit-refund system for glass bottles when these bottles are cleaned and reused is a classic example of a circular economy model.

The European Union has been investing in a circular plan for production, consumption, processing, storage, recycling and disposal, but despite significant progress, a full circular economy model still faces a variety of barriers (cultural, technological, market and regulatory) (Deselnicu et al., 2018). Cities, in particular, must cope with these challenges under increasingly regressing conditions: fragmentation of the value ecosystem, reduced budgets and social issues (e.g. inequality and social exclusion) and their consequent spatial effects such as urban sprawl, urban decay and over-urbanisation. Additionally, most of the consumers are not inclined to steer their behaviour towards circular economy (Kirchherr et al., 2017b).

Bottom-up approaches provided by the maker movement could provide a platform to accelerate citizen acceptance towards the circular economy.

3.4   The circular maker movement

The maker movement may have the potential to be a driver for the transition of cities towards a circular economy model. The maker movement is at a crucial crossroad between social inclusion and

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7   See Kirchherr et al., (2017a) for an overview.

production. Recently, a new connection has been more frequently made, relating the maker movement to sustainability. There are trends of the maker movement embracing the circular principles (Prendeville et al., 2017).

From the literature review, there are eleven references, which mentioned both circular economy and the maker movement. All the references are from Europe and except one published in 2014, most of the studies were published between 2017 and 2019. This trend in the maker literature appeared simultaneously with the element of sustainability, where 37 articles were found and 65% came from Europe. The bibliometric analysis showed that the recent notion of circular economy was mainly embraced by European makers. The interviews also disclosed the overall robust knowledge of the makers on the circular economy principles.

3.4.1 Concise definition of the circular maker movement

The circular maker movement is defined as initiatives part of the maker movement and embracing the strategies of the circular economy (as presented in Section 3.3). The circular maker movement has all the characteristics of the maker movement (as defined in Section 3.2) and additionally promotes sustainability and is more resource-oriented (Prendeville et al., 2017).

3.4.2 The maker movement impacts on the circular economy

Circular economy mostly focuses on three levels of the economy: resource, producer, consumer. Maker movement initiatives embody new ways of thinking about and acting upon circular economy and can act as support for the three levels.

On the consumer side, the maker movement is having an impact on the consumer presenting alternatives to consumerism and reinforcing the concept of sustainability (long lasting) (Unterfrauner et al., 2018). Environmental issues currently being one of the most pressing issues, nearly all maker actors show concerns about and commitment towards sustainability. This involvement is reflected in their actions. Maker initiatives engage the civil society in a bottom-up approach to promote the circular economy (Kohtala, 2015). Their actions enhance the awareness and the civic engagement towards circular economy in consumption (prosumer) (Unterfrauner et al., 2019). Citizens are empowered to take ownership of the product acquired. The maker movement provides additional information allowing consumers to make an informed choice in favour of circular economy (Kohtala, 2015). An important component of the maker movement is the way lived experiences are connected to critical perspectives. This feature enables citizens to care *for* the circular economy instead of just caring *about* the circular economy (Ratto, 2011). The maker actors are concerned consumers. The maker movement also involves citizen for a better inclusion of social in the implementation of the circular economy concept.

The maker movement has an impact on the production side, as it allows the development of prototypes, which can be produced faster and cheaper, allowing for prototyping locally in a more sustainable way (Unterfrauner et al., 2018). The movement empowers citizens to take ownership of innovation and of local productivity by providing distributed places of production. The decentralised structure and organisation of the movement allows new and sustainable production patterns (Kohtala, 2015). The maker concept of open innovation and local production can accelerate the deployment of circular economy. The maker movement promotes global knowledge for local solutions adapted to local context, another key aspect of circular economy in production.

Lastly, the maker movement promotes efficient use and sharing of resources, similar strategies to the circular economy. The makers link conceptual work with material work, allowing citizens to step in the circular economy by understanding the material flow (Ratto, 2011). Repair being part of the maker movement, the makers have an impact on circular economy thanks to their prosumer action to extend the longevity of products, thus reducing waste and resource consumption. By enhancing

local production, the resources consumption can be better tracked and secure its sustainable management. From all these perspectives, the maker movement embraces and advances the circular economy.

From the interviews conducted, one can learn that most makers agree on the potential of the maker movement to increment circular economy, however the impact is on a limited scale. Circular economy and maker movement are not, yet, two inherent concepts and there is a need to strengthen and nurture both concepts (Fleischmann et al., 2016). The remainder of this report aims at identifying the patterns and features of the circular maker movement.

3.5 Global value chain and the circular maker movement

The global value chain encompasses all activities and actors involved in a certain ecosystem (usually of the life of a product or a service). The chain includes extraction, design, production but also, distribution, consumption and (one or more) end of service phases. The local value chain analysis tries to capture which of the steps of a product's life (or service) are handled locally. Figure 8 represents the basic value changes in the life of a product in a linear economy. It shows that the value of a product starts to be reduced from its consumption (namely, use) on. All the further steps of the value chain are at loss and thus not interesting for business development (Achterberg et al., 2016).

Figure 8.   **Basic value changes of a product during its lifetime**
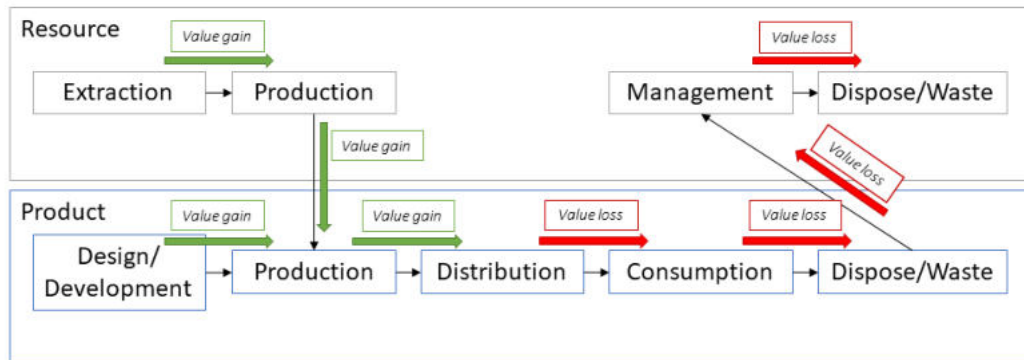
The global value chain of the Pop-Machina ecosystem characterises the various people and activities involved in the circular maker movement. Identifying the global value chain of the Pop-Machina ecosystem is important in order to understand the mechanisms that allow the local production, distribution and utilisation of the goods and services produced by the maker movement in the pilots. An analysis of the global value chain allows a better understanding of the implication of the maker movement in the circular economy.[8] The comprehension of these mechanisms allows to draw policy recommendations to enhance circular economy to emerge from the local collaborative economy. (Boons et al., 2012; Ferreira et al., 2019).

The circular maker movement ecosystem plays a role in reducing the underutilisation and the inefficient use of resource (both human, capital space and material). As shown in Figure 9, the circular movement could add value to the post-consumption phase of the life of a product. The value gains

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8 This section focuses on the value changes being shifted through the circular maker movement. The remainder of this deliverable will capture the stakeholders of the global value chain through. The strategies used to capture the characteristics and roles of the stakeholders are developed in Section 4. Figure 9. Value changes of a product during its lifetime, in a circular economy.

are realised by closing the loop and connecting the post-consumption phases with the pre-consumption phases using circular economy strategies (see Section 4.2.4 for more details on the circular strategies).

As Figure 10 illustrates, the circular maker movement can modify the value chain of a product in various ways (Unterfrauner et al., 2018). The circular maker movement favours the share of resources and goods, allowing for additional value in the product. The movement empowers resourcefulness and the possibilities to optimise local resource use (Ulug & Horlings, 2019). The product value can be shared, and thus raised. Providing a mental shift from consumer to prosumer, citizens are enabled to repair and upcycle their product. Joining the producer side, the circular maker movement releases additional value to the product post consumption.

Figure 9. **Value changes of a product during its lifetime, in a circular economy**

The circular maker movement allows the shift from mass production to decentralised production. This shift enables local and small-scale production and thus the creation of local employment opportunities and the reduction of logistic and environmental impacts of the current supply chain. This small-scale production also allows for personalisation of the products, allowing for an increase in the value of the product and persistent work for designers. Overproduction can be avoided, and thus resources can be better managed. This personalisation leads to the creation of additional and diverse local employment opportunities. The rise in local employment would benefit local economy and ultimately shift economic drivers at country and European level.

Figure 10. Interventions of the maker movement strategies in the value chain of product design following circular economy principles
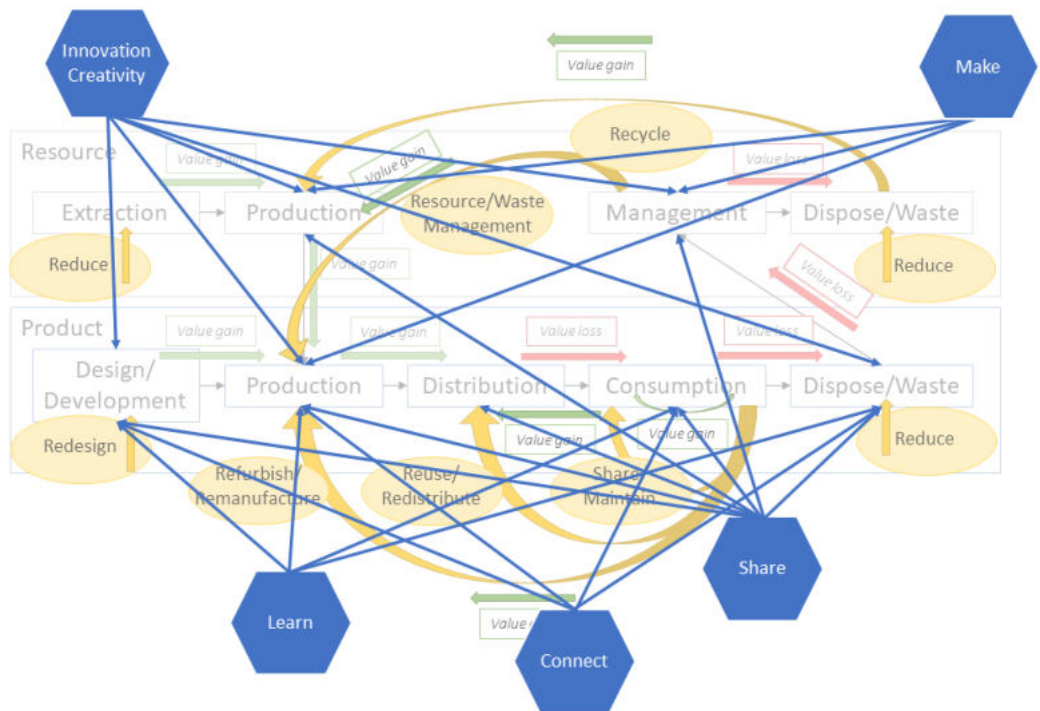
4. Delineation of circular and maker movement initiatives (MMI)

4.1 Flowchart – a tool to identify the initiatives part of the circular maker movement

To further collect and validate data on the circular maker movement, and to be able to select properly the initiatives to enter the circular maker movement database, a decision tree was created. The MMI flowchart (Figure 11) was designed based on the literature review, the definition, the interviews conducted with makers, and internal brainstorm as detailed in Section 3.1.

The conception of the flowchart was also based on previous work conducted on the typology of the makers (Bria et al., 2015; Harrison et al., 2018; Hijden et al., 2014; Lande & Jordan, 2014; Mulder & Kun, 2019; Rashof, 2016; Ratto, 2011; Seyfang & Smith, 2007; Smith & Light, 2017; Stein, 2017; Tabarés-Gutiérrez, 2016; Voigt et al., 2016).

This MMI flowchart is a decision tree, which determines whether or not an initiative should be classified as part of the maker movement.[9] It endorses initiatives tackling any socio-environmental and economic issues while allowing for a change in the current consumer model. By increasing the access to tools which allow the embodiment of goods, initiatives raise citizen awareness on the current 'take-make-dispose' production and consumption paradigm. For this reason, initiatives encouraging consumers to become actor of their consumption (prosumer) are endorsed by the flowchart. However, initiatives that are primarily profit-oriented are excluded of the scope of the circular maker movement, and they are rejected by the flowchart. Similarly, both amateurs and professional are considered part of the circular maker movement. However, professionals should follow open source concept and maker strategies not to exit the delineation of the flowchart.

The flowchart is meant to be used by the Pop-Machina partners involved in feeding the open-source maker movement initiative database (MMI database), which is discussed in Section 5.2 of this deliverable. The MMI database compiles only the initiatives having passed the identification process of the maker movement initiative flowchart (MMI flowchart), more information can be found in Section 5.2. This identification process supports the differentiation of the maker movement from the economic sector of making (in other words, manufacturing).

Once the initiative is identified as part of the maker movement, a further analysis can validate its affiliation to the circular maker movement. The step numbers allow to report the identification path of the initiative. The reported path indicates if the initiative belongs to the maker movement, to the circular maker movement or none of them.

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9   The MMI flowchart identifies the affiliation of an initiative to the maker movement.

Figure 11.   Maker movement initiatives identification flowchart (MMI flowchart)
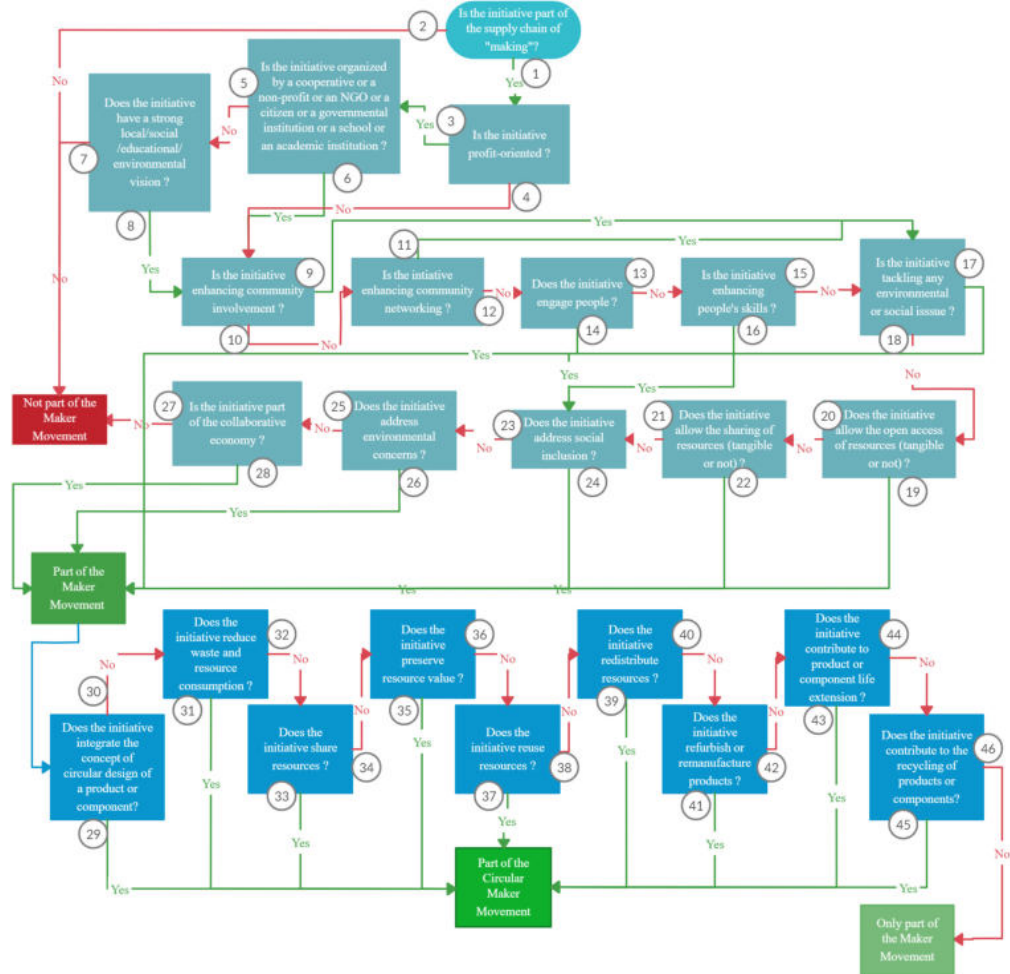
4.2 Taxonomy of the circular maker movement

To allow for a better identification of the circular maker movement and its key features, a new taxonomy was developed. The taxonomy presented below was generated with input from the literature review, the desktop research and the interviews, and it was confirmed further, using several feedback loop strategies. Among the main characteristics, the most relevant for Pop-Machina are the social relations and roles of and between the key stakeholders, the visions of the stakeholders, and the strategies used to implement circular makerspaces.

The taxonomy allows to provide insights on the stakeholders, the visions and the strategies for cities to replicate patterns to promote and enhance the circular maker movement in their local context. The components of this taxonomy were used for the construction of the survey and of the circular maker passport discussed in Sections 5.1 and 5.3 of this deliverable. The components are further described in the following sections.

4.2.1 Categorisation of stakeholders

Like any movement, the circular maker movement is built on stakeholders. Depending on the type of stakeholders and their roles, the movement might develop differently. For Pop-Machina, the identification of the stakeholders and of their roles is key for the success of the project. It is important to differentiate the stakeholders involved in the ecosystem of the circular maker movement from the stakeholders involved in the maker movement. Two types of involvement can be discerned:
- involved parties: stakeholders accredited by the decision tree (MMI flowchart, see Section 4.1). The stakeholder is included in the maker movement or circular maker movement;
- ecosystem/interest groups: all stakeholders rejected by the flowchart and not directly part of the maker movement, but having interactions with the movement.

In the remainder of the report, the focus is mainly on the involved parties.

From the systemic analysis of the literature (the bibliometric analysis), five types of stakeholders part of the circular maker movement were identified. Figure 12 illustrates these five types of stakeholders and Table 3 provides details on their definition. All the existing stakeholders are condensed in these five types. Such decomposition into five main type of stakeholders enables cities to evaluate implementation patterns based on their local context (Anderson, 2012; Millard et al., 2018). They all represent different features which are equally important for the circular maker movement. Government stakeholders provide the legal framework and recognition, while capital stakeholders provide funding opportunities. Business stakeholders offer business opportunities and projects to the circular makers. Knowledge stakeholders transfer skills and offer training supports, while citizens provide vision, working forces and leisure time to the circular maker movement. Their identification differentiates the stakeholders regarding their role in the circular maker movement.
- *knowledge:* public or private entities whose main role is to contribute to the enhancement and dissemination of knowledge;
- *business:* all parties who are profit-seeking and registered as companies/enterprises - they provide goods or services (but not financial ones);
- *capital:* parties whose main role is to provide financial support - can be either public or private entities;
- *citizen:* entities which are citizen-led. Their main goal is to tackle a social, environmental or educational problem or gap in society';
- *government:* public institutions providing administrative and infrastructure support.

Figure 12.   Icons representing the five stakeholders

Table 3.   Details on the stakeholder identities

Knowledge	Business	Capital	Citizens (incl. NGOs)	Government
Public or private entities whose main role is to con-tribute to the enhancement and dissemination of knowledge	All parties who are profit-seeking and registered as companies/enter prises – they provide goods or services (but not financial ones.)	Parties whose main role is to provide finan-cial support - can be either public or private entities	Entities which are citizen- led. Their main goal is to tackle a social, environmental or educa-tional problem or gap in society'.	Public institu-tions providing administrative and infrastruc-ture support
Academic and research commu-nity (e.g. research groups, experts and educators in urban planning, cir-cular economy, smart cities, envi-ronmental sciences, social sciences, behavioural research, relevant ICT, etc.).	Industrial stake-holders of pro-duction, raw material suppliers, tech-nology solutions and services providers (e.g. suppliers of 3D printers, logis-tics providers, waste manage-ment compa-nies, etc.).	Entrepreneurs and investors (e.g. start-ups, funding institu-tions, busi-nesses, accelerators, incubators, industry asso-ciations, etc.).	Civil society stake-holders (e.g. NGOs related to ecology, sus-tainability, urban resili-ence, social inclusion and cohesion, etc.). Customers, end-users, general public, prosumers, makers and maker communities (e.g. fablab communities, DIY communities, maker groups, individual makers, designers, and artisans).	City, regional & national authori-ties (municipali-ties, counties, etc.) Major European and interna-tional initiatives. European policy makers and national agencies.

From the bibliometric analysis, the most present stakeholder is the knowledge sector. This result can be explained by the type of literature review conducted. Most of the review concerned academic papers, creating this unbalanced representation of the knowledge sector. Nonetheless, the business sector arrives second in term of representation in the literature. Finally, Capital, citizen and govern-ment are similarly represented and highlighted in the reviewed literature.

