Constellation of Innovation Laboratories: A Scientific Outlook

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***Abstract*— Digital transformation and technology democratization are demanding new organisational structures led by trust, transparency and openness. For some years now, innovation laboratories have been embraced as unique and enabling environments acting as facilitators for the evolution of our communities, business and territories. However, as they are being embodied under different names and shaped by their context, they also seem to operate freely under multiple-related innovation approaches. This is leading to a grey-zone within the universe of innovation laboratories, making them difficult to study and manage. In this paper, Innovation laboratories are studied as innovation intermediaries that fulfil the purpose of creating communities of knowledge imbued with values of sharing and collaborating towards a common objective or project. Through a bibliometric study, a scientific outlook for the constellation of Innovation laboratories is built. Research affinities and distinctions between the most common concepts often related to these innovation intermediaries are discussed. And lastly, the grounds for a research agenda on the strategic management and assessment of this phenomenon are set.**

Keywords*— *innovation labs, bibliometric analysis, innovation intermediaries, strategic management

I. Introduction

Significant changes in our society are being introduced by the fourth industrial revolution. Digital transformation and technology democratization are enabling the creation of new business models that lead to new ways to connect, share and monetize almost everything. Likewise, values such as trust, transparency and openness are becoming more and more present at all socio-economic instances by means of modern collaboration. These are just some of the characteristics of this transformative moment we are living on and which challenges the traditional foundations of our society [1]. Precisely, it is through the emergence of new organisational structures the way we can bring out our collective responsibility to lead the evolution of our communities, business and territories [2].

For some years now, organisational structures to foster innovation processes through unique designed environments, creative and inspiring cultures, and high-tech equipped, have emerged all around the world. These type of innovation intermediaries also known as Innovation Laboratories are considered as semi-autonomous organizations within real complex contexts [3] allowing all related actors to interact under a "somewhere else feeling" -away from everyday problems- [4] with the purpose of creating communities of knowledge, strengthening people's innovative and technological competences and imbuing values of sharing and collaboration towards a common objective or project [5].

Innovation labs are embodied in different ways as they are shaped by their local context including their team experiences and their partners' interests [2]. Each one of them differs from their configuration, the practices they perform and the outcomes they achieve [6]. This leads to a fuzzy distinction among other well-known innovation-friendly structures (or labels) such as Living Labs, FabLabs, Makerspaces, Hackerspaces, Enabling spaces, Innovation spaces, Coworking spaces or even Third-places. Evidence has shown that innovation laboratories perform analogously to all these innovation intermediaries [7], making it more difficult to notice the boundaries among all these concepts. Whereas this grey-zone allows managers to freely operate under multiple-related innovation approaches, it seems that at the same time they are struggling to clearly define a strategic intention for their own laboratory [8].

In that sense, the phenomenon of innovation laboratories has captivated the attention of multiple scholars' communities, increasing the research efforts during the last decade [7], [9]–[12]. Given the recent nature of this issue, most research publications are exploratory with empirical results and qualitative analysis. Thus, we have noticed these contributions come from communities' experiences dealing with their own innovation laboratory (or innovation laboratories' network) sharing their own practices, insights and challenges according to their own context. This motivated us to conduct a bibliometric analysis on the literature of innovation laboratories looking for connections, proximities and trends between the most common concepts of these innovation intermediaries.

Our goal with this paper is to provide a scientific outlook on the constellation of innovation laboratories. This is done by presenting insights on where research efforts have been concentrated during last years, which concepts are more positioned among researchers, how they have related to each other and finally, which opportunities we identified towards the consolidation of a research agenda in the strategic management of innovation laboratories. The remainder of this document is structured as follows. First, an overview of the innovation intermediaries' structures is given. Then, the methodological approach is explained including the research parameters and criteria selection. Afterwards, results and analysis are discussed leading finally, to our conclusion

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remarking implications, limitations and following steps on this research.

II. Existing Theories and Previous Work

The challenges often posed by the uncertainty and complexity of innovation processes have led to the creation, consolidation and general recognition of innovation intermediaries. Such organisations have historically been used to denote a number of actors such as brokers, third parties or agencies, as a way of bringing together all the entities that support the innovation process [13]. Over time, this perception has evolved from mere supporters, to "animateurs" (or facilitators) and even to be considered carriers of innovation [13], [14]. However, in general terms, innovation intermediaries are recognised for seeking to improve innovation capacity. This is usually done through inter-organizational networking, technology development and financing activities that are meant to reduce the innovation gap between actors and innovation ecosystems [15].

A group of innovation intermediaries that are receiving increasing attention are the innovation laboratories. In the past, from the point of view of intermediaries, laboratories were considered chambers or test beds whose main objectives were testing, validation and training [13]. Nowadays, as new paradigms transform the way innovation is carried out, so the notion of laboratories as "mediators" of innovation has evolved to become active agents during the development phase of an innovation project [14]. From then on, a whole set of innovation laboratories under different concepts and catchy labels have started to emerge all around the world.

