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Collaborative networks between innovation spaces

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Abstract

The increase of the innovation spaces number on a territory makes them unstable and fragile. Indeed, several studies have shown that most of them are following the same “Death Valley” due to a dispersion of both the financial and human resources. This is why the hypothesis that creating collaborative networks considered as an inter-organizational alliance would make these places sustainable, was taken. Combining their variety of actors and competencies and their complementarity in materials and equipment’s would allow producing greater innovations and impacts on a territory aligned with the major transitions we have to face today.

Based on a review of the scientific literature, the trends about innovation spaces were identified and the start point of a collaborative framework was established. This start point correspond to four findings. The first one is the generic dimensions to characterize and evaluate the network performance. The second one is the five levels of collaboration and the six types of governance. The third is the identification of some key performance indicators to characterize a collaborative dynamic. The last one is the identification of emerging dynamic of collaboration between innovation spaces.

Keywords— Innovation Spaces, Collaborative network, Literature review, Dimensions

I. INTRODUCTION

Since 2005, innovation spaces such as Fab Labs, Makerspaces, Hackerspaces, Living Labs, coworking spaces, etc. have been an increasing subject of scientific research. Several studies focus on the emergence of these places and how they are organized [1][2], favoring relations and exchanges between a diversity of actors in a territory (companies, research institutions, public actors, universities and citizens...). Each innovation space (IS) has its own innovation processes, tools, methodologies, specific skills and management style [1] [2]. Each of them is created to meet particular objectives (economic, societal or environmental issues) depending on the community that is evolving on it and its needs. Nevertheless, little research has been conducted on their ecosystem impacts. The current challenges are to minimize environmental impacts, so it’s essential to analyze the impacts of IS. Moreover, to bring solutions to such complex issues, it can be necessary to mutualize skills and knowledges of a territory. Indeed, the IS should no longer be in competition with each other but should share and exchange their resources [3]. Especially as many initiatives emerge on very varied territorial perimeters, e.g.:

- Fieldlabs at TU Delft: <https://www.tudelftcampus.nl/collaborate/fieldlabs/>
- In Colombia, the ViveLabs national network launched by Ministerio de Tecnologías de la Información y las Comunicaciones [4]
- Archipelago co-design platforms within the project “Programme d’Investissement d’Avenir” PIA-3 Territoire d’innovation – Des Hommes et Des Arbres (DHDA) [5]
- IS network in a French university PIA-3 SIRIUS: <https://factuel.univ-lorraine.fr/node/18039>

- In Italy with Fablab Roma Network [6]
- In Erasmus + (Higher Education – International Capacity Building) project with Climate Lab project <http://climate-labs.org/>

the aim of having different places collaborate is to combine different skills, knowledges and points of view and thus bring value to the territory. This phenomenon is a new territorial development model. The previous projects are part of this dynamic, for example “PIA-TI aims to promote the emergence of new territorial development models in France that are propitious to sustainable economic development and the improvement of people's living conditions, while enabling local economic players to be successful”[5]. Previous works [7] have shown that they seem to be an asset for the transition towards new models. However, we have seen that in the literature no mechanism for collaboration between IS has been established. Therefore, there is no study on the territorial impacts of these collaborative networks. Consequently, it seems important to provide generic methodological tools for developing collaboration between IS in a territory.

The main question guiding this paper is “how to structure a network of IS to brings added value to the IS members as well as to the territory involved?” The purpose of this article is to provide an overview of the research trends concerning the networking of IS. This allowed us to identify a methodological gap for the creation and monitoring of this type of network. Therefore, our study contributes to the literature by providing dimensions, types of collaboration and performances indicators that will characterize a collaboration. Also, it can constitute the basis of a methodological framework to precisely describe a collaborative network. In further research, we will be able to establish a methodological framework that fosters this transition by allowing IS to collaborate with each other and with their territory. In this article, the impact of such a network on the territory was not discuss, because this topic needs more attention.