Table 4.   **Results from the keyword analysis for the five stakeholders**

Stakeholders					
	Knowledge	**Business**	**Capital**	**Citizens**	**Government**
Number of occurrences	171	82	15	22	25
Share	54%	26%	5%	7%	8%

Table 5.   **Results from the survey for the five stakeholders**

Stakeholders					
	Knowledge	**Business**	**Capital**	**Citizens**	**Government**
Pop-Machina average	**54%**	**38%**	**9%**	**43%**	**21%**
Kaunas	67%	51%	0%	58%	0%
Venlo	35%	34%	5%	39%	7%
Leuven	31%	36%	8%	34%	8%
Santander	33%	29%	17%	21%	0%
Thessaloniki	69%	50%	6%	44%	34%
Piraeus	67%	47%	18%	57%	36%
Istanbul	41%	34%	11%	32%	28%

Note: The table gathers information at initiative level, extracted from the results of the survey conducted in the seven pilot cities of Pop-Machina. Survey details can be found in Section 5.1. The table reports the occurrence (in share) of the respondents having selected the visions as being important and addressed by their initiative. In the survey, respondents could select multiple visions allowing the total share to exceed 100%.

The results from the keyword analysis of the literature review in Table 4, and the results from the survey, in Table 5, are quite similar for the stakeholders Knowledge, Business and Capital. However, the roles of Citizens and Government are significantly underestimated in the literature. Knowledge and Citizens are the key stakeholders for the development of the circular maker movement, followed closely by Business and Government. The role of Capital is much smaller for the Pop-Machina initiatives having completed the survey than in the literature. The differences between the literature and the Pop-Machina project results highlight the need for additional empirical research toward the role of stakeholders in the circular maker movement.

4.2.2   Vision of the stakeholders

Figure 13.   **Icons representing the four visons of the stakeholders**
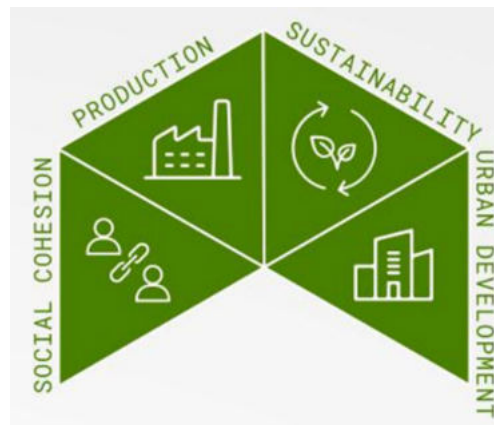
The visions are the principal areas of focus of the stakeholders. The visions are important to understand the long term strategy and the focused actions of the circular maker movement. From the literature review, four visions, illustrated in Figure 13, have been highlighted.

- *Sustainability:* Depicts a willingness to improve environmental quality and avoid depleting natural resources. Sustainable actions aim at maintaining long-term ecological balance while satisfying the current necessity without jeopardising future reserves.(Brown et al., 1987; Brundtland et al., 1987; Costanza & Patten, 1995)
- *Social cohesion* Depicts a willingness to enhance social connection between and within communities. Inclusion, poverty reduction, creation and education are part of the main values. Social cohesion includes social inclusion, creation and education as it brings equal learning opportunities and creativity to gather people around a common project and thus enhance community beliefs (Maffei, 2014; Unterfrauner et al., 2019).
- *Production:* Depicts a willingness to realise a shift to more circular, inclusive, distributed production systems (i.e. supply chains which are located in different neighbourhood areas and in charge by different actors, instead of gathered in the same factory). Change in production may occur through distributed production, localised, small and/or open source way of producing. It includes concepts such as industry 4.0, distributed production, prosumerism (Maffei, 2014).
- *Urban development*: Depicts a willingness to create spatial strategies and infrastructure for cities and neighbourhoods that facilitate community enhancement; while allowing communities to improve the liveability and value of neighbourhoods. This vision also integrates urban regeneration aspects. Examples of spatial strategies are change in land use policy to allow for more industrial activities in urban areas, or physically redeveloping a neighbourhood, building infrastructure.

As reported in Table 6, the most mentioned vision resulting from the bibliometric analysis, is social cohesion. As social cohesion is also a key characteristic of the circular maker movement, this result is not surprising. The second most common vision is production. For the same reason previously mentioned, this result was excepted. Lastly, both sustainability and urban development are rarely mentioned in the literature as key visions from the maker movement.

Table 6.   Results from the keyword analysis of the four visions

	Visions			
	Social	**Production**	**Sustainability**	**Urban**
Number of occurrences	158	102	37	33
Share	48%	31%	11%	10%

When compared with Table 7, which reports the results from the survey (for details on the survey see Section 5.1), the results obtained from Pop-Machina initiatives, reported in Table 7, are more focused on the sustainability vision than the observations drawn for the literature. While the social and production visions obtain equal attention from the survey, the interviews and the literature, the urban vision is also more represented in the data gathered from the project partners. The difference between the literature and the Pop-Machina project further endorses the need for additional empirical research on the circular maker movement.

Table 7   Results from the survey of the four visions

Visions				
	Social	**Production**	**Sustainability**	**Urban**
Pop-Machina average	**52%**	**39%**	**57%**	**30%**
Kaunas	93%	60%	73%	20%
Venlo	64%	30%	52%	9%
Leuven	62%	43%	68%	35%
Santander	56%	33%	39%	22%
Thessaloniki	92%	50%	83%	75%
Piraeus	48%	37%	72%	39%
Istanbul	38%	53%	45%	47%

Note: The table gathers information at initiative level, extracted from the results of the survey conducted in the seven pilot cities of Pop-Machina. The table reports the occurrence (in share) of the respondents having selected the visions as being important and addressed by their initiative. In the survey, respondents could select multiple visions allowing the total share to be bigger than 100%.

The evolution of visions of the maker movement from the literature review allows a better interpretation of the previously mentioned results. Indeed, while the visions of social cohesion and production raised starting in 2015, urban and sustainability are experiencing a showier and later rise, as depicted by **Error! Reference source not found.**.

Figure 14.   Evolution of publications on the maker movement considering the four visions
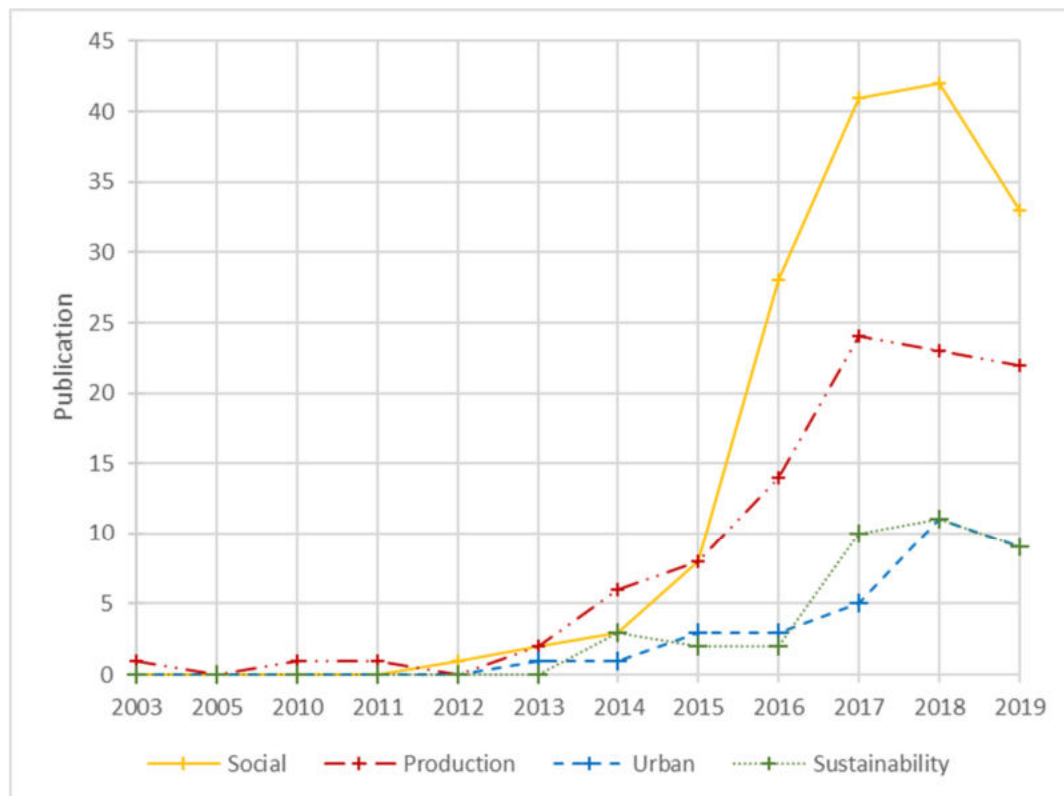
Table 8.   Interest over the four visions in European publications on the maker movement

Visions	EU	EU%
Social	71	45%
Production	54	53%
Urban	17	52%
Sustainability	24	65%

Another result worth to be mentioned is the geographical representation of the visions. Most of the visions are presented in European literature. For the US, the most important vision is in the social cohesion, mentioned in 28% of the US papers.

4.2.3   Types of interactions between stakeholders

The interactions illustrate the tangible and intangible resources flow between stakeholders. Four interactions are identified.
- *Financial:* provide financial support;
- *Support/Collaboration:* provide intangible support but financial;
- *Tools/Infrastructure:* provide tangible support but financial;
- *Material:* Show interaction between stakeholder regarding material.

4.2.4   Strategies of the stakeholders

Stakeholders adopt different strategies (or actions) in order to achieve their vision. From the literature review, five main strategies were identified for the stakeholders' part of the maker movement (Anderson, 2012; Maffei, 2014; Millard et al., 2018; Tabarés-Gutiérrez, 2016).

Figure 15.   Icons representing the five strategies of the maker movement
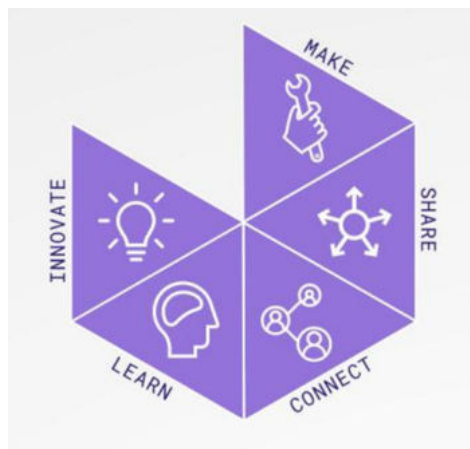
Strategies of the maker movement:
- make;
- share;
- connect;
- learn;
- innovate/creativity.

From the literature review, and as illustrated by Table 9, the maker strategy that dominates (after the strategy 'Make', which is inherent to the maker movement) is Create, which is closely related to making while encompassing the notion of design.

The strategies 'Learn' and 'Innovate' follow just behind, highlighting two important components of the circular maker movement. Indeed, the movement tends to democratise the means of innovation. The two last strategies are 'Share' and 'Connect'. However, as depicted from the Figure 16, in Europe, 'Share' is more important than 'Innovate' and 'Connect'. All strategies seem to be increasingly mentioned in the European literature.

Figure 16.   Evolution of publications on the maker movement considering the five strategies
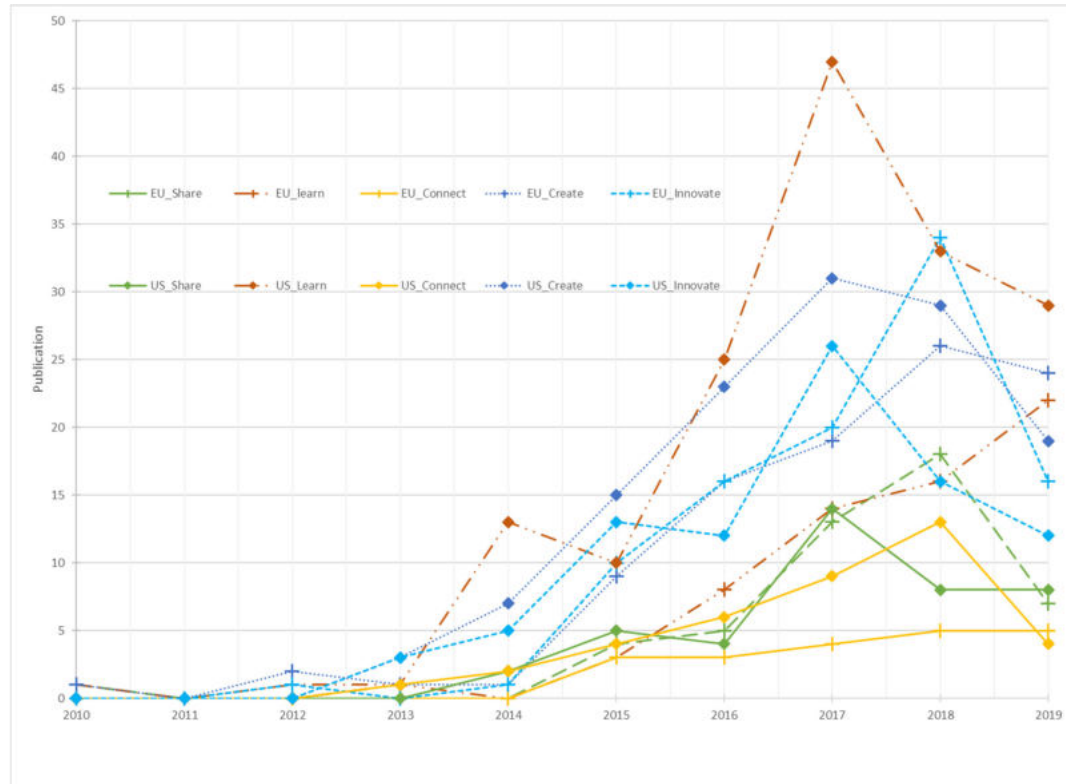
Table 9.   Results from the keyword analysis of the maker strategies

Maker strategies						
	Make	**Share**	**Learn**	**Connect**	**Innovate**	**Create**
Number of occurrences	643	118	296	82	259	312
Share	46%	8%	21%	6%	19%	22%

Table 10. Results from the survey of the five maker strategies

Maker strategies					
	Make	**Share**	**Learn**	**Connect**	**Innovate**
Pop-Machina average	**63%**	**65%**	**51%**	**50%**	**41%**
Kaunas	70%	95%	85%	75%	65%
Venlo	55%	66%	18%	36%	9%
Leuven	73%	67%	45%	49%	19%
Santander	42%	58%	29%	33%	50%
Thessaloniki	75%	88%	69%	88%	75%
Piraeus	63%	60%	82%	64%	64%
Istanbul	59%	54%	42%	36%	47%

Note: The table gathers information at initiative level, extracted from the results of the survey conducted in the seven pilot cities of Pop-Machina. The table reports the occurrence (in share) of the respondents having selected the visions as being important and addressed by their initiative. In the survey, respondents could select multiple visions allowing the total share to exceed 100%.

The results from the survey are reported in Table 10 and discord with the literature review results reported in Table 9. From Table 10, the strongest skill of the maker is to Share tools and knowledge, while the literature hardly mentions this skill. Obviously, Making is also an important skill of the circular maker, while Learn and Connect are similarly important and are mentioned by half the responding initiatives. Innovate is less of a trend in the circular maker movement.

Additionally to the maker strategies, seven circular strategies were identified from the literature review as key for the deployment of circular makerspaces.

Strategies of circular economy:
- redesign;
- reduce;
- share/maintain;
- reuse/redistribute;
- refurbish/remanufacture;
- recycle;
- resource and waste management.

Table 11. Results from the keyword analysis of the seven circular strategies

Circular Strategies						
	Redesign	**Reduce**	**Share**	**Reuse**	**Refurbish**	**Recycle**	**Resource & waste management**
Number of occurrences	5	21	118	4	0	7	9
Share	3%	13%	72%	2%	0%	4%	5%

Contrary to the results of Table 9, the literature review showcased that Share was the most frequent circular strategies mentioned in maker articles, as reported in Table 11. This result might be explained by the fact that shared resources (both tangible and intangible) are a key characteristic of the maker movement.

Table 12.   **Results from the survey of the seven circular strategies**

Circular Strategies						
	Redesign	**Reduce**	**Share**	**Reuse**	**Refurbish**	**Recycle**	**Management**
Pop-Machina average	**60%**	**58%**	**66%**	**67%**	**54%**	**56%**	**52%**
Kaunas	63%	57%	90%	80%	73%	63%	37%
Venlo	38%	26%	57%	60%	40%	40%	33%
Leuven	53%	62%	67%	73%	56%	57%	54%
Santander	100%	17%	67%	83%	50%	33%	0%
Thessaloniki	63%	75%	38%	50%	29%	75%	75%
Piraeus	68%	74%	70%	82%	62%	75%	75%
Istanbul	51%	54%	58%	35%	37%	37%	43%

Note: The table gathers information at initiative level, extracted from the results of the survey conducted in the seven pilot cities of Pop-Machina. The table reports the occurrence (in share) of the respondents having selected the visions as being important and addressed by their initiative. In the survey, respondents could select multiple visions allowing the total share to exceed 100%.

Except for the strategy Share, the results from the literature review (Table 11) and from the survey, reported in Table 12, diverge. Regarding the strategies deployed in the circular maker movement, all key strategies are equally represented in the initiatives having passed the MMI flowchart and completed the survey. The initiatives seem to have a proper understanding and overview of the skills needed to deploy circular economy processes.

4.3 The circular and maker indicators

Circular maker movements are different across Europe. From the above presented taxonomy, qualitative characteristics are highlighted. To allow comparison and assessment between the different circular maker movements, quantitative variables are required. For this purpose, a set of socio-economic indicators were developed to measure and assess the circular maker movement initiatives. The indicators were developed based on the analytical tools mentioned earlier in this deliverable (see Section 2).

Four indicators, illustrated in Figure 17, were designed to capture different fundamental aspects of the circular maker movement. The first indicator, 'Maker', measures the development of the maker aspect, the second 'Circular' encompasses the circularity of the movement. 'Inclusion' is the indicator used to scale the level of social cohesion of the movement. Lastly, 'Sector' illustrates the sectoral distribution of industry and society. The statements underneath the indicators capture the strength of the city (in Figure 17 the strength of Pop-Machina) relative to each indicator.

All indicators were firstly developed[10] as theoretical concepts based on the literature review, and secondly, quantified with real data gathered at the level of each and every pilot city of Pop-Machina. The Maker indicator evaluates the ecosystem of the maker. The number of maker initiatives, of recognised fablabs and makerspaces are standardised with country data, and compared with European data. For this indicator, the higher the density of makerspaces, the better the indicator.

The Circular indicator was defined based on the recent mathematical model by García-Barragán et al., (2019). The indicator captures the rate of recycling, rate of waste production per inhabitant, and the amount of material recycled, in local areas and compared with the European level. For this indicator, the lower the rate for waste but higher for recycling and amount of material recycled, the higher the indicator.[11]

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10 Further information on the method developed to construct these indicators is available in appendix a6.1.
11 Due to data restriction, material circularity was reduced to product and material recycling.

Figure 17.   **Indicators of the Pop-Machina pilot cities**
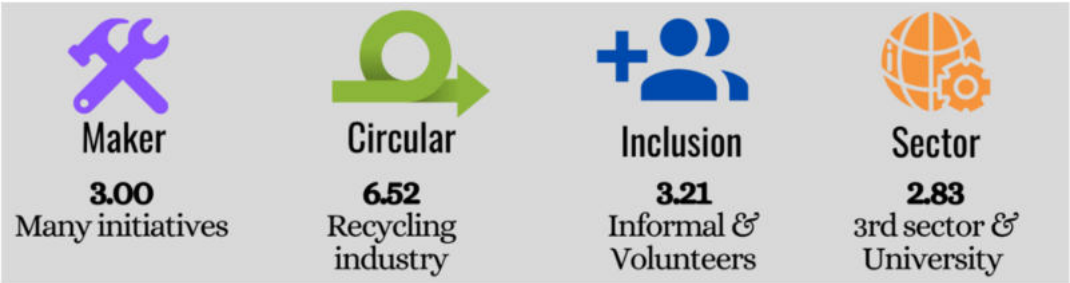
The Inclusion indicator indicates the share of women involved in the local economy (as worker). The shares of immigrants and elderly is also accounted for. For these three measures, once compared with EU levels, the higher the rate, the higher the indicator. Lastly, the share of single parent households is accounted for but negatively compared to the indicator.

The Sector indicator compares the local share of people involved in the four different sectors of the economy and in academia with EU levels. While the fourth sector and academia weight for 4, the third and second sector weight for 3 and the first sector weights for 0.

5. Mapping the maker movement

To breed the urban metabolism framework of the current situation of the pilot cities in terms of the maker movement and the circular economy, an approach was developed based on mapping of typologies. The mapping of these typologies allowed us to describe, analyse and understand the circular maker movement in Europe.