As in this paper, we seek to better understand the research connections between the universe of innovation laboratories, it is important to first make a general review on some of the most influential concepts. Starting with Living Lab, it is the broadest and most developed concept in the literature. This notion of laboratory is defined as the place in which all stakeholders from public-private-people partnerships collaborate to create, prototype, validate and test new technologies, products, services or systems in real-life contexts [16].

Alongside this are the spaces where sophisticated manufacturing technologies are available to non-specialists. FabLabs are also a very popular concept (and label) worldwide. Inspired by the maker movement, they are conceived as the cultural seedbed for sharing knowledge, experimenting with new technologies and exploring interdisciplinary projects while at the same time achieving personal achievement and enjoyment [17]. Closely related are the Makerspaces, which are defined as community workshops where members (known as makers) share access to tools for professional benefit and hobbyist pursuits [18]. In the same way, Hackerspaces appears as a place with a spirit of equality, non-profit and open, where people share tools and ideas with a strong emphasis on digital technologies [19]. As FabLab, Makerspace and Hackerspace are strongly influenced by the maker movement, they are frequently understood as the same kind of space.

The Third-place concept is also recently being used as a term associated with innovation, although this is not a new concept at all. Third places are usually described as social settings separated from the first place (home) and second place (workplace). In addition, they are given some characteristics as anchors of community life and promoters of creative interactions [20]. When these elements are compared to other innovative spaces is easy to see the similarities. That is the case of the Coworking spaces which are envisaged as the places for the "third way" of working, halfway between the well-delimited traditional workplace and independent working life as a freelancer, where the worker stays at home in an isolated way. This third way is known as 'coworking' to indicate the practice of working individually in a shared environment [21].

Moving forward, in the literature exists the notion of Enabling space, which addresses the mediation role in the innovation of such spaces as enabling rather than controlling. In this respect, innovation processes are seen as the creation of knowledge and hence, enabling spaces are conceived as multidimensional, in which social, cognitive, cultural, technological and other factors are considered [22]. Similarly, the concept of Innovation space has been used as an attempt of bringing together the main characteristics of the favourable spaces for innovation. Thus, they have been defined as physical environments that promote community, learning and making, providing opportunities to engage people and technologies, experience participatory culture and acquire modern skills [23]. However, the Innovation space concept seems to go further and is used as much as in the overarching context in which knowledge creation occurs [24], as well as a knowledge-based urban development strategy [25].

Besides the plethora of definitions, there is one common aspect that all these types of innovation laboratories share. As innovation intermediaries they all face the challenge of their impact may not be directly perceived due to their "intermediate" nature [13]. More attention, therefore, needs to be paid to observing the effects they have on their context, community and partners.

III. Methodological Design

Since the proliferation of these particular set of innovation intermediaries, it could be difficult to distinguish the differences between the concepts under so many laboratories are covered. Often, it is possible to see among researchers that they refer to them indistinctly as a group of similar innovation structures and practitioners seem to use them interchangeably. Even though we showed that literature provides specific concepts for each one of them, we believe that a broader view of the scientific outlook around the ensemble of innovation laboratories could be useful for establishing further paths of research.

In that sense, we felt motivated to perform a bibliometric content analysis as this method helps to discover up-and-coming fields as well as identifying trends in the observation of extended periods [26]. This approach favours the theorising phase during research, since mapping the literature works as a brainstorming stimulus, bringing out the researcher's assumptions to the surface. In addition, if these assumptions are followed by a bibliography discussion by means of selection processes, code structures and concepts' representations, then the accuracy of these representations is increased [27]. Also, this process can be supported by technology. In this case, a search strategy was executed using the Scopus database. Then, the literature mapping was supported by VOSviewer and finally, content analysis was performed using NVIVO. This process is explained below.

This search strategy was defined by a set of keywords, representing the most common concepts that are used

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referring to innovation laboratories or spaces according to our experience. Then, as preliminary searches were done, the observation window was defined from 2000 to 2018. Finally, title and keywords were the search fields selected as well as only articles and conferences papers. The strategy employed is summarised in TABLE I.

TABLE I. SEARCH SPECIFICATION

Specifications	Description
Keywords	"innovation laboratory" OR "innovation lab" OR "innovation space" OR "enabling space" OR "living lab" OR "fablab" OR "fab lab" OR "makerspace" OR "hackerspace" OR "coworking space" OR "third place"
Source	Scopus
Search fields	Title & Keywords
Data range	2000 - 2018
Document type	Article or Conference Paper

Afterwards, data visualization and analysis were performed under 2 stages. First, results from Scopus are exported in a CSV file in order to harvest all the keywords from the articles and papers retrieved. Then, the data is uploaded to VOSviewer software, where keywords can be mapped and clustered as a way to visualize how structures or concepts are composed by means of co-occurrence analysis [26], [28].