To identify the characteristics to create these network dynamics, a literature review on IS networks was carried out. The research methodology is composed of two literature reviews. The first research confirms the emergence of the subject around IS because network dynamics and collaborations between IS are rarely studied [3]. Then, the hypothesis that these dynamics are similar to inter-organizational networks has been set up. The second literature review on this subject was realized. The literature allows us to specify the types of collaboration and the indicators for evaluating their quality.

The remainder of this paper is organized as follows. The first section provides the theoretical background related to the proposed research, to provide common ground for the terminology of this work. The second section presents the research approach for the literature review. Finally, a conclusion and discussions are present to discussed results, and identifies the futures guidelines and perspective.

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II. THEORETICAL BACKGROUND: DEFINITION OF TERMS

This section provides the background related to the proposed research. A brief definition and conceptualization of Innovation spaces is presented, and network collaborative approach in the point of view of this study is exposed.

A. Innovation Spaces (IS)

IS are entities seen as organizations in their own right. These places are networks of actors brought together to develop innovation through processes of creation, prototyping, validation and testing in a real context [8][9]. Innovations can be technological, services, products or systems innovations [10][7]. Users of these spaces are varied and are expected to be organized around a well-defined strategic intent with established innovation processes to be sustainable [8][11]. Strategic intent can be seen as the ambition, the goal to be achieved. We can make the analogy with an organization since the latter is “goal-oriented” [12]. A second definition proposed by [13], allows us to confirm the choice of comparing IS to an organization. He proposes “An organization is the rational co-ordination of the activities of a number of people for the achievement of a common explicit goal, through a division of work and hierarchy of authority and responsibility”. These last justifications will allow us to draw inspiration from inter-organizational network management methodologies. “Inter” means to articulate which corresponds to our objective of articulating the IS in a territory to obtain a sustainable collaboration. Moreover, the diversity of actors present in these places shows us that they are important meeting points in a territory [14][10]. Networking them would therefore be beneficial for the territorial development [15]. This is not contradictory with their strategy. In fact, they all normally have an important openness dimension [16]. Moreover, they already individually have the characteristics of an actors network or an inter-organizational network [17].

B. Collaborative network

To begin with, the term network was used to refer to the collaborative’s dynamics, exchange and sharing between organizations (in our case: IS).

When collaborating and creating a real sustainable network, stakeholders conduct projects together over the long term and all resources are shared: information, expertise, tools, etc.[3].

When we talk about collaboration, several terms appear: alliance, cooperation, coalition, coordination, network, joint venture, cluster, consortium, industrial symbiosis and “public-private partnership (PPP)” [18]. These different terms will be treated interchangeably. In some configurations, IS contribute to the emergence or structuring of PPPs [19]. Therefore, IS networks would be a way to extend this collaboration to a territory.

There are many types of networks. We have already shown that inter-organizational networks can be adapted to our subject. This hypothesis has been applied in our study. There are also value networks because they have assets, tangible or intangible results created and disseminated between its actors and because our goal is to create added value to a territory [20]. Networking or collaboration has both benefits and risks. It allows actors to share costs and risks of various projects [3][21][22]. These dynamics are sometimes perceived as time consuming and inefficient: “*Critics claim that inefficiency and time delays in collaboration result ... from transaction costs reflecting duplicate organizations, excessive bureaucracy, management by consensus, equal voting rights ... and delays in decision-making which are reflected in time slippages; as well as the need to make compromises in operational requirements and delivery schedules to satisfy the different demands of each*”

[23]. So, it’s necessary to develop a new method of network management to overcome this problem.

III. METHODOLOGICAL DESIGN

The aim of this research is to identified and summarizes the research trends and limitations about these two previous topics and begin to identify key characteristics to define a collaborative network. The global process of the methodological design is show in the *figure 1*.

To draw up this overview, a literature review based on the Web of Science database and a random treatment was carried out. Initially, the Web of Science database was used because it contains a large number of publications from over 34,000 journals [24]. In addition, it allows for multi-criteria research.