The map enabled the analysis of the structure, space and rules of the circular maker movement to understand their motivation, their perception and their needs. Based on information collected through a survey, the MMI database gathering all circular maker initiatives was established (see Section 5.2). The MMI database enabled the mapping of the system and the assessment of systematic patterns in the circular maker movement.

Such patterns allow the identification and the evaluation of the impacts from the circular maker movement towards circular economy awareness. Ideally, by the end of Pop-Machina, the mapping exercise will enable the enhancement of some fundamental features of the circular maker movement throughout Europe.

5.1 The survey

In order to gather the inventory and map the maker movement, a survey was created and proved its effectivity on the Pop-Machina pilot cities (namely, Istanbul in Turkey, Kaunas in Lithuania, Leuven in Belgium, Piraeus and Thessaloniki in Greece, Santander in Spain and Venlo in the Netherlands). The survey is a key tool to create the database on the inventory of the maker movement at initiative level. The database gathers all the maker initiatives from the seven pilot cities in Pop-Machina, as far as they are part of the maker movement, as confirmed by the application of the flowchart.[12] Initiatives are reported only once.

The survey was originally produced in English and translated into the six languages of Pop-Machina to be disseminated in the seven pilot cities of Pop-Machina, and to be promoted broadly at the EU level. The questionnaire in English can be found in appendix 3. A guidebook was provided to the cities to ease the implementation. The guidebook can be found in appendix 4. Table 13 displays the statistics of the survey conducted in the pilot cities, indicating a good response rate of the survey.

Thanks to the survey, data for 83 initiatives was gathered. Additionally, 63 initiatives were entered manually in the MMI database.[13] While all initiatives having completed the survey fulfilled the requirements as assigned by the MMI flowchart (see Section 4.1 for more details), some initiatives do not consider themselves as part of the maker movement and being circular. As the results of the survey suggests in the third and fourth lines of Table 13, only 90% of them identify themselves as part of the maker movement, and only 66% as being circular.

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12 Once the initiative is 'validated' by the flowchart as part of the maker movement, it can be added to the database.
13 Each pilot cities, with the help of the authors, could enter additional initiative which have been validated by the MMI flowchart but didn't answer the survey.

Table 13. Detailed statistics from the survey[14]

City	Santander	Kaunas	Thessaloniki	Piraeus	Leuven	Venlo	Istanbul	Total
Number of respondents	6	5	8	18	21	11	18	87
Respondent considering itself as maker	100%	83%	50%	95%	60%	91%	79%	90%
Respondent considering itself as circular	17%	83%	50%	74%	60%	83%	68%	66%
Stakeholder response rate	100%	100%	100%	100%	100%	100%	100%	100%
Visions	100%	100%	50%	94%	86%	82%	100%	87%
Strategies maker	100%	100%	50%	94%	86%	82%	100%	87%
Strategies circular	17%	100%	50%	67%	91%	64%	83%	67%
Total response rate	70%	81%	55%	78%	80%	71%	68%	72%
Number of initiatives entered manually	0	13	0	1	32	12	5	63
Total number of initiatives	**6**	**18**	**8**	**19**	**53**	**23**	**23**	**150**

5.2 The MMI database

The MMI database enables a wide-scope geographical mapping of good practices regarding collabo-rative production of circular solutions across the EU. The database inventories practices of the maker movement and the circular maker movement. The database will be made available online through the interactive online maker movement platform implemented in the course of WP4, by end of 2021. The database provides a picture of current and potential collaborative production opportunities in various fields highlighting key aspects that each case aimed to solve/tackle:

- issues (externalities)/challenges;
- visions;
- strategies;
- operation models: tools and interactions with their ecosystems.

The MMI database enables to analyse the structures, space and rules of maker movement initiatives. The database allows the identification of patterns that define the maker movement in each pilot. The different categories of the database permit to map and to assess systematic patterns in the maker movement initiatives. The features of the initiatives allow understanding of their motivation, their perception and their needs. The patterns acknowledge the correlation between the maker movement impacts and some systematic features of the maker initiatives. The analysis enables the identification and the evaluation of the maker impacts towards **circular economy** policy and awareness.[15]

5.3 The map

The map enables the visualisation of the distribution of the initiatives in terms of skills, visions and stakeholders. The mapping exercise aims at finding overlaps between stakeholders in the circular economy and stakeholders in the maker movement. The goal of the mapping exercise is to identify the stakeholders in the maker movement and the circular maker communities.

The different levels of the map allow the analysis of potential opportunities, parallels and gaps between the maker movement and the circular economy. The MMI database will be made available

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14 Note: The table gathers information at initiative level, extracted from the results of the survey conducted in the seven pilot cities of Pop-Machina. The table reports the occurrence (in share) of the respondents having selected the visions as being important and addressed by their initiative. In the survey, respondents could select multiple visions allowing the total share to exceed 100%.

15 While the MMI database does not aim at being exhaustive, the information gathered is intended to be as complete as possible. Good practices from other places can be entered in the MMI database, but the aim of completeness is confined to the seven pilot cities.

online through the interactive platform implemented in the course of WP4.[16] The mapping exercise was accomplished based on the data collected by the survey (see Section 5.1). The survey, the MMI database and the maps framework were established based on literature review, interviews as well as offline and online researches.

The following characteristics are captured:

- geographical/spatial distribution;
- network & interactions;
- stakeholder types;
- stakeholder visions;
- stakeholder strategies.

The components were selected based on the literature review, interviews and desk researches. Interviewees and survey respondents were from all over the EU, e.g. Belgium, Germany, the Netherlands, France, Spain, etc.

Figure 18. **Template of a map of a pilot city representing the interaction between the initiatives**
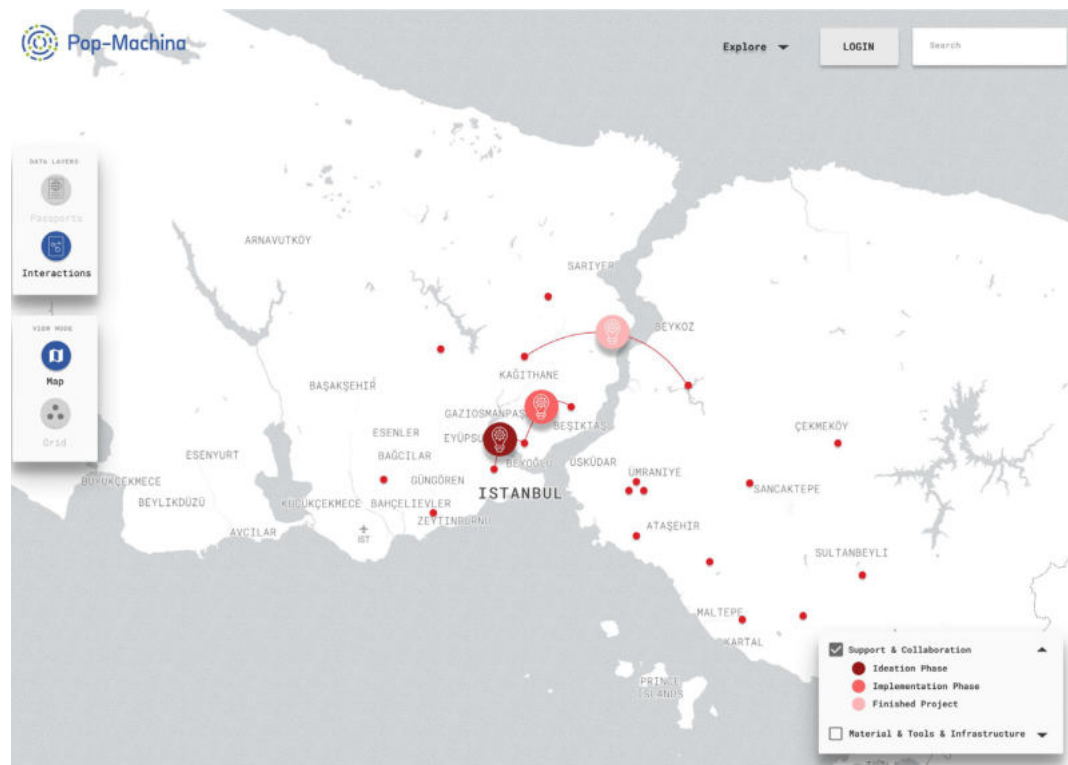
The goal of this mapping exercise is to promote and to inspire engagement within cities to enhance the development of circular maker movement initiatives. The mapping exercise focuses on the maker movement as a whole and concomitant pathways to achieve circularity. The scope includes the supply chain of making and its immediate ecosystem, in order to map the process of circular maker movement. The map visualises the state of the art of successful initiatives and their ecosystem. This study

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16 The features of the map will allow the different layers to display the opportunities to develop maker movement initiatives (e.g. layer 1: circular economy and maker movement initiatives, layer 2A: only maker movement initiatives not part of the circular economy, layer 2B: circular economy initiatives not part of the maker movement, layer 3A: other stakeholders involved in the maker movement, layer 3B: other stakeholders involved in the circular economy).

enables a better understanding of their patterns and allow the replication and the development of further initiatives among cities.(Aroles et al., 2019; Chiarello et al., 2018; Menichinelli, 2017, 2016; Millard et al., 2018; Prendeville et al., 2018; Unterfrauner et al., 2018; Wanner et al., 2017).

A first version of the map gathering all the circular maker initiatives surveyed as of month 9 of the project, is available in appendix a5.1. This map illustrates the geographical distribution and concentration of the circular maker initiatives of Pop-Machina in Europe. A second level of mapping, representing the interactions between the stakeholders as illustrated on Figure 18, was also developed and will be implemented as an online interactive map by end of 2021, by the WP4 of the Pop-Machina project. A video presenting this online map is available here: https://youtu.be/J_OjQ9nUhCk

Thanks to the city profiles developed in D5.1 (Tsui et al., 2020) and to this mapping exercise, patterns can be identified in the maker movement initiatives. Depending on either their stakeholders or their visions, cities will have patterns to align their strategies and policies to the visions they want to achieve.

5.4   The circular maker passport

The creation of a city passport for the pilot cities highlights the urban metabolism and ecosystem of the maker movement in each pilot city. Such an identity is needed for stakeholders to identify themselves within an ecosystem but also for future cities to evaluate potential opportunities for the development of circular makerspaces (Bria et al., 2015). A maker movement « passport » of every city illustrates the key maker movement skills and visions of the city. The passports provide a rapid and clear overview of strengths and assets of each city's maker movement.

Figure 19.   Template of a circular maker city passport
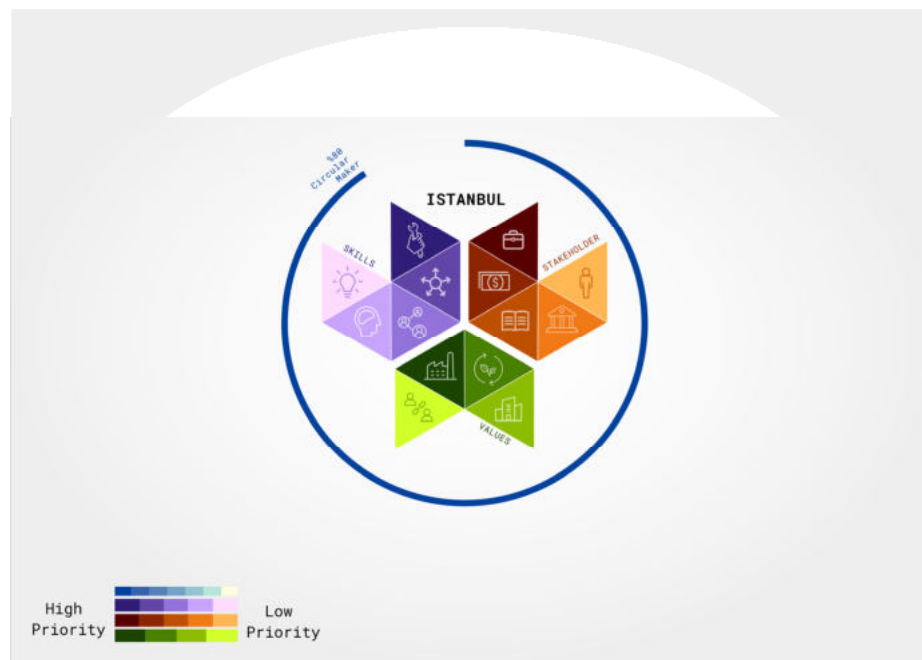
Note for the two passports: The blue surrounding heptagon represents the different set of circular strategies developed. The blue nuances indicates the level of priority.

The passport is composed of two layers capturing the maker and the circular maker movements. The passport depicts the different characteristics and their importance for the city as well as the quantitative repartition of stakeholders in terms of identities, visions and strategies. Figure 20 provides an example of a circular maker city passport, indicating the share of initiatives considering themselves as circular compared to the total number of maker initiatives.

Figure 20.   Template of a circular maker initiative passport
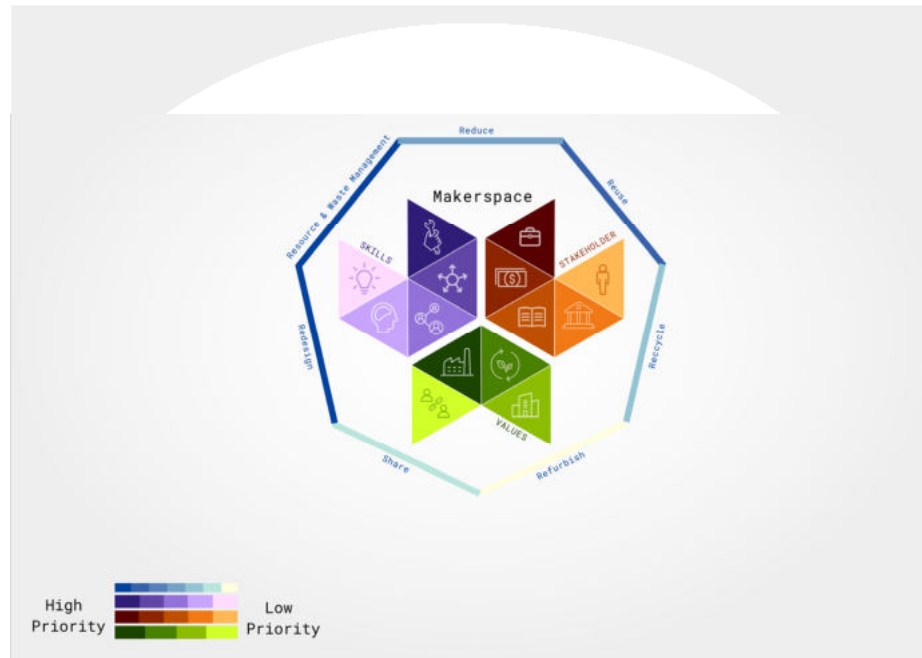
A similar passport is also created for every initiative that has completed the survey. The passport reports the level of priority in terms of circular and strategies, visions and stakeholders involved for each initiative located in the city and having passed the flowchart.

The passport of each initiative is reported at city level to provide an overview of the heterogeneity of the circular maker movement in each city, as illustrated by Figure 21. An online version of the map exposing all circular maker passport for each initiatives in each pilot city is available here: https://pop-machina.eu/mmimap. Such a map representing the different circular maker passports of Europe at city level also captures the geographical distribution of the initiatives in the city. The geographical mapping allows urban patterns to be identified, and to be used for developing policy recommendations. Figure 21 illustrates the city map gathering the passports for all the circular maker initiatives in the pilot, with the template example of Istanbul. The details of each pilot cities are available in the storyboards of the pilot cities presented in Section 7 of this report.

Figure 21.   Map of Piraeus illustrating the circular maker passports of the city's initiatives
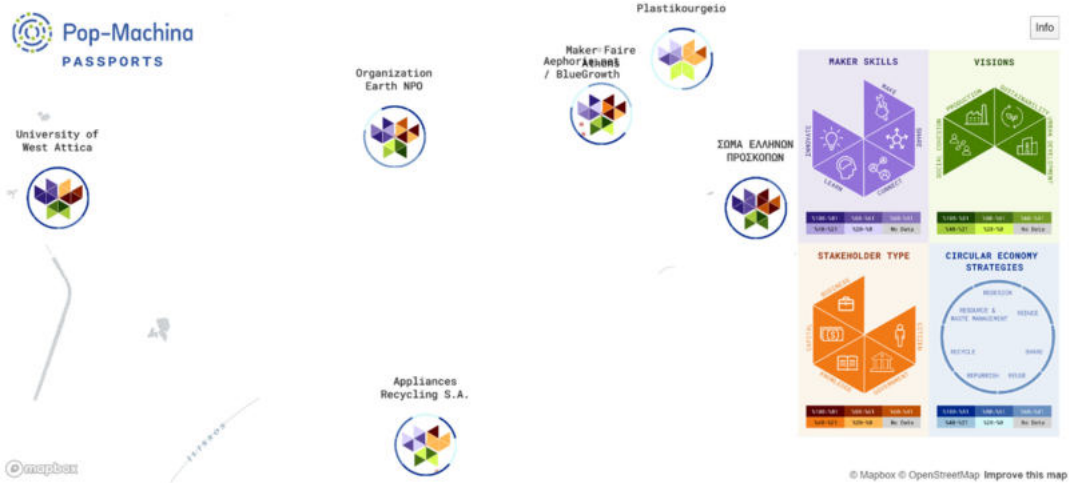
Note: For more details please consult *https://pop-machina.eu/mmimap*

6. European circular maker good practices

In order to report the good practice cases, all tools developed above in this report were combined to perform a targeted mapping of the local circular maker ecosystems in each pilot city. This section focuses on the inventory of circular maker practices at the Pop-Machina's level. Further inventorying the good practices, this section embrace their distinguished characteristics through a cross-pilot city analysis. The storyboards developed provide a picture of current and potential circular collaborative production opportunities in various fields, highlighting key aspects of each pilot city. The storyboard of Pop-Machina, reporting the aggregated key characteristics of the circular maker movement nine months after the start of Pop-Machina, is illustrated in Figure 27. While the mapping exercise of the good practices cases was performed at the Pop-Machina level, it can be certainly and efficiently replicated at the whole European level, thanks to the tools developed.

This section presents aggregated data at European level while the next section presents the data at pilot city level. An analysis of the maker movement initiatives in each pilot city is reported in Section 7, based on the survey conducted at maker movement initiatives level.

The data employed for the analysis was based on a survey conducted at maker movement initiatives level in all the pilot cities of Pop-Machina, as detailed in Section 5.1. Ongoing activities related to the application of circular collaborative production were identified and documented, enhancing the inventory of circular solutions. Several socio-economic indicators developed in Section 4.3, were reported for each pilot city.

The European map of the Pop-Machina circular maker movement is illustrated in Figure 23. It gathers the many characteristics of the circular maker movement of Pop-Machina. The circular maker passports at city level provide a picture of current and potential collaborative production opportunities in various fields, highlighting key aspects that each case aimed to solve.

Figure 22 illustrates that the circular practices are not yet fully embraced by the maker movement in Europe. Figure 23 exposes that the pilot cities located in Northern Europe seem, on average, more concerned by circular strategies than the pilots located in Southern Europe. Innovation as a skill appears to be a focus of pilots located in the East, where learning is the most developed skill. The most frequent stakeholders are capital and government, the latter being especially involved in southern countries. Visions are homogeneously spread in Europe.