At the second stage, aiming to provide a more detailed content analysis, a sample of most recent articles is imported to NVIVO software. There, titles, abstracts and keywords are analysed by a coding process where key issues can be identified and classified. The synthesized process is shown in Fig. 1.

IV. FINDINGS

As a result of applying the search strategy described before, 1307 publications were retrieved from the Scopus database. In Fig. 2 it is possible to observe the increasing interest among scholars in this phenomenon during the last years. In any case, it is not until 2005 that a real growth begins to become visible, reaching 198 publications by 2016.

From a general perspective, it is worth to remark that around 58% of the publications are conference papers while the rest correspond to journal articles. Additionally, Computer Science, Social Sciences, Engineering, Business and Mathematics are the five main disciplines more actively involved within our search topics. Likewise, the countries that are publishing the most are United States, Germany, Italy, France and United Kingdom accounting 644 papers during the range established.

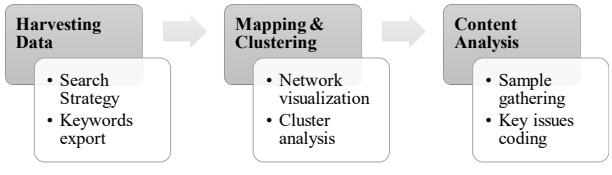

Fig. 1. Methodological design

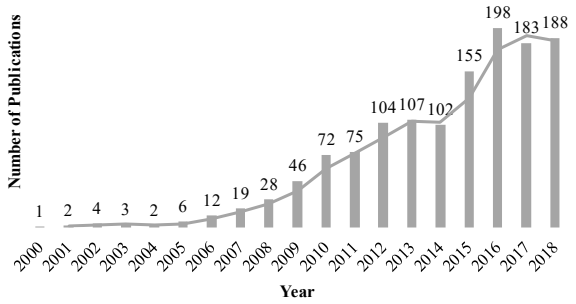

Fig. 2. Scientific publications per year

A. Network Visualization

TABLE II. shows the conditional specification defined for network construction. The total of 1307 references retrieved from Scopus was uploaded to VOSviewer as bibliographical data. The co-occurrence type of analysis was selected based on the authors' keywords as a unit of analysis. Additionally, the full counting method was chosen in order to maintain the full weight of keywords [29]. Due to variations among the way scholars have labelled some concepts, a data cleaning process was necessary to merge different variants of keywords for the same concept, e.g. *innovation laboratory, innovation labs, innovation lab*. Thus, a thesaurus file was created which was included in the conditions. Finally, the minimum number of occurrences was set at 8 ensuring that we could observe all the keywords included in the search equation. In this case, enabling space was the one with the lowest number of occurrences.

The network visualization is shown in Fig. 3. The circles are a representation of the number of occurrences of each keyword. The higher the number of keywords, the larger the label and the circle of each item. The distance between two keywords indicates their relatedness in terms of co-occurrence links. In general terms, the closer two keywords are located to each other, the stronger their relatedness is.

TABLE II. CO-OCCURRENCE ANALYSIS PARAMETERS

Specification	Condition
Total of documents	1307
Total of keywords	3240
Counting method	Full counting
Thesaurus	Yes
Minimum occurrences	8
Keywords meeting threshold	55

B. Cluster Analysis

The colours in Fig. 3. show the cluster to which the keywords belong. Clusters that are located near to each other indicate closely related fields. For this case, eight clusters were created as a result of the co-occurrence analysis. As can be seen in the map, Clusters 1 (red) and 2 (green) are the largest while the rest of them are located around them. Here