A literature review on the subject of IS networks allowed us to understand the challenges of this subject as well as the limitations present in the literature.

To structure our research, the first phase was to conduct random searches in order to identify the relevant keywords to be used in the research equation. The chosen keywords will be around 2 notions: IS, collaboration networks. (*Table 1 (AB)*). These keywords were searched only in the Author keyword to have a specific article and less off-topic articles.

To choose the keywords related to innovation spaces, a test was realized with each of its synonyms. Many of them brought inappropriate publications (on social, psychological, medical topics...). To refine the results, these were not included in the equation, for example: “enabling space”, “enabling lab”, “living space”, “crea*space”, “crea*lab”, “idea space”, “social space”. Moreover, some other terms didn’t bring results such as “hackerlab”, “makerlab”, “co-design space” OR “co-design lab”. The same approach was taken with the other keywords in the equation.

The publication on collaboration between IS started in 2010. This phenomenon is correlated with the success of IS and sometime reinforced by national policies, for example:

- In France: calls for FabLab projects in 2013 or in 2016 the PIA3-Territoire d’Innovation that supports territories to adopt Living Lab approaches
- In Colombia, in 2012, launch of the ViveLabs project promoted and financed by the Colombian government.
- In the U.S, since 2010, U.S. policy has been oriented towards the development of manufacturing laboratories [25].

The challenges of the IS are increasingly encouraged by the territories and oriented towards their development [8]. Since 2006, many international dynamics around IS emerged (e.g., ENOLL network in 2006 or the Fab Foundation in 2009).

Our first results highlighted certain gaps in our research method. Indeed, we have only 77 results. These needs for further study are due to the youth of the subject. Our hypothesis allowed us to go deeper. Inter-organizational networks are older dynamics (1985, [26]) and are already study in depth.

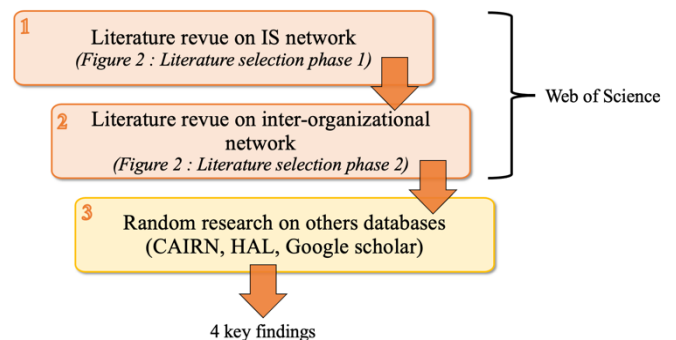


Fig. 1. Process of the methodological design

To this end, an additional literature review with more specific information on the networking process was conducted. The objective is to identify methods, indicators and more concrete tools for collaboration between companies, organizations or other forms of structure. As this notion is very abundant, the keywords were searched only in “Author Keywords” (*Table 1 (CD)*). As with the first step, each keyword was tested to see if it provided us with relevant publications. The process of selecting relevant publications was the same as before. *Table 1* shows the different equations used for this research.

The results were studied using the VOSViewer software. It provides an overview of all articles. The use of this software makes it possible to obtain a network of keywords by co-occurrence links. Each keyword is represented by a circle and its diameter represents the frequency of occurrence of the keyword [27]. The links between keywords represent the fact that they have appeared together in articles. The closer the two keywords are to each other, the stronger their relationship (i.e. the frequency of their mutual appearance is high). This format makes it possible to create clusters which are represented by different colors.

Following the analysis with this software, the articles’ abstracts have been read to select only the documents dealing on IS network. Indeed, articles dealing with medicine or technology or agriculture or social networks were not selected. At the end of the process, 12 papers were selected that were deeply studied (see *figure 2*). Given this very low number of articles, we decided to add a second phase in our selection process. Thanks to other database, new articles have been added, as for example CAIRN (management science-oriented database) and HAL. They were carried out to bring Open-

Science or French-speaking articles. Indeed, we decided to also analyzed the Francophone literature.