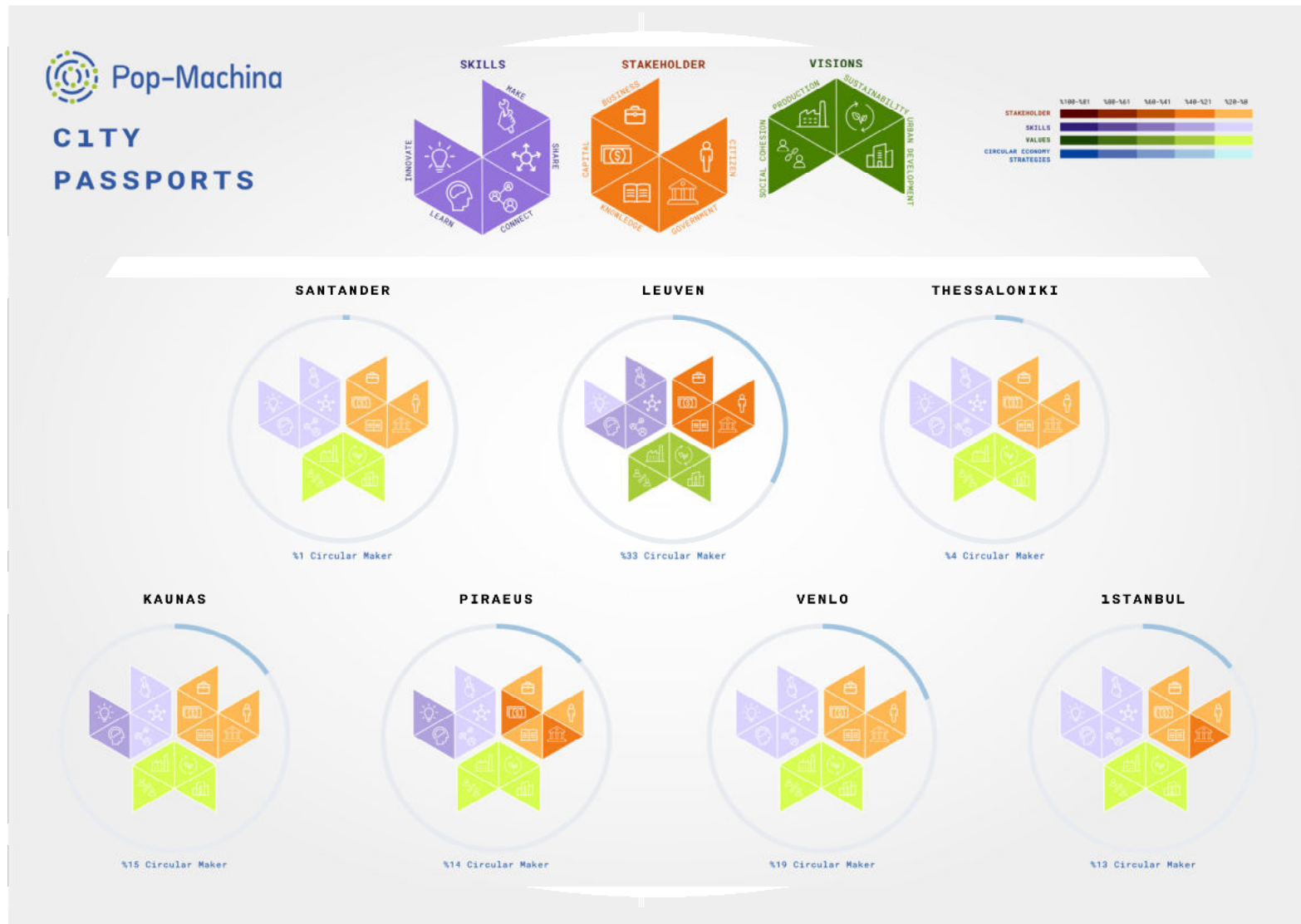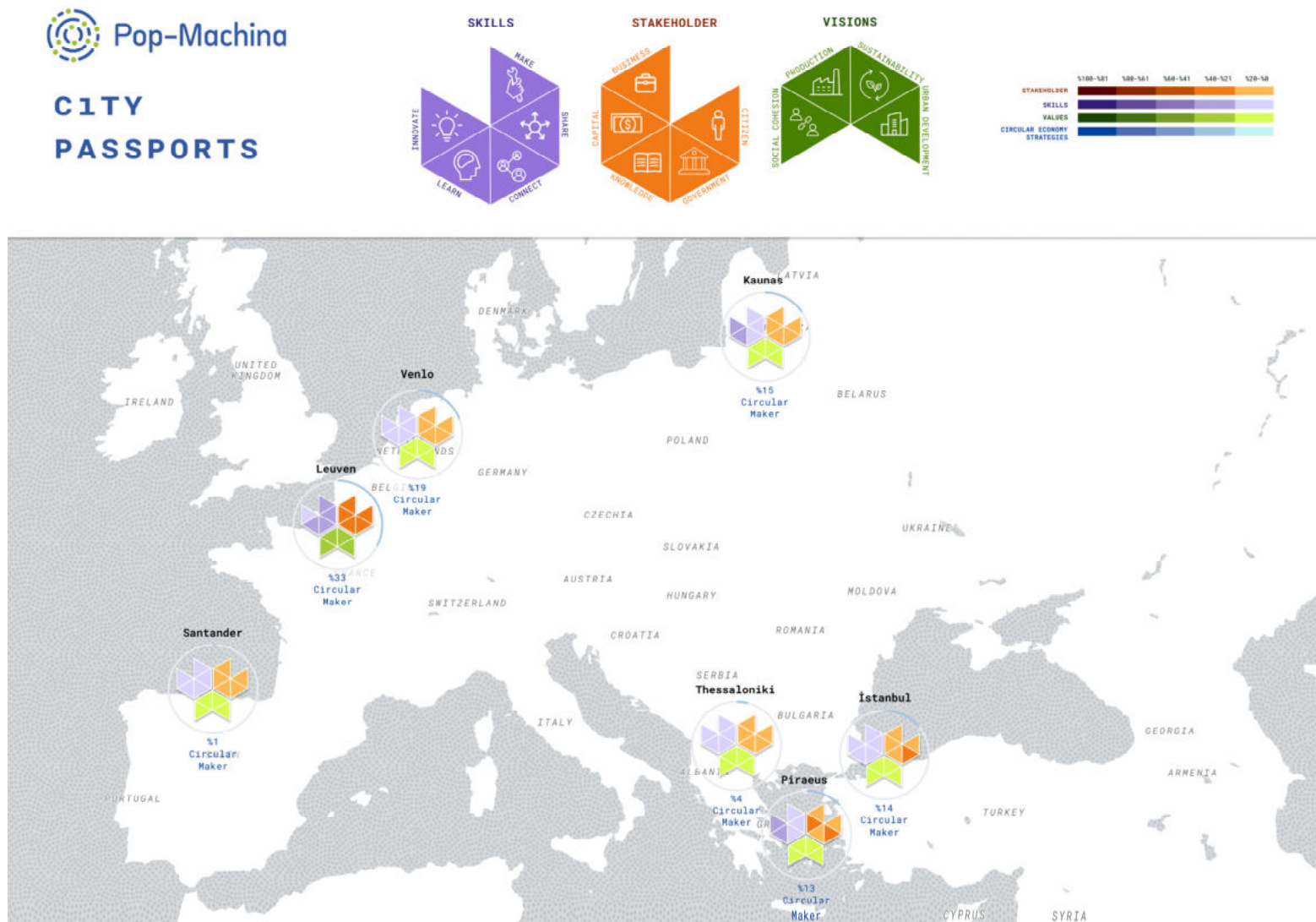**Figure 22.** **Passports of all Pop-Machina pilot cities**

Figure 23. European map of the circular maker movement

An analysis of the aggregated survey results demonstrates the interactions between the circular and the maker movement in the initiatives of Pop-Machina. Firstly, when considering the maker movement integration in the circular economy, Table 14 lays out that all strategies integrate in the circular movement with more than 50% except innovate. The maker movement could bring further innovation towards circular economy if this strategy would be enhanced. The maker strategy that integrates the best the circular movement is learn. The maker strategies seem to account for refurbishment and management of waste and resources only to a limited extent. While makers share resources, the strategy is evaluated as a way to collaborate rather than a way to better manage resources. However, reuse and redesign seem to be strategies embraced by the circular maker movement.

Table 14. **Matrix presenting the interrelations of the maker strategies with regard to the circular strategies**

From MM to CE	Maker strategies	Make	Share	Connect	Learn	Innovate
Circular strategies	Cities' average	0.62	0.69	0.54	0.53	0.47
Redesign	0.62	0.500	0.413	0.492	0.552	0.571
Reduce	0.52	0.469	0.395	0.524	0.603	0.464
Share	0.64	0.588	0.558	0.581	0.612	0.548
Reuse	0.66	0.638	0.599	0.597	0.690	0.524
Refurbish	0.5	0.413	0.430	0.371	0.474	0.393
Recycle	0.54	0.538	0.494	0.532	0.560	0.583
Management of waste and resources	0.45	0.406	0.395	0.516	0.483	0.369

Note: The ratio presented here are the marginal scores of each circular strategies when a circular maker initiative had scored the maker strategy above average. The higher the ratio, the better the synergy between the maker and circular strategies. The appendix 6 provides more details on the method.

Figure 24 shows that all maker strategies interconnect homogeneously with the circular strategies. With an average of 2.96 (the smallest number being the best), it depicts that some efforts could be done to further integrate the maker movement in a circular process.

Figure 24. **The interrelations of the maker strategies with the circular strategies (right side) and of the circular strategies with the maker strategies (left side)**

However, Figure 24 (right side), exposes that with an average of 2.3, the circular economy embraces the maker movement strategies very well, especially the concept of making and sharing. Table 15 shows that both the strategies of making and sharing are homogeneously encompassed by the circular strategies. The only strategy lagging behind is innovation.

Table 15. **Matrix presenting the inter-relations of the circular strategies with regard to the maker strategies**

From CE to MM	Maker strategies	Make	Share	Connect	Learn	Innovate
Circular strategies	Cities' average	0.62	0.69	0.54	0.53	0.47
Redesign	0.62	0.750	0.765	0.640	0.647	0.456
Reduce	0.52	0.757	0.779	0.664	0.671	0.450
Share	0.64	0.750	0.831	0.669	0.631	0.431
Reuse	0.66	0.763	0.822	0.671	0.697	0.408
Refurbish	0.5	0.783	0.842	0.650	0.683	0.408
Recycle	0.54	0.815	0.871	0.734	0.718	0.492
Management of waste and resources	0.45	0.741	0.806	0.741	0.657	0.417

Note: The ratio presented here are the marginal scores of each maker strategies when a circular maker initiative had scored the circular strategy above average. The higher the ratio, the better the synergy between the circular and maker strategies. The appendix 6 provides more details on the method.

7. Pop-Machina circular maker practices

This section provides an overview of the circular maker practices inventoried in the seven pilot cities. While Figure 25, reports only the good practices in Leuven, the initiatives gathered in the all seven pilot cities are detailed in appendix a5.3 (also available here: https://docdro.id/xZyFO9x).

Figure 25.   **Circular maker passports reporting the good practices in the city of Leuven**
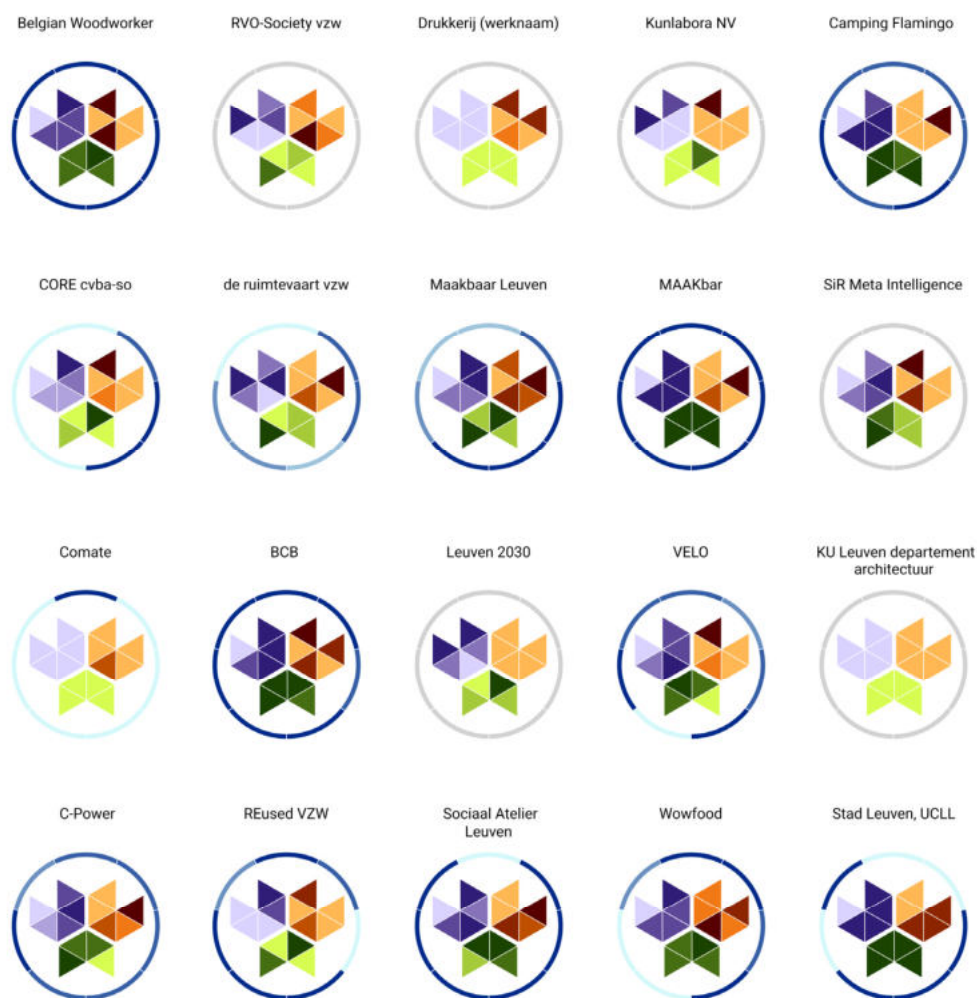
Figure 26. Legend of Figure 25
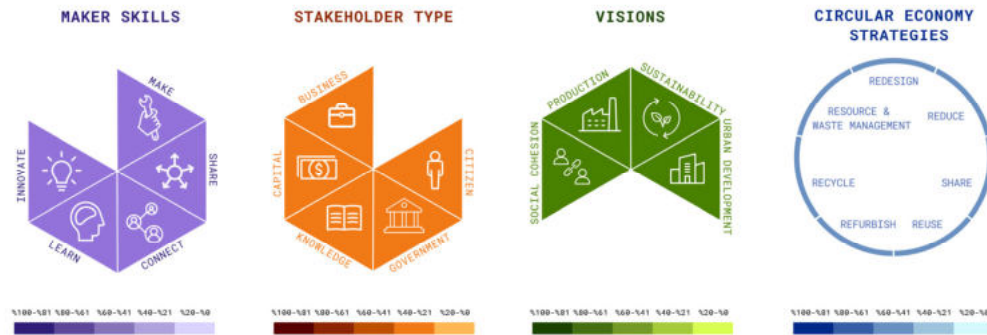
To integrate all indicators and tools developed for this task (T2.1), a storyboard was created at the Pop-Machina level as well as one for each pilot city (namely, Istanbul in Turkey, Kaunas in Lithuania, Leuven in Belgium, Piraeus and Thessaloniki in Greece, Santander in Spain and Venlo in the Netherlands). Each storyboard is composed of the maps created from the survey at initiative level as well as the circular and maker indicators. The storyboards provide an overview of the circular maker deployment in the Pop-Machina project. The storyboard for Pop-Machina is presented in Figure 27.

Figure 27. Circular maker movement storyboard of Pop-Machina

7.1 Istanbul

Figure 28. Circular maker movement storyboard of Istanbul
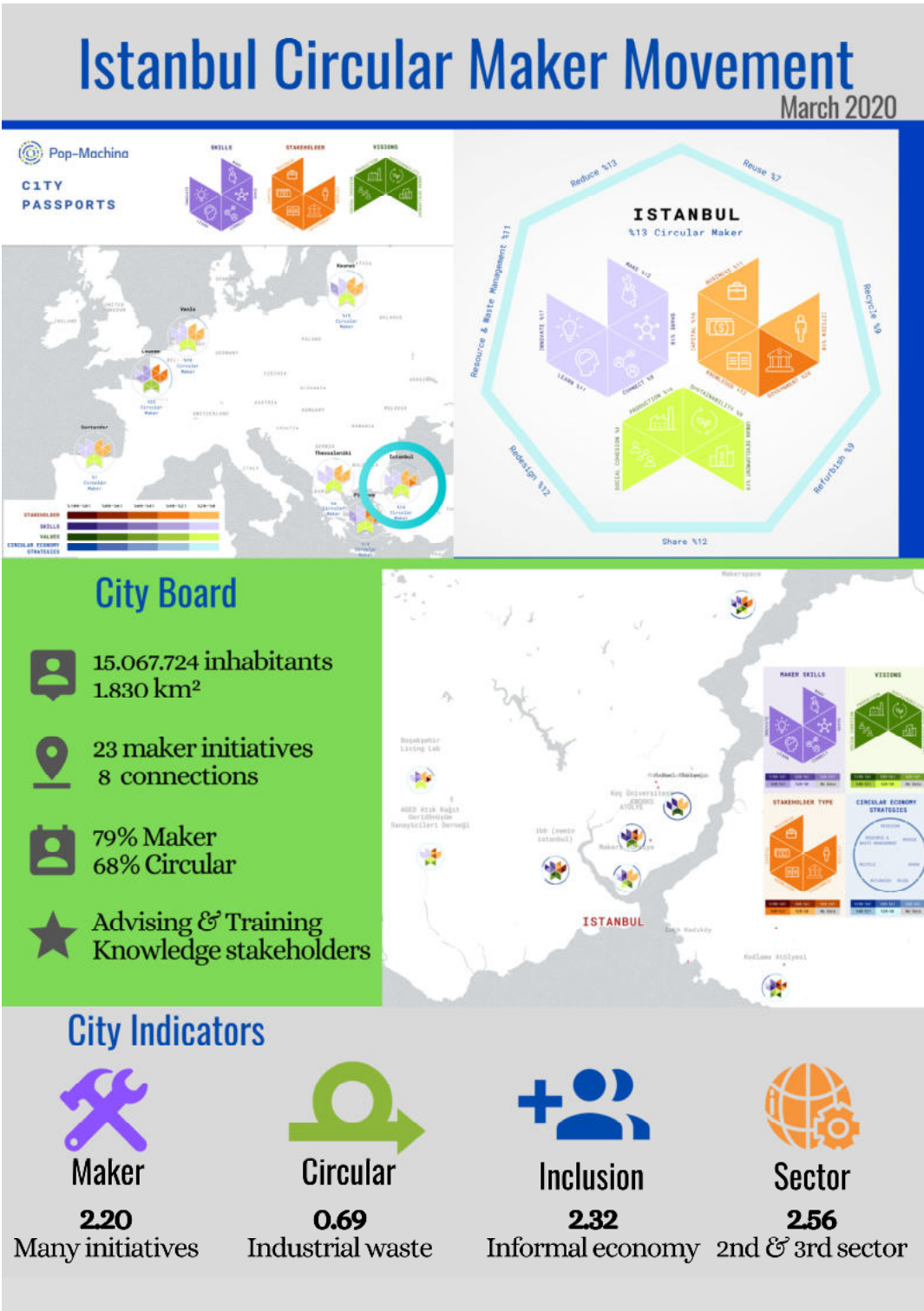
7.2 Kaunas

Figure 29. Circular maker movement storyboard of Kaunas
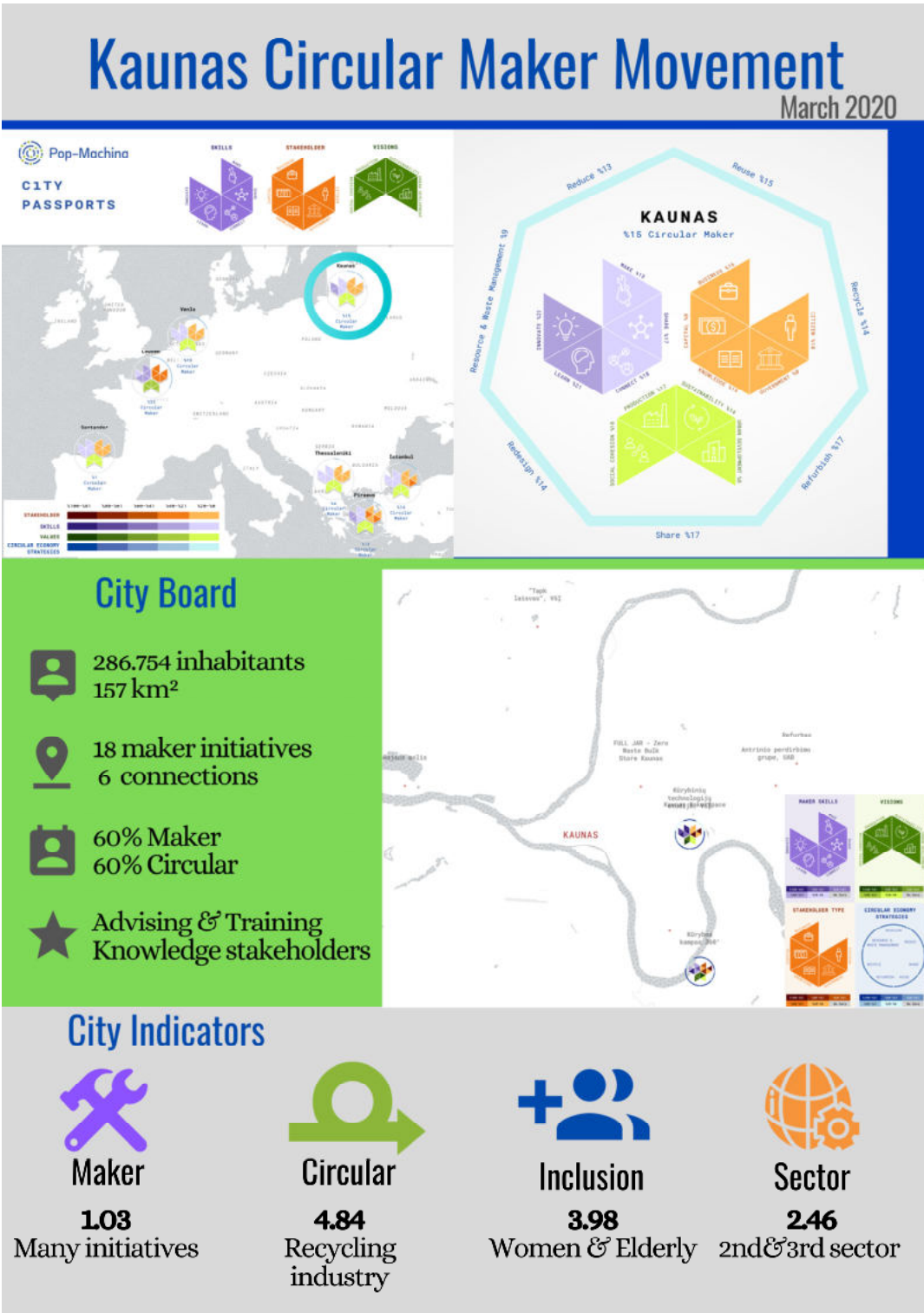
7.3   Leuven