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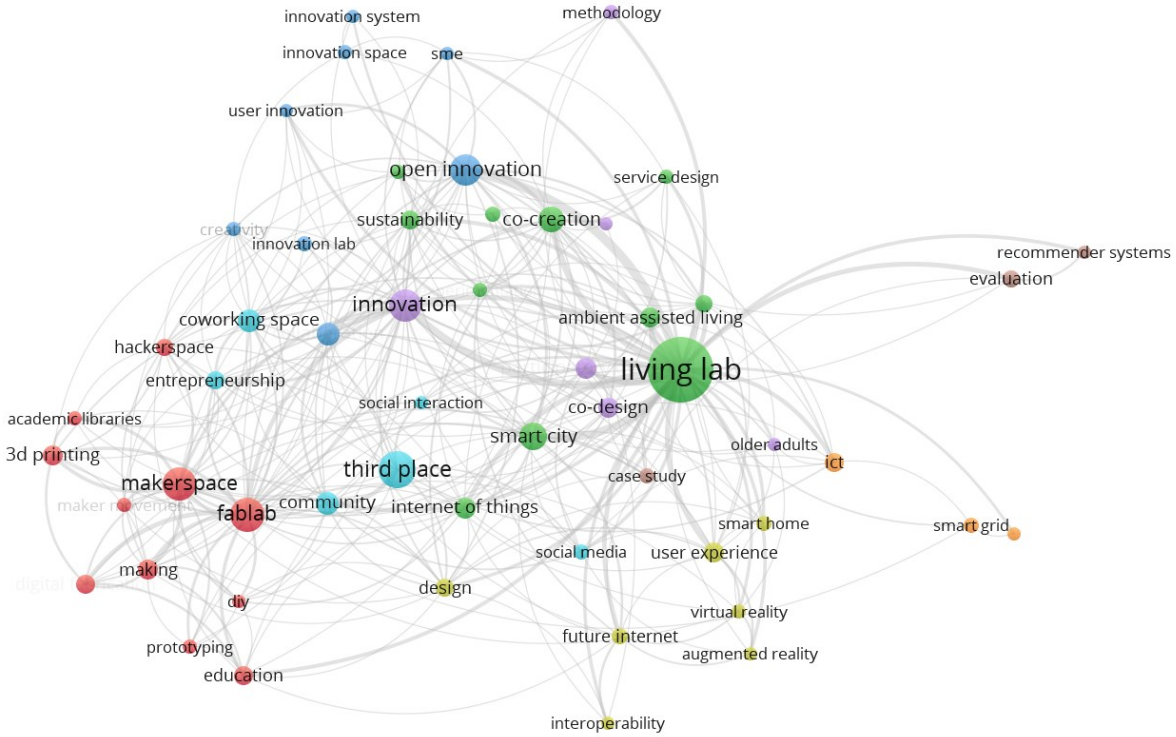

Fig. 3. Network visualization

some relations can be remarked between our laboratory concepts and the composition of the clusters (TABLE III.).

First, Cluster 1 groups together research subjects related to *education, DIY* (do-it-yourself), *making, maker movement, digital fabrication, prototyping, 3d printing* and *academic libraries*. Also, this cluster gathers three of our laboratory concepts: *fablab, makerspace* and *hackerspace*. Here, such laboratories and spaces appear to be more involved in studies that combine learning and academic areas with the maker movement and prototyping technologies.

Following this, *living lab* is by far the largest keyword in terms of weight and links across the network. Although *living lab* is connected with the majority of all other keywords, the concepts in Cluster 2 are the ones with the strongest relation to it. In this sense, areas such as *ambient assisted living, co-creation, experimentation, internet of things, service design, smart city, social innovation, sustainability, urban living lab* and *user involvement* are those which are leaning the most on *living lab*, whether as a laboratory concept, a methodology or an approach. In any case, it is possible to say that experimentation of new technologies in diverse contexts through user involvement and co-creation is what seems to distinguish the research around Living Labs.

Subsequently, Clusters 5 (purple) and 6 (cyan) appear in the middle of Cluster 1 and 2. Specifically, Cluster 5 looks to be interlaced with the Cluster 1 in terms of the distribution in the map but still, certain research areas are clustered as follows: *innovation, co-design, participatory design, older adults, methodology* and *enabling space*. In this case, the term *enabling space* does not seem to have a strong presence in the network, relating only to areas on participatory design, co-creation and innovation. On the contrary, cluster 6 shows well-defined relations among its keywords conveying a clearer line around *social interaction, entrepreneurship, community* and *social media*, highly linked to the *coworking space* and *third place* concepts.

Furthermore, on the top of the map is the Cluster 3 (blue) where keywords are concentrated around open innovation. In this cluster are found in our last two laboratory concepts: *innovation lab* and *innovation space*. However, they are not even related to the same keywords in the cluster. That is, *innovation lab* is closer to creativity and collaboration areas whereas *innovation space* has a stronger relation to innovation system and SME subjects.

Lastly, on the right and the bottom of the map are located Clusters 4 (yellow), 7 (orange) and 8 (brown). These clusters, mainly composed of new technologies and evaluation techniques seem to be more distant from the rest of the network elements, are almost solely related to the *living lab* keyword. This is to be expected insofar as the *living lab* concept is also widely used as a methodology for the design and user experience evaluation of new technologies [16]. Therefore, we can identify not only the shared links between the areas and laboratories we have analysed but also, those issues that seem to be more distant and exclusively related.

Once the cluster network has been explored, understanding the evolution in time of our research subject is a useful approach to identify trends as well as some missing issues in our network. As shown before in Fig. 2, publications regarding our selected issues are very recent. Nevertheless, we can still take a closer look at what are the trends in recent years. Using the overlay visualization of VOSviewer, Fig. 4 presents the same network distribution but in this case, colours are defined by the average publication per year of each keyword, with yellow for the most recent and dark blue for the oldest.