Google scholar was also used to identify articles with a large number of citations in this field or to find recent articles that were not yet present on WOS (*Table 2*).

After reading these additional articles, sufficient qualitative information was at our disposal. Indeed, the characteristics of sustainable collaboration have been confirmed a large number of times and so leading us to reach the theoretical saturation point around the characteristics of networking and collaboration [37].

TABLE II. ADDITIONAL RESEARCH

Database	Input	References
CAIRN et HAL	Francophone articles	[26][28] [29] [30] [31]
Google Scholar	Articles with a large number of citations in this field	[32] [22] [20] [16] [10]
	New articles that were not yet on WOS	[7] [5] [33]
	Articles from the references of the selected publications	[34] [21] [35] [36]

TABLE I. SEARCH EQUATION 1 (AB), EQUATION 2 (CD) FOR THE SELECTION OF PUBLICATIONS

Field	Option introduced
A - Innovation spaces Keywords (Adapted from [1] & [7])	“Inno* space” OR “Inno* lab*” OR “living lab” OR “fab lab” OR “fablab” OR “fablabs” OR “makerspace” OR “hackerspace” OR “coworking space” OR “third place” OR “social lab” OR “creative space” OR “open lab” OR “co-design platform”
B - Networking Keywords (From literature)	“inter-*” OR “Orchastrat*” OR “Organization” OR “Ecosystem” OR “Network*” OR “Interconnection” OR “interrelation” OR “combination” OR “association” OR “collaboration” OR “grouping” OR “gathering” OR “inter-organizational” OR “cooperation” OR “partnering”
Search in	Author keywords
Period explored	1950 To 2021
Document type	Article, proceedings paper, book, book chapter, book review, review or early access
Database	Web of Science
Number of publications	77

Field	Option introduced
C - Collaboration Network Keywords (From literature)	“interorganizational collaborat*” OR “inter-organizational collaborat*” OR “interagency collaborat*” OR “inter-agency collaborat*” OR “multi-organizational collaborat*” OR “multiagency collaborat*” OR “multi-agency collaborat*” OR “cross-organizational collaborat*” OR “cross-agency collaborat*” OR “cross-boundary collaborat*” OR “collaborat* governance” OR “collaborat* management” OR “Collaborat* network*” OR “collaborat* public management” OR “organizational interconnection” OR “Interconnection” OR “interrelation” OR “collaboration” OR “inter-organizational” OR “Orchestra*”
D - Indicators Keywords (From literature)	“Indicator repository” OR “criteria” OR “indicator*” OR “indicator* Proposal” OR “indicator* framework” OR “indicator* referential”
Search in	Author keywords
Period explored	1950 To 2021
Document type	Article, proceedings paper, book, book chapter, book review, review or early access
Database	Web of Science
Number of publications	174