Figure 30.   Circular maker movement storyboard of Leuven
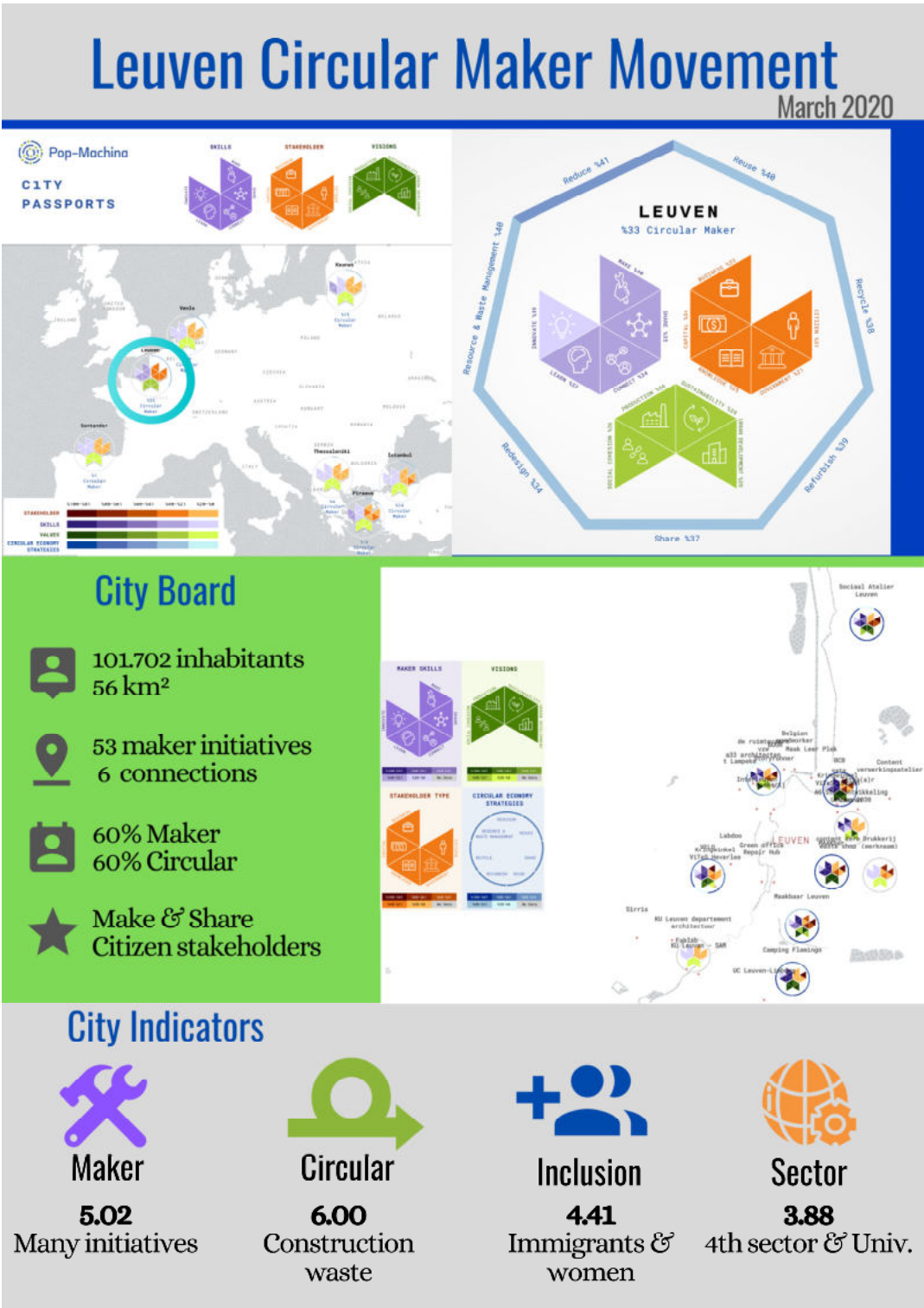
7.4   Piraeus

Figure 31.   Circular maker movement storyboard of Piraeus

7.5   Santander

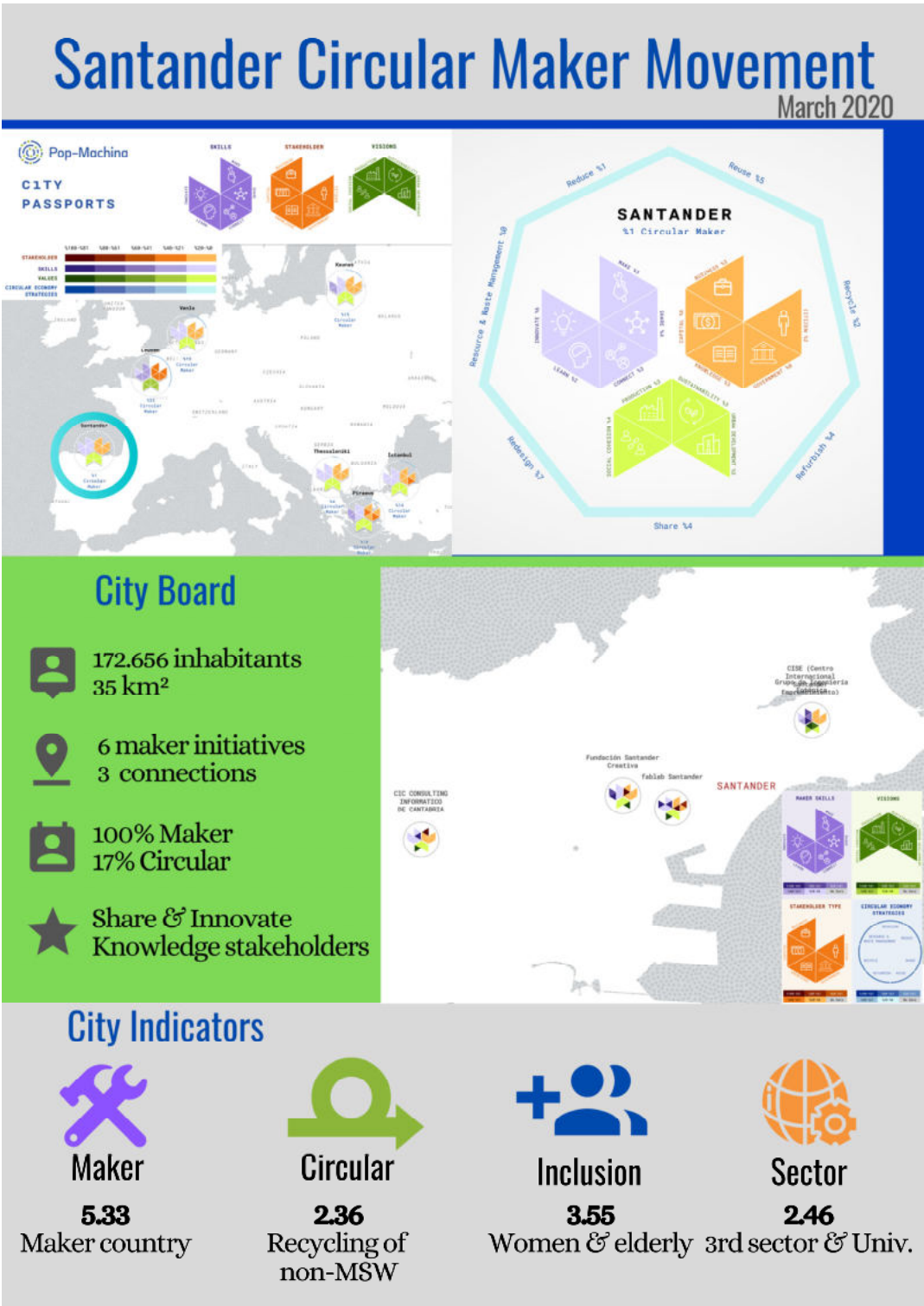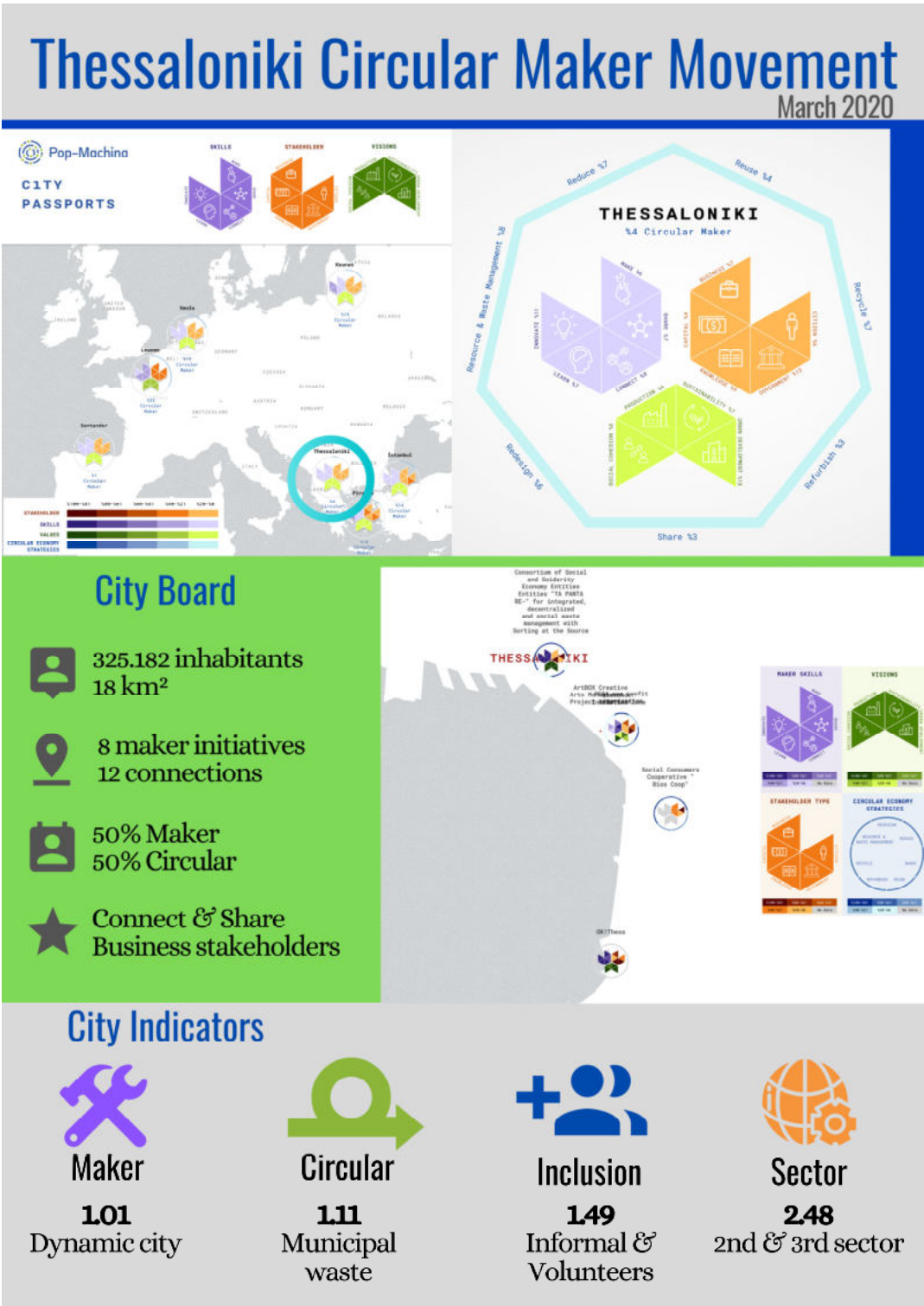**Figure 32.**   Circular maker movement storyboard of Santander
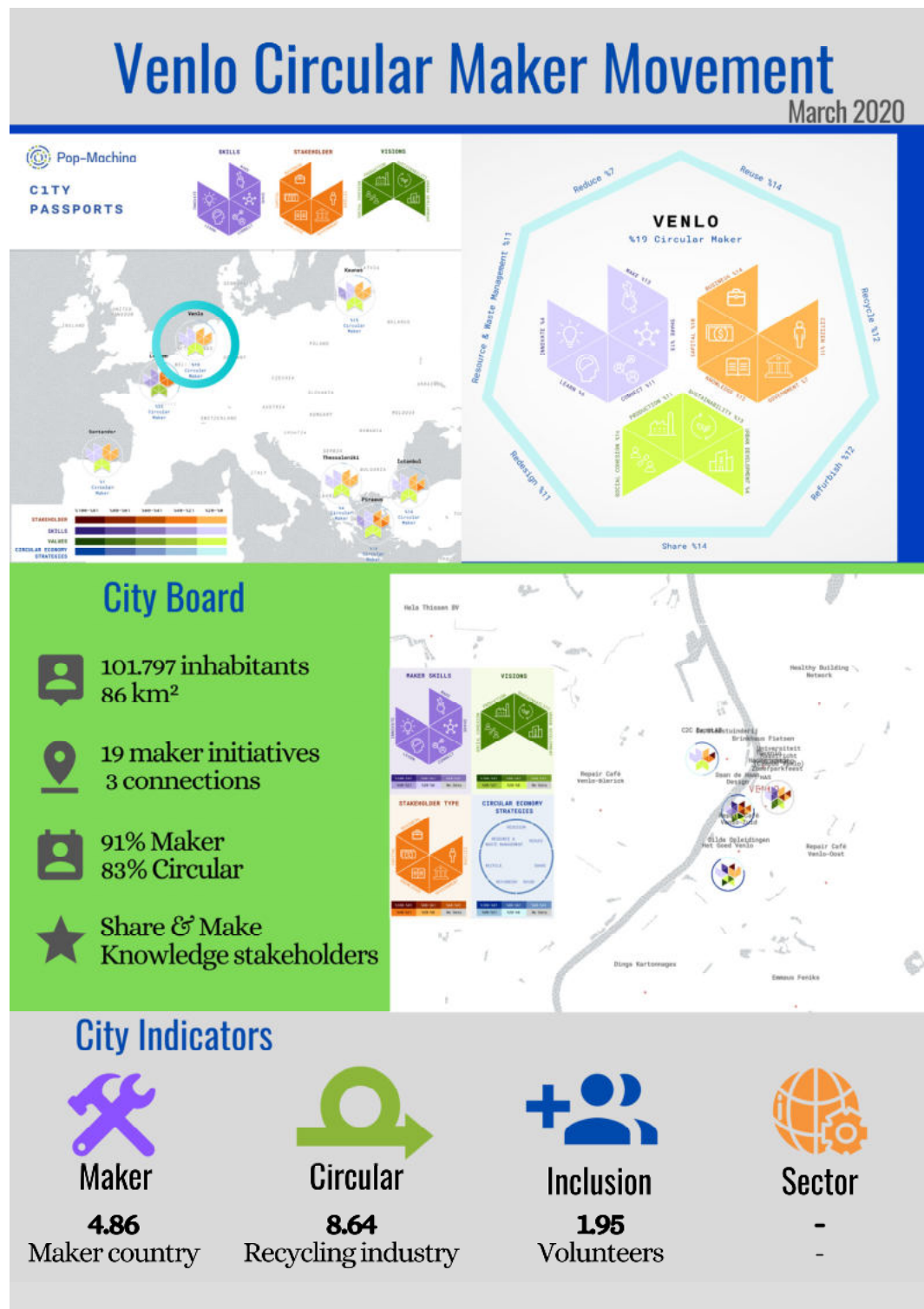
7.6 Thessaloniki

Figure 33. Circular maker movement storyboard of Thessaloniki

7.7 Venlo

Figure 34.   Circular maker movement storyboard of Venlo

8. Limitations

From all data and elements collected and developed during this study, a few limitations were identified, which require further research that goes beyond the scope of this report. The first limitation relates to the bibliometric analysis and to the chasm between academic literature and actual social movements. The maker movement is a recent societal phenomenon with little academic description. This gap in the literature on the maker movement hinders the accurate apprehension of its complete dynamics and characteristics.

The second limitation lays in the number of cases collected from the survey. While the survey contributed to capture original features of the maker movement from the field, only about a hundred of initiatives were observed in our seven pilot cities in the first attempt of the MMI database. From the city knowledge gained, some initiatives of the pilot cities have definitely been overlooked and omitted from the survey. Furthermore, the cases were captured in only seven cities, accounting for less than a percent of the overall European population. This relatively low number of cases may hamper the information value of the results and their ability to be extended to Europe. Surely, the number of cases seized by the MMI database will continuously grow over the remaining three years of the Pop-Machina project.

A third limitation appertains to the identification of the circular maker movement. The low identification is diagnosed at two levels. Firstly, the initial limited experience of cities towards the circular maker movement made the identification of the stakeholders arduous. Secondly, the observation made from the survey highlights the extent to which makers do not genuinely identify themselves with the circular maker movement. Hopefully, the Pop-Machina project will allow the cities to encompass their supporting role of the circular maker movement, favouring the identification of additional circular maker initiatives. The tools developed in this report will further contribute to the identification strategies for both the cities and the makers, supporting the accreditation of an increasingly growing community of circular makers.

The last limitation lays in the social and inclusion dimensions of the circular maker movement. From the first results, and confirmed by the literature (Voigt et al., 2017), it appears that the movement is mainly dominated by mid to high social classes, educated, white, middle aged men. From the interviews conducted, only 16.7% of the practitioners were women, (three out of 18 interviewees). Considering this social cluster, Pop-Machina will have to redouble its efforts to enable the circular maker movement to enhance social capital and inclusion.

9. Policy recommendations

The main aim of this report is to propose a conceptual framework for the recent but trending phenomenon of the maker movement. Although developing policy recommendations was not a central aim of the study, several ways are highlighted in which policy and government actors could play a supporting role in this citizen-driven movement. Governments could assert this stimulating role for two reasons. First, because maker movement initiatives have the potential to make society (locally and more widely) more resilient in terms of the environment, the economy, and in terms of social inclusion. Secondly, because these actors and initiatives can – both directly and indirectly – contribute to the formulation of their own policy visions and strategies, e.g. regarding policy on circular economy and on equal opportunities.

As such, from this study, the following policy recommendations are made distinctly between recommendations to city governments and national/subnational region level.

Recommendations on the city level
First, cities are recommended to grasp the opportunity that is offered by them by the dynamics created by the local maker movement initiatives, to feed local policy formulation processes regarding circular economy, climate change mitigation, economic and regional development, city and spatial planning, city branding, labour, and social inclusion. Second, cities could – like the seven Pop-Machina pilot cities did – actively seek involvement in innovation and other externally funded projects to create learning opportunities and support their local maker movement in a smart way. Third, the learning from such projects, pilots, experiments, cases, needs a structural approach. From the very first steps in designing such projects and cases, cities should outline an explicit valorisation strategy that exceeds the duration of the project. That way, learning effects can be optimised, and the risk of not translating the experience into structural progress can be tackled.

Fourth, the maker movement has the potential to popularise technologies within local communities, which can increase citizen technological skills and interest in science-related education (STEM). This impact could in turn increase the local labour market and entrepreneurship.

Last but not least, the COVID-19 crisis has shown and confirmed the vulnerability of global value chains. In the post-corona era, the maker movement could offer the missing link in increasing economic resilience by decreasing dependency on the globalised economy, and empowering local value chains.

National/subnational region-level recommendations
On a higher level, the maker movement could benefit from measures promoting the circular economy by incentivising investments and choices that discourage the consumption of primary resources, and support more circular and sustainable choices. On this higher policy level, instruments such as regulatory taxes, subsidies, deposit-return systems, and product/material standards can be deployed to further stimulate the circular economy in general, and the circular maker movement in particular. Finally, the national and EU levels have the responsibility to enhance the knowledge needed to further increase the maker movement's environmental, social and economic impact. Research programmes on the national (regional) and EU levels can greatly contribute to that objective.