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TABLE III. CLUSTERS COMPOSITION

Cluster	Main Keyword	Related keywords
Cluster 1 (red)	fablab	3d printing, academic libraries, digital fabrication, DIY, education, hackerspace, maker movement, makerspace, making, prototyping
Cluster 2 (green)	living lab	ambient assisted living, co-creation, experimentation, internet of things, service design, smart city, social innovation, sustainability, urban living lab, user involvement
Cluster 3 (blue)	open innovation	collaboration, creativity, innovation lab, innovation space, innovation system, SME, user innovation
Cluster 4 (yellow)	user experience	augmented reality, design, future internet, interoperability, smart home, virtual reality
Cluster 5 (purple)	innovation	co-design, enabling space, methodology, older adults, participatory design
Cluster 6 (cyan)	third place	community, coworking space, entrepreneurship, social interaction, social media
Cluster 7 (orange)	ICT	smart grid, energy efficiency
Cluster 8 (brown)	evaluation	case study, recommender systems

The keywords to the left of the map seem to be the most popular since 2016. In particular, *fablab, makerspace, maker movement* and *making* appear to be capturing the attention of researchers recently. This shows a clear tendency for making practices to become more connected to educational and academic environments. Following this, *coworking space* looks like an issue that is developing closely to *entrepreneurship* in recent years.

Regarding living lab's side of the map, we can find that there is a recent interest in addressing the user experience of older adults who interact with ICT (Information and Communication Technologies). Likewise, it is possible to note that the concept of *urban living lab* is gaining attention from scholars and is becoming independent of the *living lab* issue. Moreover, the *sustainability* keyword appears an emergent subject which not only is related to *living lab*, some technologies and approaches, but also to some of the laboratories we seek to understand. This makes us wonder how researchers are addressing the sustainability issues in relation to the operation and continuity of laboratories initiatives.

C. Towards a research agenda

As we have stated in previous works, we are interested in understanding what are the factors and practices that most influence the designing and managing innovation laboratories [6], [8]. One thing that is worth noting from the present analysis is the absence of keywords oriented to *management*, *strategy* or *assessment* issues. Although, if we look thoroughly among the 1307 publications retrieved from Scopus it is possible to find some related work to these topics. Therefore, we decided to take a sample of 53 publications to which we analysed the content of their titles, abstracts and keywords, with the aim of identifying some more detailed information that we could not see with the co-occurrence analysis of keywords. The 53 publications were found by including the *management* keyword as a condition in our main search equation, focusing only on documents between 2017 and 2019.