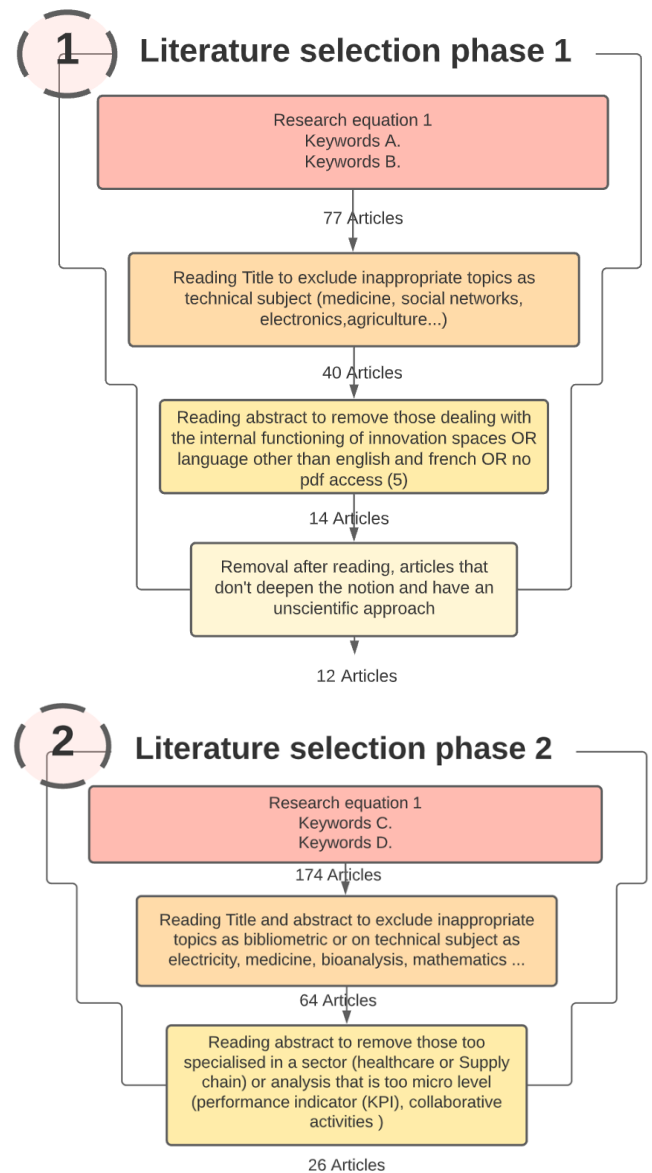


Fig. 2. Literature selection process

IV. FINDINGS

A. Collected data

For our analysis, the following criteria was integrated: minimum of 4 occurrences per keyword in order to obtain usable representations.

We studied the evolution over time of the keywords. In figure 3, the colors are defined by the average publication per year of each keyword, with yellow representing the most recent and dark blue the oldest. The keywords associated with our topic are part of the recent trends (such as: sustainability, city, model, networks, management or performance). Indeed, these are in yellow or light blue which corresponds to 2019-2020. The clusters on the bottom right were popular mainly before 2016. The clusters on the left, it was mainly in the 2018-2020 period [7]. This analysis was also conducted with the articles on inter-organizational networks. The notions of impact, quality, indicators, knowledge and governance are also recent (figure 4). The keyword of territory isn't present. The territory in which the network operates is still poorly considered. The research problematic: what are the parameters for creating a network and a sustainable collaboration? is a recent topic [8]. Indeed, by taking articles from 1950 to March 2021, the beginning of publications is only from 2010.