10. Conclusion

This report examines the development of the circular maker movement initiatives by providing a conceptual framework for the circular maker movement highlighting the scope for Pop-Machina. Following the framework, the circular maker was analysed in the context of the project of Pop-Machina and especially, a characterisation of the circular maker movement was conducted to enable a better understanding of the circular maker movement patterns. This characterisation was achieved through the conception of a set of tools. All the tools presented in this report were developed based on a bibliometric analysis of literature supplemented with a series of expert and practitioner interviews and a survey in the seven pilot cities of Pop-Machina. The tools developed include:
- a conceptual framework;
- a set of definitions;
- an MMI flowchart;
- a survey;
- an MMI database;
- a taxonomy;
- a set of indicators;
- several maps;
- a circular maker passport;
- circular maker storyboards.

This set of tools allows to identify and assess the different components and characteristics of the circular maker movement. The stakeholders in the maker movement and the circular maker communities can be identified and characterised. The defined circular maker characteristics enhance the understanding of the circular maker movement. From their characteristics, the commonalities between stakeholders in the circular economy and stakeholders in the maker movement are delineated and differentiation can be made. The tools also capture the state of the art of the circular maker movement and provide an inventory of circular maker solutions, in the context of the Pop-Machina project.

The features of the social framework of the key stakeholders of the circular maker movement are demonstrated, capturing their roles and interactions. The peculiarity of the circular maker movement is released with a focus on the features of the movement to achieve circularity. The drivers of the makers and of their communities, and their needs to further develop their circular activities are discerned. The report showcases the potential contributions of the maker movement to the circular economy and the distributed production. This report allows the replication and the development of further circular maker initiatives among cities with different contexts in Europe.

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Appendices
appendix 1 Lexicon – highlighting the concepts

The following definitions are provided as common concepts to ease communication and understanding of the Pop-Machina project. They are built on several academic works from the literature review and on Oxford dictionary. (English Dictionary, Thesaurus, & Grammar Help | Lexico.com n.d.)[17]

1.1 Circular design

Circular Design integrates a product conception and its manufacturing process into a circular economy. The objective is to design services or products that are adapted to the principles of the circular economy, and therefore reusable and recyclable.

The Circular Design method reflects on all the stages of manufacture. Furthermore, circular design questions and aims at redesigning distribution and sale, and also, on the role of all the actors and stakeholders involved in the whole supply chain, from consumption to end-of-life. The approach rethinks all or part of the process (Atlason et al., 2017; De los Rios & Charnley, 2017; Hollander et al., 2017; Moreno, 2016; Romme & Endenburg, 2006; Wastling et al., 2018). The following part explains an example of circular design. A leather children's shoe made of leftover leather from an 'adult size' shoe. The sole of this same children's shoe is made of crushed old or leftover leather. At the end of the life of this shoe, the entire shoe will be crushed to make soles for other shoes.

1.2 Circular maker ecosystems

The circular maker ecosystem is the community of institutions and individuals in interrelation with the circular and maker movement environment. The stakeholders of the ecosystem develop interconnections and exchange flow of tangible (tools, materials, etc.) and intangible resources (information) allowing the maintenance and development of circular maker community (Brody, 2003; Maffei, 2014, 2014; Menzel & Teng, 2010; Pera et al., 2016).

1.3 Collaborative economy

The collaborative economy is a peer-to-peer socioeconomic approach aimed at creating a higher collective value. The collaborative economy is based on new forms of trade and work organisation. The services and goods are pooled to allow higher utilisation rates. Actors of the collaborative economy gather in communities (networks) and often use platforms (mainly numerical) as means to exchange resources (tangible and intangible). (Cohen & Muñoz, 2016; Domenech & Bahn-Walkowiak, 2019; Witjes & Lozano, 2016). Peer-to-peer carpooling platforms are an example of the collaborative economy.

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17 n.d. means 'no date' often seen in the reference for websites.

α1.4 Grassroots

A grassroots initiative is generally organised by a group of individual citizens in a given district, region, or local community. Often these individual citizens are guided and helped by a larger organisation (e.g., government, university, library, etc.) Grassroots initiatives use collective movement from the local or community level and are thus identified as bottom-up, rather than top-down actions. (Boni et al. 2019; Charter n.d.[3]; Seyfang and Smith 2007). Citizens organising beach clean-ups and cooperatives to mutualise food production and distribution are examples of grassroots initiatives.

α1.5 Makerspace

A makerspace is a place, which can host workshop, and is open to the public. A maker space is community place where tools are present. Maker spaces usually combine manufacturing tools, community and educational means to enable community members to design, prototype and create manufactured objects that would not be possible for someone working alone. These spaces can be created both around individuals wishing to share places and machines and within an association, whether for profit or not, schools, universities, libraries, etc. But all are united in providing access to equipment, community and education and all are unique according to the needs of the community forming the place. Professionals can also access the space for the purpose of rapid prototyping or small-scale production. Other common names for makerspaces are Hacker space and Fablab. These two latest terms defined specific makerspaces, which have several specific characteristics not developed here. (Barrett et al., 2015; Marusteru et al., 2017; Pinto, 2015; Smith & Light, 2017)

α1.6 Prosumer

A prosumer is a person who consumes and produces a product. It mostly refers to a person using commons-based peer production. Commons-based peer production refers to a **collaborative** model of production. The consumer participates – often through the collaborative economy - in one or several steps of the supply chain of making. This participative way of consumption - through the production phases - softens (or eliminates) the boundary between production and consumption activities. This new way of producing and consuming often allows more distributed and local ways of production and consumption. (Kotler, 2010; Ritzer et al., 2012; Ritzer & Jurgenson, 2010). Creating a 3D printer inspired by open source design to create a missing part (e.g. for fixing an electronic device) is a complete example of a prosumer.

α1.7 Social and environmental issues

Generally, social and environmental issues have negative outcomes that affect a third unaccountable party (citizen). For example, the costs of air pollution caused by driving a diesel car are not fully paid by the person driving it. These issues can be 'internalised' into economic decision processes by government interventions, e.g. a carbon tax. When such government decisions are not taken, the citizens sometimes organise themselves to find more suitable alternatives to treat these issues. (Acuff & Kaffine, 2013; Chen et al., 2018; Peretto & Valente, 2018). The lack of customer services and the lack of accessibility of the job market for immigrants are social issues. Lack of education opportunities due to high costs (in the USA) is another social issue. The lack of recycling facilities and of green energy are environmental issues.

α1.8 Social inclusion

Social inclusion is the process to ensure that each and every individual has the means and opportunities to participate on the basis of their identity, as valued, respected and contributing members of

their community and society. Among others, some cornerstones are: value recognition, offer opportunities for human development, involvement and commitment, closeness, material well-being. In Pop-Machina, the targeted individual groups requiring a stronger social inclusion are women, disabled persons and immigrants. (Peace 2001; Social Inclusion n.d.)[18] Programmes targeting women for integration in the entrepreneurship ecosystem is an example of a social inclusion initiative.

a1.9   Supply chain of making

The supply chain of making (making as manufacturing) includes all activities associated with making, consuming and end-of-life treatments of a tangible product. While the product has to be something 'material' (tangible), the supply chain steps can be intangible activities. All the following steps and their intermediaries are regarded as part of the supply chain of making: the design process, the supply of materials and components, the platform allowing the supply of components and services, the manufacturing process, consumption, end-of-life treatments and all services linked with distribution and end-of-life processes, such as repair and refurbishment activities, but also reuse platforms, and ultimately the recycling and disposal activities including waste management. Intermediary activities are also part of the supply chain of making e.g. trainings on making, providing material for making, having a discussion group on making, providing services to maker activities, organising or participating in a conference on making, doing research on making, … (Bridgens et al. 2018; Chu et al. 2015; Kohtala 2017; Ratto 2011; Vossoughi and Bevan n.d.[4]). An open source online platform to exchange material is also part of the supply chain of manufacturing as is the creation of an open source code library for 3D printing.

a1.10   Urban regeneration

Urban regeneration is a city planning strategy. Urban regeneration refers to the action of rebuilding the city on itself while increasing the efficiency of its underused resources (built environment and land, tangible and intangible).). This urban planning strategy covers many aspects of city life: physical, social and environmental. Approaches depend on a city's characteristics. Urban regeneration tends to integrate local redevelopment of city districts. In particular, urban regeneration initiatives aim at addressing social, economic and environmental issues of certain (often degraded or deprived) city districts. This city planning strategy tends to limit urban sprawl and peri-urbanisation by enhancing local (re)development, particularly to reduce the environmental footprint of the city. Urban regeneration encourages new economic and sustainable development, and develops solidarity at the scale of the district, aiming at more social inclusion and wealth distribution.

  (Allwinkle & Cruickshank, 2011; Evans & Jones, 2008; Guy et al., 2002; Meegan & Mitchell, 2001). The city of Amsterdam has developed an urban regeneration project called 'Amsterdam Smart City'. The project has gathered business, government, and community in a partnership to focus on energy saving through different themes: 'Sustainable Work, Living, Mobility, and Public Spaces'. The partnership has established a portfolio of actions to implement energy saving while providing new sustainable and economic development.

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18 n.d. means 'no date' often seen in the reference for website.

appendix 2 Results of the keywords analysis

Table 16. Results of the keywords analysis

Word	Occurrences	Frequency	Rank
Make/ing	3113	2.92%	1
Maker	2411	2.26%	2
Use*/using	2377	2.23%	3
Space	1651	1.55%	4
Study/ies	1147	1.08%	5
Design	1046	0.98%	6
Student	606	0.57%	7
Movement	555	0.52%	8
Maker movement	462	0.43%	9
Produc*	454	0.43%	10
Science/scienti*	438	0.41%	11
Digital	422	0.40%	12
School	353	0.33%	13
Project	301	0.28%	14
Knowledge	287	0.27%	15
Fabrication	280	0.26%	16
Process	275	0.26%	17
Model	275	0.26%	17
Cities/y	238	0.22%	18
Social*	230	0.22%	19
Information	213	0.20%	20
Public	210	0.20%	21
Concept	196	0.18%	22
Culture	196	0.18%	22
Value	190	0.18%	23
Academic	180	0.17%	24
Econom*	177	0.17%	25
Future	167	0.16%	26
Problem	159	0.15%	27
Opportunities/y	159	0.15%	27
Sustainab*	152	0.14%	28
Different	152	0.14%	28
Business	128	0.12%	29
Network	104	0.10%	30
Innovative	101	0.09%	31
Connect	101	0.09%	31
Develop*	82	0.08%	32
Local	79	0.07%	33

Word	Occurrences	Frequency	Rank
Environment*	64	0.06%	34
Initiative	64	0.06%	34
Society	64	0.06%	34
Urban	62	0.06%	35
Understand*	55	0.05%	36
Learn*	47	0.04%	37
Circular	33	0.03%	38
Citizen	33	0.03%	38
Group*	32	0.03%	39
Tool*	32	0.03%	39
Grassroot	31	0.03%	40
Waste	29	0.03%	41
Fab*lab*	28	0.03%	42
Plastic	27	0.03%	43
Supply chain	23	0.02%	44
Capital	22	0.02%	45
Government	22	0.02%	45
Print*	21	0.02%	46
Circular economy	19	0.02%	47
Skill*	15	0.01%	48
Resource	14	0.01%	49
Maker*space*	10	0.01%	50
Prosumer	9	0.01%	51
Solution*	8	0.01%	52
Engineer*	8	0.01%	52
Reuse/redistribute	8	0.01%	52
Regeneration	6	0.01%	53
Redesign	5	0.00%	54
Educat*	4	0.00%	55
Stakeholder*	4	0.00%	55
Entrepreneur*	4	0.00%	55
Maintain	4	0.00%	55
Social inclusion	3	0.00%	56
Social cohesion	1	0.00%	57
Urban development	1	0.00%	57
Practic*	0	0.00%	58
Recycl*	0	0.00%	58
Distribut*	0	0.00%	58
Analys*	0	0.00%	58
Creati*	0	0.00%	58
Shar*	0	0.00%	58
Solv*	0	0.00%	58
Activit*	0	0.00%	58
Manufactur*	0	0.00%	58
Collaborati*	0	0.00%	58
Communit*	0	0.00%	58
Technolog*	0	0.00%	58

Word	Occurrences	Frequency	Rank
Consum*	0	0.00%	58
Universit*	0	0.00%	58
Reduc*	0	0.00%	58
Circular design	0	0.00%	58
Inclusi*	0	0.00%	58
Librar*	0	0.00%	58
Refurbish/remanufacture	0	0.00%	58

appendix 3 Details of the survey used to map the circular and maker initiatives in Europe

a3.1 Survey used at pilot city's level

Below is the English version of the survey that was translated in 6 languages and implemented locally in the 7 pilot cities (6 countries). The surveys for each city are available at the following links:

Table 17.   **List of survey links by pilot city**

City	Link to access survey by respondents
Santander	https://forms.gle/7ARBHXKz7vwAtwb29
Kaunas	https://forms.gle/oSJ7Bz2HHJT3WTCb6
Thessaloniki	https://forms.gle/hcSgA5vu4dMqQZMS9
Piraeus	https://forms.gle/vrwCaXYe7eaDtYsc6
Leuven	https://forms.gle/fanruNw9hh1Yx6jq8
Venlo	https://forms.gle/u4ASuUxtCnKxZQFKA
Istanbul	https://forms.gle/nXwS9RrjBCTgV4Tu6

a3.2 Survey used at Europe wide level

Based on the pilot city survey, a similar survey was developed to gather data on the circular maker movement at European level. The survey designed to gather data at European level is available here: https://forms.gle/VUmGoTmDQ2k6pHTT9

Database Pop-Machina

The survey takes about 15 min to complete.

The purpose of this survey is to gather comprehensive data to build an extensive database regarding the "Maker Movement" in Europe.

You are invited to participate in this research project because you have been identified as a stakeholder of the maker movement. Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. If you decide not to participate in this study or if you withdraw from participating at any time, you will not be penalized.

More info on the Pop-Machina project here: pop-machina.eu
Follow us on our social medial accounts:
Twitter: Pop_Machina
YouTube: Pop Machina Project
Facebook: @PopMachina.H2020
LinkedIn: Pop Machina

This is a research project led by KU Leuven. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 821479. The sole responsibility for the content of this survey lies with the Pop-Machina project and in no way reflects the views of the European Union.

*Required

1. Email address *

_____

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The purpose of this survey is to gather data regarding maker movement initiatives. This is a research project led by KU Leuven. The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 821479. You are invited to participate in this research project because you have been identified as a stakeholder of the maker movement.

Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. If you decide not to participate in this study or if you withdraw from participating at any time, you will not be penalized.

The procedure involves completing an online survey that will take approximately 15 minutes. Your responses concerning personal data will be confidential. While we collect identifying information such as your name and email address, only the information collected after the section 3 (regarding the maker movement and not regarding the respondent) will be public. All the information collected after section 3, will be public and open source. The survey questions will be about the maker movement initiatives.

Your information will be stored from the time when the information is collected and for a period of 7 years after the completion of the research project due to auditing requirements.

Informed consent

Please kindly read the full informed consent available here:
https://forms.gle/XefL4XnmJ6D25BMF7

If you have any questions about the research study, please contact pop-machina@kuleuven.be.

ELECTRONIC CONSENT:
Please select your choice below.
Clicking on the 'I agree' button below indicates that:
• you have read the above information
• you have read the full information regarding the GDPR accessible here:
https://forms.gle/XefL4XnmJ6D25BMF7
• you voluntarily agree to participate in the survey
• you are at least 18 years of age.

Alternatively, if you do not want to complete the survey and to do not wish to participate in the research study, please decline participation by clicking on the "I disagree" button.

2. ELECTRONIC CONSENT: Please select your choice below. Clicking on the "I agree" button below indicates that: • you have read the above information • you have read the full information regarding the GDPR accessible here: https://forms.gle/XefL4XnmJ6D25BMF7 • you voluntarily agree to participate in the survey • you are at least 18 years of age. Alternatively, if you do not want to complete the survey and to do not wish to participate in the research study, please decline participation by clicking on the "I disagree" button.

Mark only one oval.

◯ I agree

◯ I disagree

Respondent Information

Information regarding the person completing the survey.

3. Respondent name *

_____

4. Respondent email (to access the data input) *

_____

5. Respondent affiliation - where do you work/what's your link with the stakeholder

_____

Stakeholder information

Provide information on the stakeholder.
A stakeholder is a person, group or organization that has interest or concern in the Maker Movement and Circular Economy. A stakeholder represented an organization, society, etc. A stakeholder is involved with the maker movement and the circular economy. A stakeholder is affected or affects the maker movement and the circular economy

Please give details (name, weblink, contact person, telephone, etc.) of the main person in charge of this stakeholder

Stakeholder name
Name of the stakeholder part of the Maker Movement. Please DO NOT input a person' name.

6. Stakeholder name *

_____

7. Weblink - Input the link to the stakeholder website.

_____

Date of creation of the stakeholder (organisation)

Date of creation. Only the stakeholder being active during the Pop-Machina project (from June 2019 till May 2023) are included.

The stakeholder' structure can be created before or during Pop-Machina (June 2019 - June 2023), finishes during or after Pop-Machina (June 2019 - June 2023), but needs to have been at least partly in existence during the Pop-Machina duration (June 2019 - June 2023).

8. Date of creation *

    Example: 7 January 2019

9. Name of the main person responsible for the stakeholder (if different from the respondent)

10. Telephone number to reach the stakeholder or the person responsible for this stakeholder (add the country code)

11. Other contact details to reach the stakeholder (email)

Stakeholder categorization

Details on the role of the stakeholder.

•   Knowledge : public or private entities which the main role is to contribute to the enhancement and dissemination of knowledge
•   Business : all parties which are profit seeking and registered as company/enterprises - they provide goods or services (but not financial ones.)
•   Capital: parties which their main role is to provide financial support - can be either public or private entities
•   Citizen : entities which are citizen led. Their main goal is to support citizen right (social, environmental, educational, etc.)
•   Government : public institution providing administrative and infrastructure support

Please report on the type of stakeholder. Please order them by priority 1 being the main type.
[1=Totally define by this type ; 2=Main characteristics ; 3=Partially define by this type ; 4= Have some characteristics of this type ; 5=Not this type]
If several users are similarly frequent, please input the same number (e.g. Business:1; Knowledge: 2 and Citizen: 2)

12. In which stakeholder category(ies) does the stakeholder belong?

Mark only one oval per row.

	1	2	3	4	5	Not relevant
Knowledge	◯	◯	◯	◯	◯	◯
Business	◯	◯	◯	◯	◯	◯
Capital	◯	◯	◯	◯	◯	◯
Citizen	◯	◯	◯	◯	◯	◯
Government	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

Legal status

The legal status of the stakeholder as registered e.g. Limited Company, School, University, Non Governmental Organisation, Cooperative, Charity, etc.

13. Legal Status

Mark only one oval.

◯ Small Citizen association (not-registered)

◯ Local NGO/non-profit

◯ International NGO/non-profit

◯ Local governmental institutions

◯ International governmental institutions

◯ Small company (<100 employees)

◯ Big company (>100 employees)

◯ Cooperative

◯ School

◯ University (Higher Education establishment)

◯ Other: _____

Geographical info

Provide information on the location of the stakeholder

Address (if any)
Address of where the stakeholder is located

14. Address

_____

Location of the stakeholder
Please select "City Center" if the stakeholder takes place in the city center. Select "Suburban Area" if it takes place outside from the city center but still easily reachable, and select 'Rural area' for the other (harder and/or longer to reach)

15. Where is the stakeholder located? *

Tick all that apply.

☐ City centre
☐ Suburban area
☐ Rural area
Other: ☐ _____

16. Please enter the stakeholder's geographical coordinates (link to a -google- map' URL) *

_____

Scale of the stakeholder

Provide information on the size and the reach of the stakeholder

Revenue of the last known year
Please input the overall amount of money generated by the stakeholder - the revenue is the overall income or say differently gross receipts for the last known year.

17.   Stakeholder' Revenue for the last year known (in euros €)

_____

Number of employees currently employed (FTE)

Please input the total amount of Full Time Equivalent (FTE) employees working for the stakeholder. If three people are working half time for the stakeholder, the number of employees (FTE) is 1.5

18.   Number of employees currently employed (FTE)

_____

Number of volunteers involved per year (on average)

Please input the average number of volunteers involved per year for the stakeholder. If the stakeholder was active for less than a year just enter the total number of volunteers involved during the time the stakeholder was/is active.

19.   Number of volunteers involved per year

_____

Part of the Maker Movement ?

20.   Is the stakeholder of the Maker Movement? (If you are not sure click yes by
        default) *

Mark only one oval.