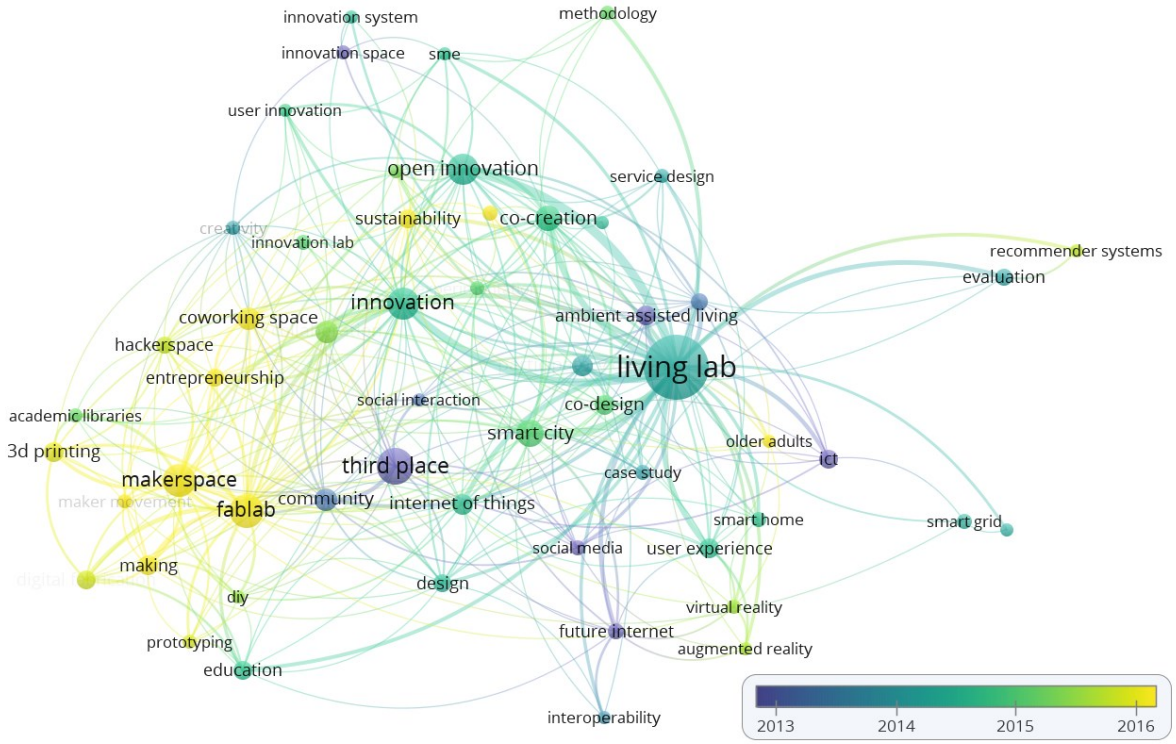

Fig. 4. Evolution over time of keywords

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In performing content analysis, several categories can be identified by coding e.g., the goal of the research, the context in which it was developed, the methods or tools that were used and the main findings the authors claim they achieved. With this in mind, we concentrate our analysis on retrieving from the sample what type of publication they are, the main method or tool, and the contributions. The results of this process are summarized in TABLE IV.

Although the search condition is linked to management keywords, it is possible to see different trends in researches and applications of a significant variety of methods. Thus, we choose to group the contributions in six categories that can also be seen as trends in this matter (Fig. 5). First, it seems that several studies are presenting lessons for technologies testing or user validation. Next to this, there is a prominent category related to urban and public matters where researches are providing insights on the process of implementing collaborative approaches and the digitalization of public practices. Similarly, there is a smaller category specifically related to the collaboration phenomenon in which applications of collaborative methods and practices are being tested across a broad spectrum. In addition, only four documents are categorized as 'other contributions' where knowledge management, learning techniques, intellectual property and energy policies subjects are addressed.

TABLE IV. METHODS AND CONTRIBUTIONS COMPARISON

Technology testing (TT), Urban & public experiences (UE), Collaborative project applications (CA), Lab management (LM), Lab assessment (LA), Other contributions (OC)				
Ref.	**Year**	**Type**	**Method/Tool**	**Type of Contrib.**
[30]	2017	Conf Paper	Didactic process	LM
[31]	2017	Conf Paper	IP protection	OC
[32]	2017	Article	Planning development	LM
[33]	2017	Conf Paper	ISM Modeling	LM
[34]	2017	Article	Actor-Network Theory	UE
[35]	2017	Article	Structural Equation Model	UE
[36]	2017	Conf Paper	Psychosocial & behavioural analysis	UE
[37]	2017	Article	SECI Model	OC
[38]	2017	Article	Participatory Co-design	UE
[39]	2017	Conf Paper	Digital platform	TT
[40]	2017	Conf Paper	Cross-case analysis	**LA**
[41]	2017	Conf Paper	Comparative analysis	LM
[42]	2017	Conf Paper	Value Chain Impact Analysis	TT
[43]	2017	Article	Participatory Design	LM
[44]	2017	Conf Paper	Cloud Ecosystems & IoT	TT
[45]	2017	Article	Interviews	**LA**
[46]	2017	Article	Results assessment	TT
[47]	2017	Conf Paper	Recommender platform	TT
[48]	2017	Article	Conceptual framework	UE
[49]	2017	Conf Paper	Interviews	UE
[50]	2017	Conf Paper	Wireless Power Transfer	TT
[51]	2017	Article	Analytic Hierarchy Process	**LA**
[52]	2017	Article	Community-based approach	UE
[53]	2017	Conf Paper	Focus group	UE
[54]	2017	Article	Living Labs Harmonization Cube	LM
[55]	2017	Article	Structural Equation Model	LM
[56]	2017	Article	Design management	CA
[57]	2017	Conf Paper	Data Stream Processing	TT
[58]	2018	Conf Paper	User's behaviour	TT
[59]	2018	Conf Paper	Creation process	LM
[60]	2018	Conf Paper	Productivity Analysis	LM
[61]	2018	Article	Outcomes-based assessment	**LA**
[62]	2018	Article	Community participation & logic framework	UE
[63]	2018	Conf Paper	Living Lab method	CA
[64]	2018	Conf Paper	Interactive Collaboration	CA
[65]	2018	Conf Paper	Research through Design	CA
[66]	2018	Article	Smart City IoT platform	UE
[67]	2018	Conf Paper	Virtual Collaboration	OC
[68]	2018	Article	Innovation capacity analytical framework	UE