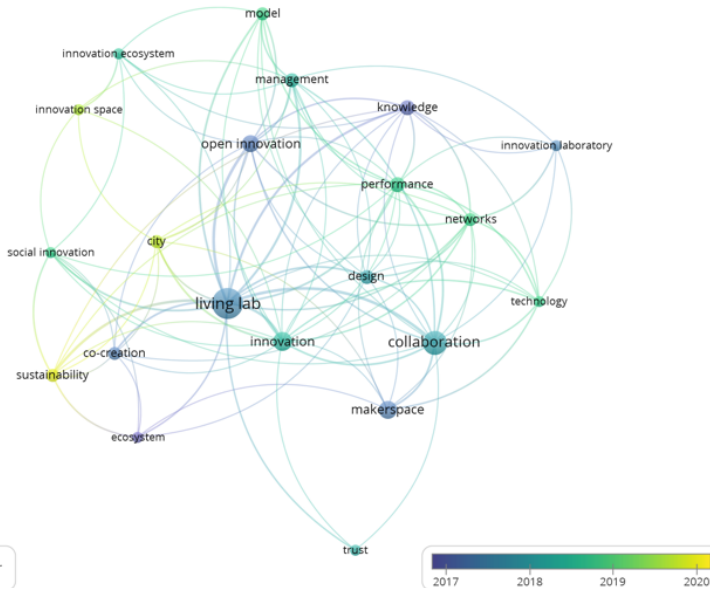


Fig. 3. Temporal analysis on VOSViewer

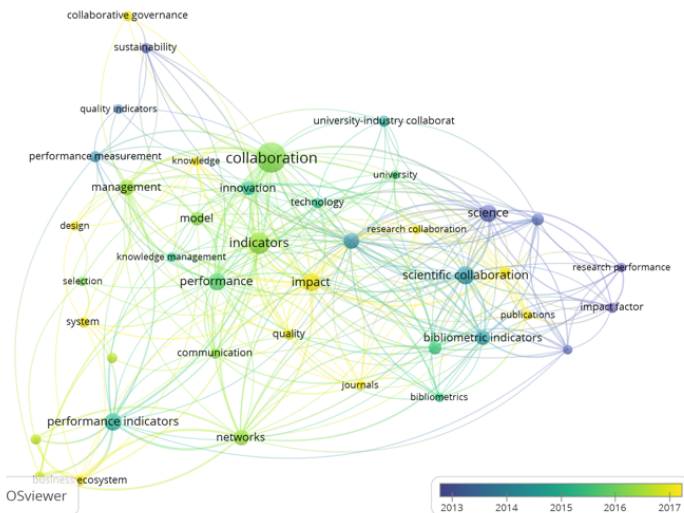


Fig. 4. Temporal analysis on VOSViewer

Our analysis continued with the study of the density of focus of the keywords (figure 5). The keywords sustainability, model, network, performance and management have a low density compared to other topics such as living lab and collaboration. Collaboration is for actor collaboration inside an IS. In literature about inter-organizational network (figure 6), the keywords impact, performance, indicators, management, model, quality indicators needed further research.

Therefore, we identify a new area that has not been studied in depth and for which our objective is to provide insights (model; management; indicators of performance, quality and impact).

B. Analysis of collected data

The results of this analysis are presented in this section. This literature review allowed to identify 4 significant results: The dimensions that characterize a collaborative network, the different types of collaboration and levels of governance, the indicators that make it possible to evaluate the performance or quality of a collaborative dynamic, and finally the mechanisms of collaboration linked to IS.

a) Network dimensions

This literature review highlighted research trends around IS. In addition, the basis for a methodological framework was identified. The 9 dimensions characterizing a network are presented in Table 3. These dimensions constitute the most generic level, the basis for analysis of an IS network [38]. The dimensions specific to IS (because they are themselves networks of actors) and those specific to the analysis of a network integrated into a territorial strategy were combined. Apart from the organizational dimension, the cognitive dimension proved to be important because it presents fundamental elements to achieving sustainable collaboration: trust [39][40] and knowledge management [41][42]. Trust is important because it allows the network to have flexibility [43]. This leads us to show that the temporal dimension is a key dimension. The network must be dynamic and follow the movements of a territory. Indeed, actors must be able to join or leave the network without constraint [30]. It must be flexible [44] and in constant rearrangement [39].



Fig. 5. Density analysis of IS network keywords on VOSViewer

Each indicator must be prioritized and given a weight to measure its importance with respect to the others (e.g., using the AHP method [61][62]).

These indicators are only on the network performance. But there is few research about the impact of these collaborative network on the territory and on the members. Some authors start to think indicator can help to link actors and define their common values[47]. We think that defining a repository of indicators considering all these aspects could be a potential future research topic.

d) *Network of Innovation spaces*

Almost every article talks about the collaboration between actors within an IS [2][55][48] but not about collaboration between IS. However, we can take inspiration from the structures of collaboration between actors and extend them to collaboration with other organizations. Indeed, they have similar key elements : shared vision, role defined, innovation a process, a structure, commons objectives...[48]

Some IS are created around a similar thematic to develop a territory [14][63] and by the way looks like a network. For example, Urban Living Lab looks like a network, in fact, each of them has the same objective of territorial development and are constituted by a network of various actors [14]. However, besides the theme of their project, they have nothing in common and especially no common operating modes.