⬭ Yes

⬭ No   *Skip to question 49*

Scale of the initiatives

An initiative is an action, project or event which purpose is to spread information, knowledge, ideas, technics, etc. and which is taking part in the Maker movement and the Circular economy.

21. How many maker movement initiatives does the stakeholder organize? *

Mark only one oval.

◯ One main initiative   *Skip to question 25*

◯ Several initiatives of similar characteristics (same size and same topic, etc)
   Skip to question 25

◯ Multiple initiatives with different characteristics (different sizes or different topics etc.

Multiple scale stakeholder in the Maker Movement	In case the stakeholder is organizing several, varied and different initiatives part of the maker movement, please choose one initiative and complete the following questions for only one initiative. Repeat the survey for as many initiatives as you seem needed to add. If some initiatives are quite similar you can choose to combine them in one survey only.

22. Number of initiatives organized by the Maker stakeholder *

_____

23. Name of all initiatives organized by the maker stakeholder (please add weblink if available)

_____

_____

_____

_____

_____

24. Name of the initiative chosen as reference to complete this survey *

_____

Audience of the initiative

This section provides specification on the main targeted audience (visitor/users/etc) of the maker initiative;

- Knowledge : Public or private entities which the main role is to contribute to the enhancement and dissemination of knowledge
- Business : all parties which are profit seeking and registered as company/enterprises - they provide goods or services (but not financial ones.)
- Capital: parties which their main role is to provide financial support - can be either public or private entities
- Citizen : entities which are citizen led. Their main goal is to support citizen right (social, environmental, educational, etc.)
- Government : public institution providing administrative and infrastructure support

Please report on the type of user/visitor groups of the initiative. Please order them by priority 1 being the first priority.
[1=Essential ; 2=High priority ; 3=Medium priority; 4=Low priority; 5=Not a priority]
If several users are similarly frequent, please input the same number (e.g. Business:1; Knowledge: 2 and Citizen: 2)

25. Type of users/participants/visitors

Mark only one oval per row.

	1	2	3	4	5	Not participating at the initiative
Knowledge	◯	◯	◯	◯	◯	◯
Business	◯	◯	◯	◯	◯	◯
Capital	◯	◯	◯	◯	◯	◯
Citizen	◯	◯	◯	◯	◯	◯
Government	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

26. If you tick "Other" please specify

_____

Structure of the initiative

This section provides four specifications on the interactions and partnerships between the stakeholder and other actors.
Please do not input the main initiator (already reported in section 2).

Please order the following initiators by their importance for the initiatives.
[1=Essential ; 2=High priority ; 3=Medium priority; 4=Low priority; 5=Not a priority]
If several initiators have the same importance in the initiative, please input the same number (e.g. Knowledge: 1 and Capital: 1). Please input the main supporting stakeholder category as 1.

First, please report the profile of the institutions providing intangible support to the initiative which are not initiators. Those are the stakeholders providing intangible support to the initiators (but financial). They may be communication support.

Second, please report the main sources of funding.

Third, report the profile of the other institutions which supply tangible material.

Lastly, report stakeholders providing infrastructure and tools.

Reminder:
· Knowledge : Public or private entities which the main role is to contribute to the enhancement and dissemination of knowledge
· Business : all parties which are profit seeking and registered as company/enterprises - they provide goods or services (but not financial ones.)
· Capital: parties which their main role is to provide financial support - can be either public or private entities
· Citizen : entities which are citizen led. Their main goal is to support citizen right (social, environmental, educational, etc.)
· Government : public institution providing administrative and infrastructure support

27. How many stakeholders are proving intangible support to the initiators (but financial)? *

_____

28. Who are the main stakeholders proving intangible support to the initiators (but financial)?

Mark only one oval per row.

	1	2	3	4	5	Not participating in the initiative
Knowledge	○	○	○	○	○	○
Business	○	○	○	○	○	○
Capital	○	○	○	○	○	○
Citizen	○	○	○	○	○	○
Government	○	○	○	○	○	○
Other	○	○	○	○	○	○

29. If you tick "Other" please specify

_____

30. How many stakeholders are providing funding? *

_____

31. What are the main stakeholders funding sources of this initiative?

Mark only one oval per row.

	1	2	3	4	5	Not participating in the initiative
Knowledge	⬭	⬭	⬭	⬭	⬭	⬭
Business	⬭	⬭	⬭	⬭	⬭	⬭
Capital	⬭	⬭	⬭	⬭	⬭	⬭
Citizen	⬭	⬭	⬭	⬭	⬭	⬭
Government	⬭	⬭	⬭	⬭	⬭	⬭
Other	⬭	⬭	⬭	⬭	⬭	⬭

32. If you tick "Other" please specify

_____

33. How many others stakeholders are providing material supply ? *

_____

34. What are the other stakeholders providing material supply?

Mark only one oval per row.

	1	2	3	4	5	Not participating in the initiative
Knowledge	◯	◯	◯	◯	◯	◯
Business	◯	◯	◯	◯	◯	◯
Capital	◯	◯	◯	◯	◯	◯
Citizen	◯	◯	◯	◯	◯	◯
Government	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

35. If you tick "Other" please specify

_____

36. How many others stakeholders are providing infrastructures and/or tools? *

_____

37.   What are the other stakeholders providing infrastructures and/or tools?

Mark only one oval per row.

	1	2	3	4	5	Not participating in the initiative
Knowledge	◯	◯	◯	◯	◯	◯
Business	◯	◯	◯	◯	◯	◯
Capital	◯	◯	◯	◯	◯	◯
Citizen	◯	◯	◯	◯	◯	◯
Government	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

38.   If you tick "Other" please specify

_____

| Vision and strategies | Provide information on the scope (vision) of the initiative. Please order them by priority 1 being the first priority.
[1=Essential ; 2=High priority ; 3=Medium priority; 4=Low priority; 5=Not a priority]
If several visions have the same priority order, please input the same number (e.g. Social Cohesion: 1; sustainability: 2 and Urban: 2)

•   Sustainability: actions which aims at improving the environmental quality and/or avoid depleting natural resources. Sustainable actions aims at maintaining long-term ecological balance.
•   Social cohesion: enhance social connection between and within communities. Inclusion, creation and education are part of the main values. Education as it bring equal learning opportunities and creativity to gather people around a common project and thus enhance community beliefs.
•   Production : Towards improvement and change of more circular, inclusive, distribute production systems. Change in production may be either through distributed production, localized, small and/or open source way of producing. It includes concepts such as industry 4.0, distributed production, prosumerism.
•   Urban development: Depicts a strong willingness to create spatial strategies and infrastructures for cities and neighbourhoods that facilitate community enhancement; while allowing communities to improve the liveability and value of neighbourhoods. This vision also integrates urban regeneration' aspects. Examples of spatial strategy: change in land use policy to allow for more industrial activities in urban areas, physically redeveloping a neighbourhood, building infrastructure. |

39. What are the main visions/missions of the initiative (please order by priority)

Mark only one oval per row.

	1	2	3	4	Not part of the vision/mission of this initiative
Sustainability	◯	◯	◯	◯	◯
Social Cohesion	◯	◯	◯	◯	◯
Production	◯	◯	◯	◯	◯
Urban development	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯

40. If you tick "Other" please specify

_____

Strategies of the initiatives

Provide information on the strategies used by the stakeholder to reach the visions of the initiative. Please order them by priority 1 being the first priority.
[1=Essential ; 2=High priority ; 3=Medium priority; 4=Low priority; 5=Not a priority]
If several strategies have the same priority order, please input the same number

41. What are the main Strategies of the initiatives - what are the activities about (please order by priority)

Mark only one oval per row.

	1	2	3	4	5	Not part of the strategies/actions of this initiative
Make	◯	◯	◯	◯	◯	◯
Share	◯	◯	◯	◯	◯	◯
Connect	◯	◯	◯	◯	◯	◯
Learn/Educate	◯	◯	◯	◯	◯	◯
Innovate/Creativity	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯

42. If you tick "Other" please specify

_____

Activities conducted

Provide information on the content of the initiative. Please order them by priority 1 being the first priority.
[1=Essential ; 2=High priority ; 3=Medium priority; 4=Low priority; 5=Not a priority]
If several activities have the same priority order, please input the same number (e.g. Workshop: 1 and Food&Beverage: 1; Networking: 2)

Training - The initiative provides a teaching lesson. The lesson can be purely theoretical or involving some practising exercise.   E.g. how to use CAO software, how to speak english etc.

Repair activities/ facilities -The activities of the initiative focus on repairing

Workshop - The initiative provides a partical lesson with active participant/user involvment expect repairing. e.g. handwork, art, clean up, etc. the users are guided through the process

Making activities   - The initiative allows users to make and or create goods of his/her wish e.g. creating a bike, a bag, a pen holder, a etc.

Facilities rental - The initiative allows the rental of a space : a room, a garage, a open air area, a kitchen etc.

Other rental services (goods) - The initiative allows the rental of tools, goods or services: bikes, hammers, tents, seats, 3D printers, sewing machines, consultants, nursery, etc.

Sharing - The initiative provides a platform for sharing tools and services. Users can bring their goods, tools or skills to be shared and potentially use other users' skills, goods and tools.

Recycling - The activities of the initiative focus on recycling.

Advising   - The initiative provides advice to users.

Conferences/seminars - The initiative organises conferences and seminars where users can attend.

Food & beverage activities - The initiative sells or provides food and beverage goods or services e.g. cafe, restaurant, etc.

Networking - The initiative thoroughly organises social and networking activities

43. What is the main activities conducted by the initiative (order by priority)

Mark only one oval per row.

	1	2	3	4	5	6	7	8
Training	◯	◯	◯	◯	◯	◯	◯	◯
Repair activities/ facilities	◯	◯	◯	◯	◯	◯	◯	◯
Workshop	◯	◯	◯	◯	◯	◯	◯	◯
Making activities	◯	◯	◯	◯	◯	◯	◯	◯
Facilities rental	◯	◯	◯	◯	◯	◯	◯	◯
Other rental services (goods)	◯	◯	◯	◯	◯	◯	◯	◯
Sharing	◯	◯	◯	◯	◯	◯	◯	◯
Recycling	◯	◯	◯	◯	◯	◯	◯	◯
Advising	◯	◯	◯	◯	◯	◯	◯	◯
Conferences/seminars	◯	◯	◯	◯	◯	◯	◯	◯
Food & beverage activities	◯	◯	◯	◯	◯	◯	◯	◯
Networking	◯	◯	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯	◯	◯

44. If you tick "Other" please specify

_____

Continuance and occurrence of the activities

First complete the usual occurrence of initiative.
Then complete the number of time the initiatives has taken place.
In case the initiative is a one-off event or a Event series, please input the number of time the initiative has occurred (e.g. 3 week-ends, 4 times, etc.).
Else input for how long the initiative runs (e.g. 2 years, 6 months, etc.)

45. Continuance of the initiative

Tick all that apply.

☐ Determined duration
☐ Undetermined duration
☐ One-off event
☐ Event series
Other: ☐ _____

46. Enter the number of time the activities has taken place/or for how long it is ongoing

_____

Mobile/fixed location

Please select "Mobile location" if the initiative is changing location each time e.g. a repair cafe which happens every Sunday in a different cafe.
Please select "Fixed location" if the initiative always takes place in the same location e.g. a workshop always happening in the same university.

47. Mobile/fixed location

Tick all that apply.

☐ Mobile
☐ Fixed
Other: ☐ _____

Type of location

Please input the type of location (building/space) where the initiative is occurring. If the type is not in the list choose 'other' and details what other means in the category: 'Other description regarding the activities conducted by the maker movement initiatives'

48. Type of location

Tick all that apply.

☐ Private house
☐ Private storage e.g. garage
☐ Private outdoor area
☐ Public building
☐ Public outdoor area
☐ Commercial building e.g. restaurant,
Other: ☐ _____

Part of the Circular Economy?

49. Is the stakeholder part of the circular economy? *

Mark only one oval.

◯ Yes
◯ No   *Skip to question 52*

Scope in Circular Economy	Provide information on the circular strategies which are targeted by the stakeholder. Please order them by priority 1 being the first priority strategy. [1=Essential ; 2=High priority ; 3=Medium priority; 4=Low priority; 5=Not a priority] If several strategies have the same priority order, please input the same number

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50. What are the main circular strategies of the stakeholder - what are the activities about (please order by priority)

Mark only one oval per row.

	1	2	3	4	5	6	7	Not part of strategies/ac of this initia
Redesign	○	○	○	○	○	○	○	○
Reduce	○	○	○	○	○	○	○	○
Share / Maintain	○	○	○	○	○	○	○	○
Reuse / redistribute	○	○	○	○	○	○	○	○
Refurbish / remanufacture	○	○	○	○	○	○	○	○
Recycle	○	○	○	○	○	○	○	○
Resource and Waste management	○	○	○	○	○	○	○	○
Other	○	○	○	○	○	○	○	○

51. If you tick "Other" please specify

_____

Additional information

52.   Please add here any details and information that might be relevant for the project.

_____

_____

_____

_____

Thanks a lot for taking time to complete the survey!

Pop-Machina aims to combine the maker movement and collaborative production with circular economy, demonstrating the value of circular maker ecosystems for integrated urban planning and development in the EU.

Follow us on our social medial accounts:
Twitter: Pop_Machina
YouTube: Pop Machina Project
Facebook: @PopMachina.H2020
LinkedIn: Pop Machina

More info on the Pop-Machina project here: pop-machina.eu

Shall you need any further information, please contact pop-machina@kuleuven.be.

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Google Forms

appendix 4 Guidance for city and city supporting partners regarding the survey

The following sections present the guidance provided to the pilot cities and their supporting partners followed by the survey itself. The guidance book shared with the cities was composed of three sections explaining the role and deadline of the survey, the respondents targeted by the survey and the methodology and tool allowing their identification and a set of definition. These three elements are presented below.

a4.1 Guidance

The survey was the main tool used for the completion of a circular maker movement database. This database gathers all the maker stakeholders and initiatives harvest from the seven pilot cities in Pop-Machina.

The database enables to analyse the structures, stakeholders, visions, strategies and interactions of maker movement initiatives. The different categories of the database support the mapping, the creation of the passport and the systematic patterns in the maker movement initiatives. The features understanding of the stakeholders' motivation, perception and needs. The patterns will acknowledge the correlation between the maker movement impacts and some systematic features of the maker stakeholders and of their initiatives. The analysis will enable the identification and the evaluation of the maker impacts towards circular economy policy and awareness.

The **stakeholders and initiatives need to be part of the maker movement, as confirmed by the application of the flowchart, and having existed during the Pop-Machina project** (from June 2019-June 2023). The stakeholder and initiatives can be created before or during Pop-Machina, finished during or after Pop-Machina, but needs to have been at least partly in existence during the Pop-Machina duration.

Cities and their supporting partners are in charge of the good completion of the survey. The cities have to ensure that the survey is completed as at least:
- **80% of their list of stakeholders** (to be provided);
- **80% average of question** with the 13 following questions being **compulsory 6; 8;12;16;20;25; 28;31;34;37;39;41;50**.

The deadline for this survey' completion is **December 30, 2019**.

04.2 Flowchart

Is the initiative part of the supply chain of "making"? — 2 / Yes 1

Is the initiative organized by a cooperative or a non-profit or a NGO (Citizen) or a governemental institution or a school or academic institution (Knowledge)? — 5 / Yes 3

Is the initiative profit-oriented? — Is the initiative

Does the initiative have a strong local/social /educational/ environmental vision? — 7

No — No — 6 — 4

8

Not part of the Maker Movement

Is the initiative enhancing community involvement? — 9 / 10

Is the intiative enhancing community networking? — 11 / 12

Does the initiative engage people? — 13 / 14

Is the initiative enhancing people's skills? — 15 / 16

Is the initiative tackling any environmental or social isssue? — 17 / 18

Is the initiative part of the collaborative economy? — 27 / 28

Does the initiative address environmental concerns? — 25 / 26

Does the initiative address social inclusion? — 23 / 24

Does the initiative allow the sharing of resources (tangible or not)? — 21 / 22

Does the initiative allow the open access of resources (tangible or not)? — 20 / 19

Part of the Maker Movement

Does the initiative reduce waste and resource consumption? — 32 / 31

Does the initiative integrate the concept of circular design of a product or component? — 30 / 29

Does the initiative maintain resource value? — 36 / 35

Does the initiative share resources? — 34 / 33

Does the initiative redistribute resources? — 40 / 39

Does the initiative reuse resources? — 38 / 37

Does the initiative refurbish or remanufacture products? — 42 / 41

Does the initiative contribute to the product or component life extension? — 44 / 43

Does the initiative contribute to the recycling of products or components? — 46 / 45

Part of the Circular Maker Movement

Only part of the Maker Movement

04.3 Definition

Element	Definition
Initiative	An action, project or event which purpose is to spread information, knowledge, ideas, technics, and which is taking part in the maker movement and the circular economy.
Stakeholder	A person, group or organisation that has interest or concern in the maker movement and circular economy. A stakeholder represented an organisation, society, etc. A stakeholder is involved with the maker movement and the circular economy. A stakeholder is affected or affects the maker movement and the circular economy. E.g., associations, research centres, or governments, among others.

appendix 5 Details of the mapping exercise and of the circular maker passports

05.1   Map of all circular maker initiatives of Pop-Machina reported in the survey

Figure 35.   European map gathering all circular maker initiatives of Pop-Machina

05.2   Template of the circular maker initiatives for Istanbul and displayed as passports

Figure 36.   **Template of the circular maker initiatives as displayed in the future online platform**
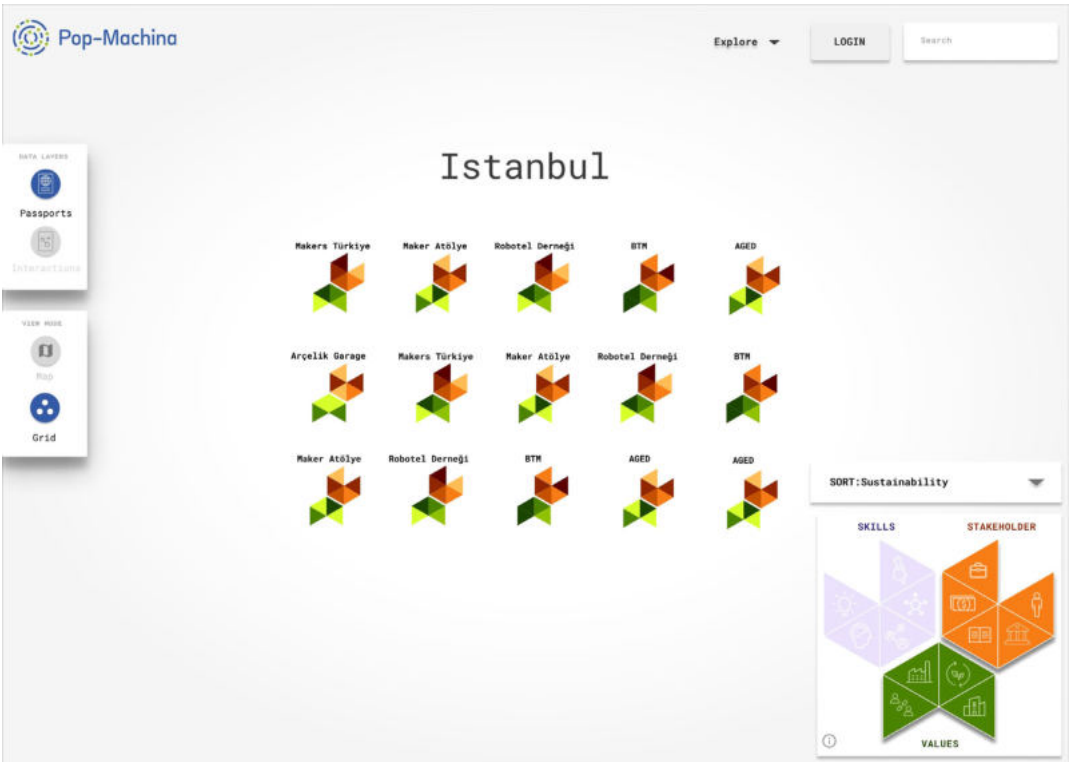
0.6.2 **Circular maker passports of all the Pop-Machina MMI surveyed** *(also available here:* https://docdro.id/xZyFO9x*)*