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[7]	2018	Article	Service-based taxonomy	**LA**
[69]	2018	Article	Living Lab method	CA
[70]	2018	Conf Paper	Value Chain Mapping	CA
[71]	2018	Conf Paper	Interviews	CA
[72]	2018	Conf Paper	Smart space management system	TT
[73]	2018	Conf Paper	SWOT Analysis	**LA**
[74]	2018	Conf Paper	Km4City Tools	TT
[75]	2018	Conf Paper	Living Lab method	TT
[76]	2018	Article	Conceptual framework	LM
[77]	2018	Conf Paper	Dynamic System Modeling	OC
[78]	2018	Article	Conceptual framework	LM
[79]	2018	Article	Job-demands-resources Model	**LA**
[80]	2019	Article	Semi-structured interviews	**LA**
[81]	2019	Conf Paper	Digital Healthcare platform	TT

The last two categories identified are the ones we will take into account for the remainder of this paper. There is a specific set of contributions that focus on management issues from the perspective of the laboratory to which the corresponding authors are linked. Makerspaces and Living labs seem to be the spaces that have recently been the object of analysis by the scientific community in this matter. In this sense, it is possible to find studies that share experiences mainly on management models, design experiences, context comparisons and even recommendations on health and work balance. This body of literature shows that understanding the operation of this kind of organisational structures is a matter of current interest, but even so, they all seem to remain exploratory and scarce.

However, there are some authors who are addressing the challenge of pinpointing the results and evaluating the performance of these types of innovation laboratories. For this reason, our last category is called laboratory assessment. As one of our research objectives is to contribute to the strategic management of these innovation intermediaries, identifying which method (or set of tools) are suitable for this purpose is a key step in our path. Then, by taking a closer look at the methods used by authors in this category, we have some qualitative ones, such as semi-structured interviews and cross-case analysis. Moreover, we also have SWOT analysis, Analytic Hierarchy Process (AHP), Service-based taxonomy and Job-demands-resources (JDR) model as prominent methods to consider.

Now, once this set of methods has been identified, it would be interesting to explore in more detail what kind of results they are achieving. To this end, all contributions retrieved from the abstracts of the 53 documents were coded, allowing us to identify the six categories previously mentioned. Furthermore, as a result of this coding exercise, it is possible to visualise through a hierarchical chart the proportion