For the moment, the only existing IS networking model is structured exclusively according to horizontal and vertical interactions between IS categories [64]. Currently, only A. B. Memon, K. Meyer, and M. N. Tunio have considered the question of creating a tool for the IS collaboration. Their two articles are the only two rich and interesting articles on this subject. However, we believe it is possible to create a more generic collaborative network, without classifying each IS into a category. We would a framework that can enable collaboration between more different IS and with fewer vertical relationships. Moreover, they don't provide tools for monitoring and improving this collaboration. In the literature, there are few tools to monitor and evolve a network between IS. Some research present the importance of a tool to link diverse actors, like a digital platforms [14]. We think it will be an interesting intermediary to facilitate interactions in a collaboration.

The territorial impact is little studied [8][33]. There are still few indicators for evaluating the impacts of IS on a territory and for evaluating collaboration outcome [47]. Further research is needed to establish key indicators. Analyses at the scale of a territory are few, only a few researchers are starting to look at the impacts of these places separately and of co-creation on their close ecosystem. Some authors shows that due to the specialization of each IS, they are complementary. So, if they work in a network, they could play a key role in global challenges facing their local ecosystems [7].

V. DISCUSSIONS AND LIMITS

A. *Limitations*

Our study has some limitations, we may not have identified all the keywords allowing access to all the articles and we used only the Web of Science database. To partially compensate these limitations, we conducted a constant lookout to identify other documents dealing with our subject.

B. *Key findings*

This study allows to identify the main dimensions of a network (9), some initial performance indicators (9) and the emerging topics around these places of innovation. Indeed, there are lots of gap in a literature on the subject of network

between IS and their role on a territory. This research has allowed to define the basis of a collaborative network analysis framework (9 key dimensions). Moreover, it allowed to understand the five levels of collaboration. As well as the five different ways of governing a collaboration network.

This research identifies a gap around territory. We have seen that IS are a tool for ecological transition. It is therefore important to evaluate the impact of the dynamics they generate on a territory. However, the notion of territory linked to IS is still very understudied. Moreover, in the literature related to collaborations, the territory in which they take place is also rarely studied. These conduct to several questions: do these characteristics influence the territorial impacts generated by this collaboration? Do similar characteristics bring identical territorial impacts? How many and what types of IS are needed to have a relevant impact on the territory? To answer these questions, we believe that the articulation of these nine dimensions will faithfully represent the characteristics of a collaborative network.

VI. CONCLUSION

Thanks to our different results we can confirm that the hypothesis used is coherent. It makes sense to assimilate IS networks to inter-organizational networks, because of the diversity of actors they integrate and also because of the similarity of the dimensions used to describe them. In addition, it allows us to have new insights presented above. This brings interesting limits and perspectives.

The study's results are the identification of research trends about IS and the lack of studies on their collaboration potential and their territorial impact assessment. Moreover, this literature revue provides key elements to study collaborative network.

Further research is needed to deepen this initial analysis. It would be interesting to identify indicators that would allow us to evaluate the territorial impacts of these places and their networks. Moreover, it's still lacking framework, tool or method to develop and maintain a network. It would be interesting to demonstrate that these places can support territorial dynamics. Indicators would also facilitate the replication of these dynamics in other territories. These indicators would analyze the network in three aspects (we will analyze it at a broader level than simply at the level of activities [65]): in the collaboration (on network outcomes), in the organization (structure and network management) and in the territory (strategies, responses to territorial issues). The IS network could be monitored for quality and improved according to these indicators.

From all the previous analyses we can affirm that a network of innovation spaces will permit to create sustainability dynamic on a territory thanks to their diversity of actors, the sharing of their varied resources and knowledges. There is a lack of studies which place territorial development at the center of their analysis [63][8]. Moreover, collaboration between IS could allow them to have access to resources or skills that they lack. This would certainly reduce the number of IS closing after only a few months.

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