Figure 37. Circular maker passports of Kaunas, Venlo and Santander

Figure 38.   Circular maker passports of Thessaloniki, Piraeus and Istanbul
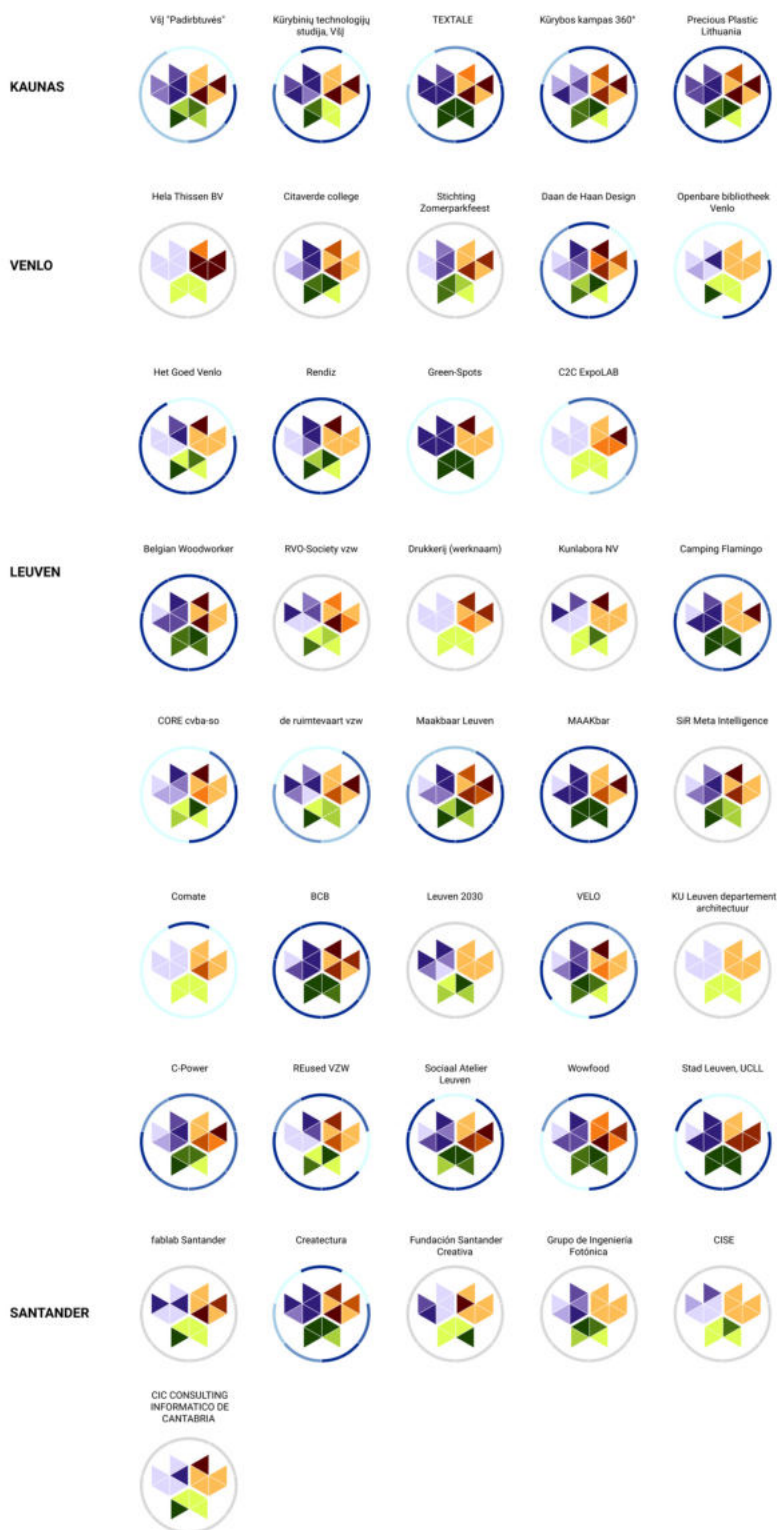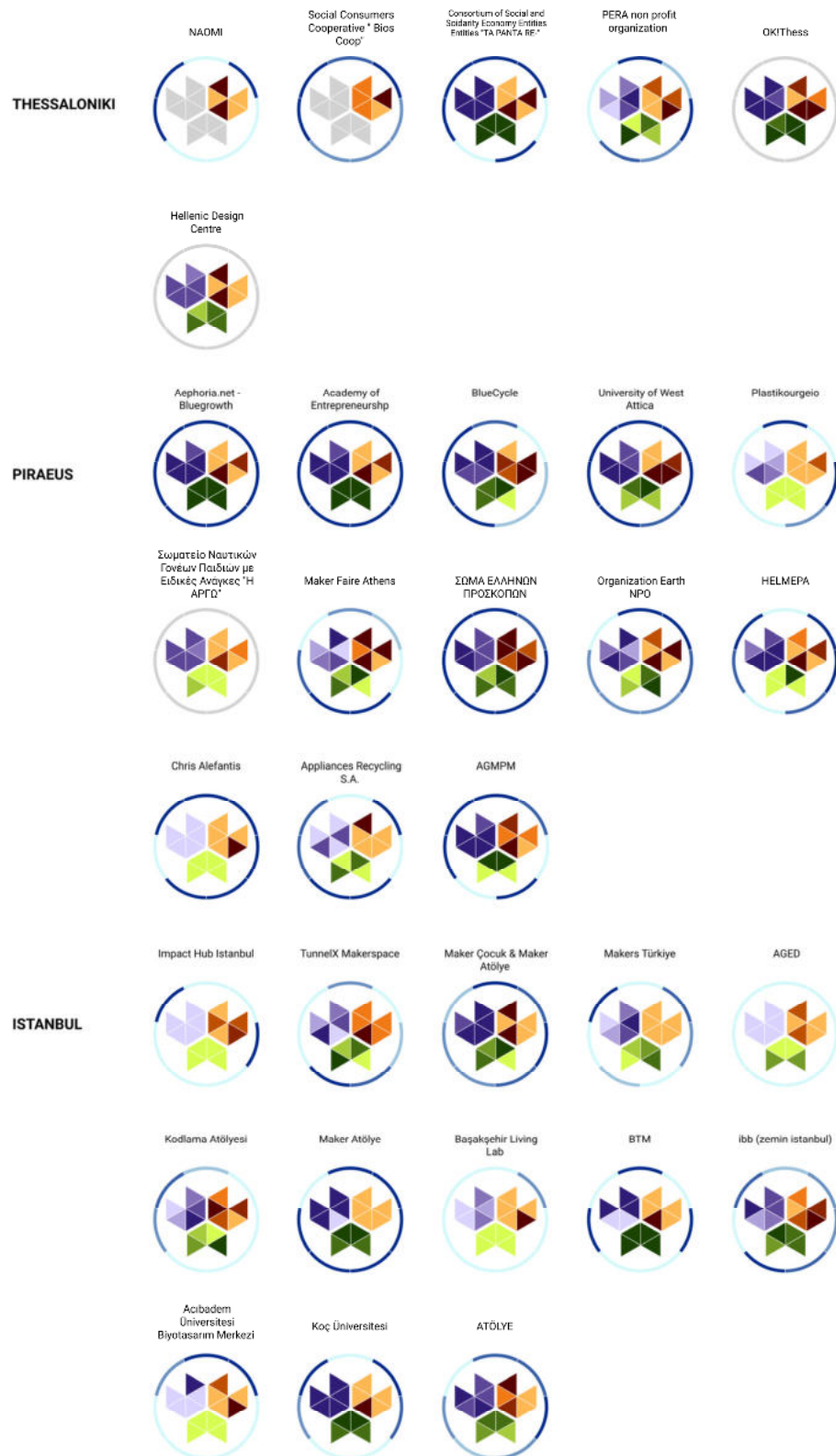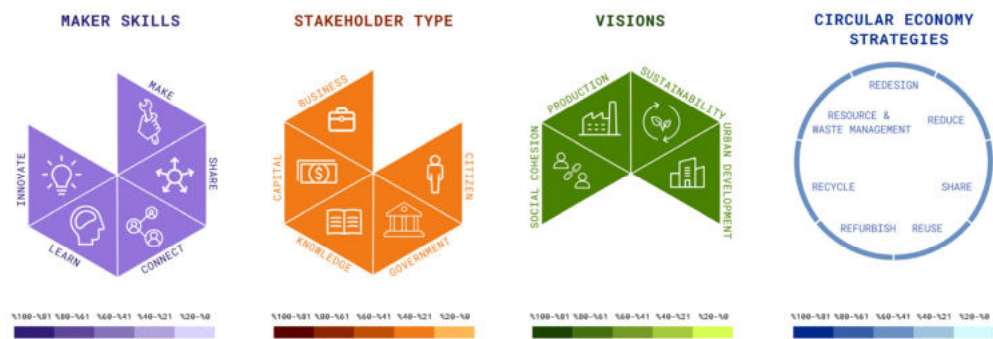
Figure 39.   Legend of the Figures 28 and 29

6.5.4 Template of the detailed storyboard of a circular maker initiative

Figure 40. Template of the detailed storyboard of a circular maker initiative as displayed in the future online platform

appendix 6 Methods used to build the indicators, the circular maker passport and the synergies between maker and circular strategies

A6.1 Method to build the indicators (see Section 4.3)

To construct the indicators, each pilot cities city was asked to complete socio-demographic and waste related information and similar data was collected at European level. The data formed sub-indicators which were classified into four categories of indicator, namely, 1) 'maker' to capture the level of development of the maker movement, 2) 'circular' related to the circular economy development, 3) 'inclusion' to appreciate the social inclusion level and 4) 'sector' to delineate the major economic branches of attraction of each pilot city. Table 18 summarises all sub-indicators and their weight for each indicator. For each of the four indicator categories, the sub-indicators were assigned weighted (positive or negative) to build the final indicators calculated following equation (Eq. 1). Each pilot city indicator is normalised with respect to the Pop-Machina average indicator.

$$Normed\ indicator_j\ in\ pilot_c$$
$$= \sum_i \frac{sub_{indicator_i} in\ pilot_c * weight_i}{\sum_{c=\{1;7\}}(sub\_indicator_i\ in\ pilot_c * weight_i)} \qquad \text{Eq. 1}$$

Table 18.   **Indicators and their weights**

Indicator	Sub-indicators	Weight
Maker	Number of fablabs in the country	1
	Number of makerspaces per country	1
	Number of MMIs per city	1
Circular	Recycling rate of municipal solid waste	1
	Recycling rate of industrial/company waste	1
	Recycling rate of construction waste	1
	Amount of total household waste/pop	-0.25
	Total recycling rate	1
	EU circular indicator	1
Inclusion	Share of employed people	3
	Share of women employed	3
	Share of elderly (>65 yo)	2
	Share of single parents households	2
	Share of immigrants	1
Sector	1sr sector	1
	2nd sector	2
	3rd sector	2.5
	4th high tech	3
	Graduates	2
	Post graduates	3

06.2   Method to build the circular maker passport (see Section 5.4)

The MMI database was used to construct the circular maker passport at city and at initiative levels.

For each circular maker characteristic (namely, vision, stakeholders, and strategies), the average score for each initiative of each pilot was calculated from the results provided by the survey and reported in the MMI database. When the scale was from 1 to 5, the score 1 was converted to 100%, the score 2 equals 75%, 3 50%, 4 25% and 5 or not score hold for 0%.

For each of the circular maker movement characteristics, the marginal average of the city was taken over the average for Pop-Machina. The marginal average allows a normalisation of the results to be able to compare the seven pilot cities. The average score in each city for each category was calculated based on the following equation (Eq. 2):

$$
Normed\ \%\ category_j\ in\ pilot_c = \\
\frac{\%\ category_j\ in\ pilot_c * \dfrac{nber\ of\ inititiaves\ in\ pilot_c}{nber\ of\ initiatives\ in\ the\ 7\ pilots}}{\sum_{i=\{1;7\}}\left(\%\ category_j\ in\ pilot_c * \dfrac{nber\ of\ inititiaves\ in\ pilot_c}{nber\ of\ initiatives\ in\ the\ 7\ pilots}\right)}
$$

Eq. 2

16.3 Method to build the synergies between maker and circular strategies (see Section 6)

The MMI database was used to build the matrices representing the synergies between the maker and the circular strategies. For each maker (respectively circular) strategy, every initiative with a score above average (the scores 1 and 2 for the maker strategies and 1 to 3 for the circular strategies) were extracted and the corresponding scores for the circular (maker) strategies were normalised. For the normalisation, the sum of the total score for each circular (maker) strategy was taken and divided by the theoretical optimal score for this specific strategy. The score was then converted to a percentage. The process was reiterated 70 times (for the five maker strategies with regard to the seven circular strategies and reciprocally).

appendix 7 Details of the interviews conducted

From September 2019 to May 2020, a series of in-depth interviews to gather experts' knowledge on the circular maker movement was conducted. In most of the cases, the questionnaire was sent to the interviewee, and was followed by an interview. The interview lasted between 30 minutes and more than an hour depending on the interviewee availability. Interviews took mostly place by phone and were all conducted by Julie Metta. The list of questions is available in the Section a7.1 below. The Section a7.2 reports the profiles of the experts interviewed.

a7.1 Questions for maker initiators/specialists
1. How would you quickly define the maker movement?
2. Does a typology of the maker movement exist?
   a. which different initiatives types exist?
   b. what are their characteristics?
3. Else, what are the characteristic needed to be considered as part of the movement?
4. To be part of the maker movement, does the initiative need to 'Make (build physically)' something? (e.g. is a company recruiting disabled people to sort and sell second hand goods part of maker movement?)
5. What are the main strategies of the maker movement?
6. What are the vision/mission of the maker movement?
7. What are the success reasons of the maker movement?
8. What are the failure reasons of the maker movement?
9. Can makers be professionals or should they be amateurs? Where is the border between amateurs, makers and professionals (if there is one)?
10. Why does the maker movement attract people?
11. Why does the maker movement attract companies?
12. How should the maker movement be financed?
13. Can maker initiatives be purely profit seeking?
14. Do you know any maker initiative (Fablab) that is profit seeking?
15. Do you know/are there financial institutions specialised in investments towards Maker Initiatives?
16. Do you know companies which have invest in Maker Initiatives?
17. Do you know maker initiatives which were financed by big companies as an investment strategy?
18. Do you have/know of an inventory of maker movement initiatives in the circular economy?
19. Is there any individual or institution you recommend to be interviewed for this purpose?

a7.2 Interviewees' details
1. Lucas van Beers, Maker in Leuven
2. Salim Deeb, Co-Founder and secretary of MakerSpace Bonn e.V.
3. Desmoulins Mickaël, Intrapreneurship and Open Innovation Ecosystems Expert at Renault
4. Mathilde Berchon, Founder at FuturFab & Ambassador Women in 3D Printing

5. Gaëlle Kikteff, Project manager for circular economy & Design, previously Training responsible for Villette Makerz and project manager Reflow
6. Vivien Roussel, Manager and maker chez Makerspace de l'École des Ponts ParisTech
7. Jordi Ros-Giralt, founder and president of Labdoo.org
8. Romain Chanut, Co-founder at Social Media Squad & Jerry CanDoIT
9. Alessandra Schmidt, coordinator of IAAC
10. Demian Wismer, Creator and manager of the Belgium Labdoo.org hub
11. Finlay Degrauwe, Maker in Leuven
12. Cesar Jung-Harada, Director MakerBay & Scoutbots
13. Massimo Menichinelli, Research Fellow at RMIT Europe
14. Bas van Abel, Founder Fairphone, Co-founder De Clique
15. Xavier Auffret, Designer, Cofondateur de l'Atelier Universel
16. Angel Urueña De Castro, Maker in Leuven
17. Samuel Remy, CEO Villette Makerz
18. Nicolas Bard, co-foundor of MakeIci (ICIMontreuil)

appendix 8 Database MMI

All non-private data collected and extracted from the survey (see Section 5.1) are available online. The MMI database can be found at: https://docdro.id/x6f08Yd

appendix 9 Drafts of the passport concept

The original conceptual draft of the circular maker passport at initiative, city and European levels are reported below as reference to illustrate the evolution of the design.

Figure 41.   **The initial concept of the passports at different levels. From top-left: European level, bottom-left: city level, right side: circular maker passport**

appendix 10 Key performance indicators management plan

a10.1 List of KPIs mentioned in the grant agreement to be covered by WP2

KPI-9. Urban metabolism and productive systems analysed and optimised based on the project outcomes: 7

KPI-10. Socio-economic contexts analysed and optimised based on project outcomes: 7

KPI-11. Spatial urban structures (city and/or neighbourhood level) analysed and optimised based on project outcomes: at least 7

KPI-12. Legislative, governance and taxation contexts analysed and optimised based on the project outcomes: 7

KPI-21. Remodelled buildings and/or open spaces: > 7

a10.2 List of KPIs addressed in this deliverable 2.1

a10.2.1 KPI-9. Urban metabolism and productive systems analysed and optimised based on the project outcomes: 7

This KPI also concerns T2.2;[19] T2.4; T2.5; T5.2; T5.3; T5.4; T6.1; T6.2; T6.3; T6.4

The deliverable partially achieves this KPI through four ways.

First, the creation of a city passport for each pilot highlights the urban metabolism and ecosystem of the maker movement in each pilot city. Second, a dedicated analysis of the maker movement initiatives in each pilot city is reported based on the survey conducted at maker movement initiative level. Third, the analysis enables the identification of patterns which define the maker movement in each pilot. Finally, the 7 analyses of the patterns enable to draw policy recommendations on possible optimisation of the maker movement ecosystems in Europe.

a10.2.2 KPI-10. Socio-economic contexts analysed and optimised based on project outcomes: 7

This KPI also concerns T2.2; T2.4; T2.5; T5.2; T5.3; T5.4; T6.1; T6.2; T6.3; T6.4

This KPI is partially completed by T2.1 in two ways. First, D2.1 includes different socio-economic indicators of each pilot city such as recycling indicators. Second, the patterns and policy recommendations identified allow the characterisation and optimisation of the maker movement ecosystem in Europe.

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19 T holds for task.

a10.2.3 KPI-11. Spatial urban structures (city and/or neighbourhood level) analysed and optimised based on project outcomes: at least 7

This KPI also concerns T2.3; T3.1; T5.1; T5.2; T5.3; T5.4; T6.1; T6.2; T6.3; T6.4

This KPI is partially completed by T2.1. The 7 maps created from the survey at initiative level for each pilot city enables to complete this KPI by highlighting the repartition and the distribution of the maker movement initiatives in each pilot city. The maps also enable the visualisation of the distribution of the initiatives by skills, visions and stakeholders of interested.

a10.3 List of KPIs not addressed by D2.1 and details

a10.3.1 KPI-12. Legislative, governance and taxation contexts analysed and optimised based on the project outcomes: 7

This KPI does not concern T2.1 but rather concerns T2.2; T2.4; T2.5; T5.2; T5.3; T5.4; T6.1; T6.2; T6.3; T6.4, and in particular **T2.2; T2.4; T5.2; T5.4; T6.4**

a10.3.2 KPI-21. Remodelled buildings and/or open spaces: >7

This KPI does not concern T2.1 but rather concerns other Tasks, such as T2.3; T3.1; T5.1.

About Pop-Machina

Pop-Machina aims to demonstrate the power and potential of the maker movement and collaborative production for the EU circular economy. We draw from a number of cut-edge technologies (factory-of-the-future, blockchain) and disciplines (urban planning, architecture) to provide the support necessary to overcome scaling issues; a typical drawback of collaborative production; to find the areas more in need of our intervention and to reconfigure unused spaces. We put forth an elaborate community engagement programme to network, incentivise and stimulate through maker fairs and events existing and new maker communities in all our municipalities. We build upon the current informal curriculum for maker skills development by nurturing the social side and we put educators and makers together to exchange ideas on the training modalities. A particular focus on the skill development of women and vulnerable groups will aim to empower these (underrepresented) segments to partake actively in collaborative production. In every pilot area we will demonstrate business oriented collaborative production of feasible and sustainable concepts from secondary raw material or other sustainable inputs, based on the needs and preferences of the local stakeholders. A thorough impact assessment framework with increased scope (e.g. social) will be codesigned with stakeholders after short basic assessment trainings and will be used in the assessment of our pilot work. Based on the findings we will kick-start a series of policy events to discuss openly – without pushing our results – the tax and legal barriers that hamper collaborative production.

Partners

KU Leuven (coordinator): HIVA - Research Institute for Work and Society and BEE - Behavioural Engineering Research Group
City of Leuven (BE)

ETAM (GR)
Municipality of Thessaloniki (GR)
Municipality of Piraeus (GR)
Q-PLAN INTERNATIONAL (GR)
University of Macedonia (GR)
Ayuntamiento de Santander (ES)
Universidad de Cantabria (ES)
Gemeente Venlo, KanDoen (NL)
TU Delft (NL)
Istanbul Metropolitan University (TR)
İSTAÇ AŞ (TR)
Planet Turkey (TR)
Koç University (TR)
Municipality of Kaunas (LT)
ISM University of Management and Economics (LT)
University of Cambridge (UK)
CERTH (GR)
White Research (BE)
CommonLawgic (GR)
INTRASOFT International (LU)
Institute for Advanced Architecture of Catalonia (IAAC) (ES)