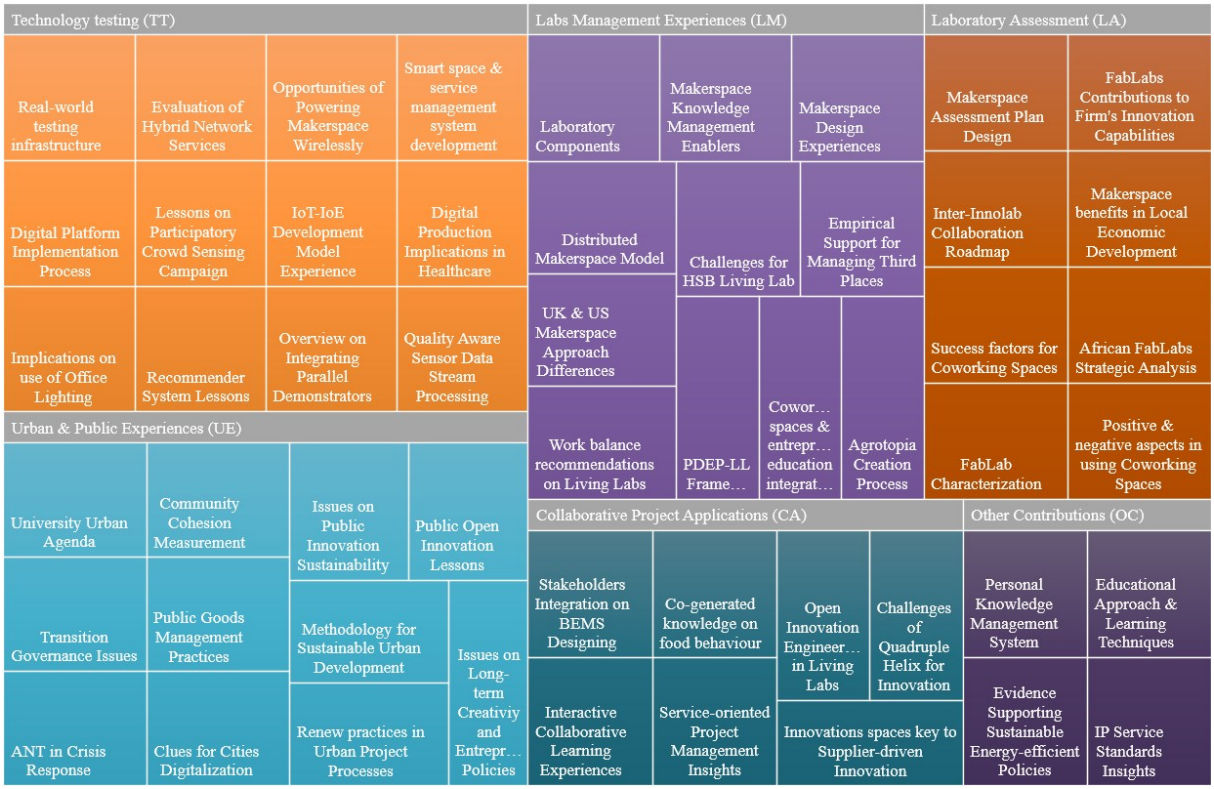

Fig. 5. Hierarchical chart of contributions

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represented by each category, composed of the codes extracted from the corpus analysed. Fig. 5 shows the contributions of each study distributed under the mentioned categories. Here it can be appreciated how research related to the management of innovation laboratories focuses mainly on project applications, since the categories of technology testing (TT), urban & public experiences (UE), collaborative project applications (CA) and other contributions (OC) represent 34 of our sample of 53 documents (64%). However, it is also important to underline that the remaining 19 studies (36%) deal in some way with the understanding of this issue, either their management practices (LM) or the assessment of their impacts (LA), highlighting a prominent interest in this regard.

Based on Fig. 5 and the way in which these categories are composed, it is possible to pinpoint some of the axes on which research is being oriented around the management of innovation laboratories. These axes are described below:

Innovation labs for product development in accordance with the qualitative analysis of papers that provide TT contributions: Traditionally, one of the reasons for the existence of laboratories was to support the development, testing and market introduction of new technologies, as products or services. Regardless of the evolution of these intermediary structures, this is something that has a strong presence in this bibliometric study. Today, research around innovation laboratories is leading, for example, to the development of digital platforms, hybrid network services, recommender systems or data processing. This is a clear line that scholars should keep in mind as a path for research in innovation laboratories.

Innovation labs for territories in accordance with the qualitative analysis of papers that provide UE contributions: Every day more laboratories are conceived in order to transform the way in which public management and urban development have historically been done. Cities digitalization, public goods management, crisis response, open public innovation and sustainable development are examples of promising research areas where innovation laboratories have a key role to fulfil.

Innovation labs for collaboration in accordance with the qualitative analysis of papers that provide CA contributions: Collaborative approaches are inherent to innovation laboratories, regardless of how they are embodied. Nevertheless, there is also a specific tendency that focuses on studying the application of collaborative methods in a wide scope, such as service-oriented project management, supplier-driven innovation, open innovation engineering or interactive collaborative learning. In this aspect, there is a vast outlook for innovation laboratories to be studied as mediators of knowledge creation and interinstitutional collaboration.

Managing Innovation labs according to the qualitative analysis of papers which provide LM contributions: Design and creation processes, framework and management models, as well as component configurations, are being discussed in the literature through case studies that share laboratory management experiences. Such contributions are valuable inputs for teams seeking inspiration in terms of examples, practices and challenges. Furthermore, laboratory teams willing to share their experiences will allow future researchers interested in this topic to access more enriching information.

Assessing Innovation labs according to the qualitative analysis of papers which provide LA contributions: It is noteworthy that studies dealing with the assessment of innovation laboratories are already feeding the literature. In this respect, laboratory success factors, positive and negative aspects, characterizations, assessment plans or even roadmaps and impacts on firms' innovation capabilities are all issues being explored. The importance of seeing this matter as a research area is founded not only on the possibility of measuring results and appreciating impacts but also on the opportunity to create new knowledge in terms of how to make the most of these dynamic innovation structures. This is an emerging topic of interest that still has a long way to go before establishing itself in the literature.

V. Conclusions

A scientific outlook of the constellation of innovation laboratories was presented in this paper. This was done through a bibliometric study based on co-occurrence analysis of keywords and content analysis. The results provide a network of 8 clusters in which it is possible to observe both research affinities and distinctions between the most common concepts often related to innovation labs. This will prove helpful for scholars and practitioners, as they can observe which areas of research are most prominent as valuable insights to guide further studies.

Furthermore, as the content analysis was based solely on title, abstract and keywords, this could be seen as a limitation due to the way the authors present some abstracts. This could result in a possible loss of valuable information that otherwise could only be retrieved from complete documents. However, the corpus was constructed solely from peer-reviewed publications in order to mitigate this issue. Also, the inclusion of results from other databases such as Web of Science and Google Scholar could serve as input to enrich this study.

Lastly, we have set the ground for a research agenda on the strategic management and assessment of innovation laboratories. Tools and methods were identified, as well as whether they are being used to analyse, characterise or evaluate this phenomenon. Future research paths should be oriented towards the consolidation of a strategic methodological framework through which host teams of the innovation laboratories can unlock the potential of the collective intelligence of the surrounding communities as proposed by [5]. In this way, we would be favouring the consolidation of collaborative open spaces that would help us to keep pace with technological and social transformations.

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