Systemic design for sustainable territorial development: ecosystem definition to support autopoietic local economies

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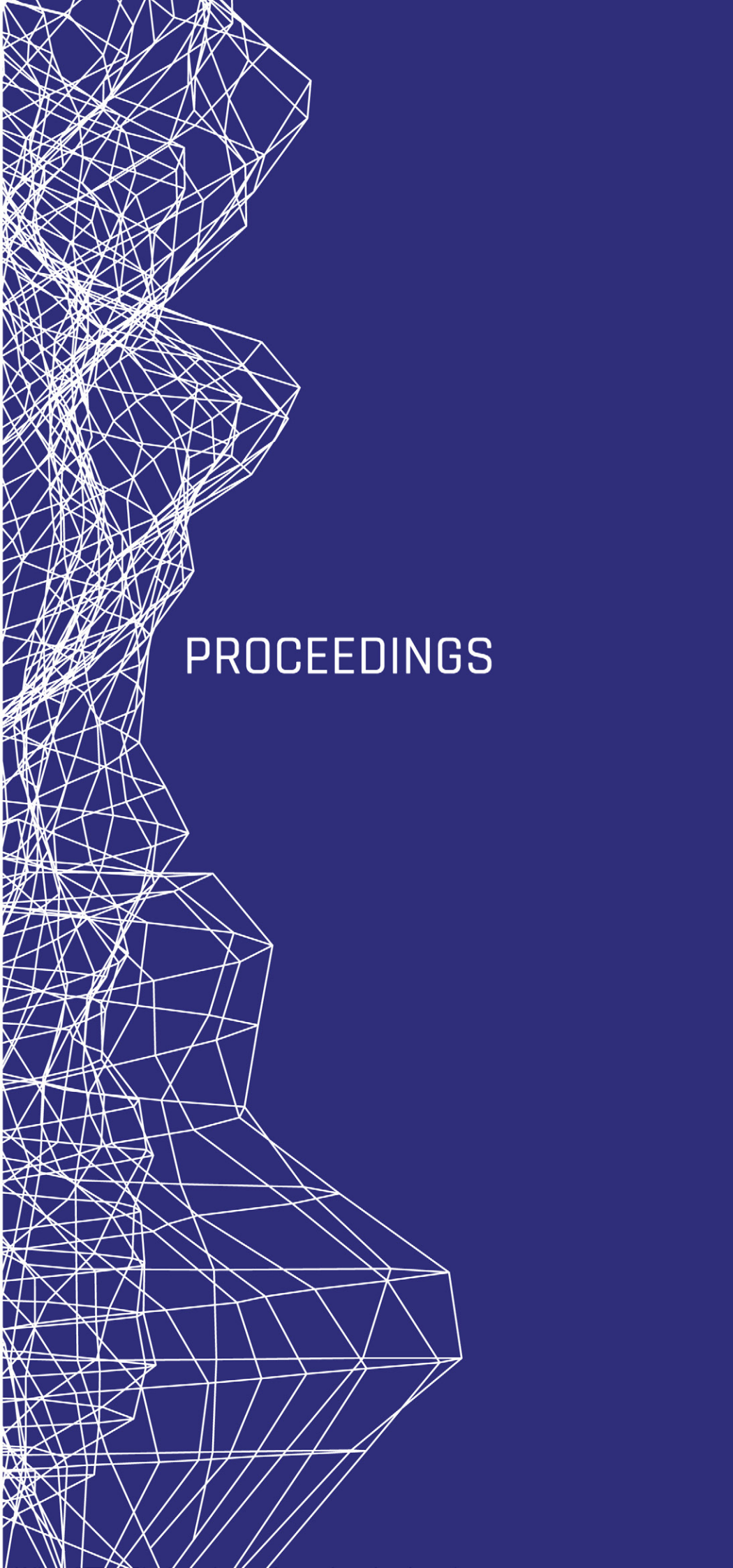

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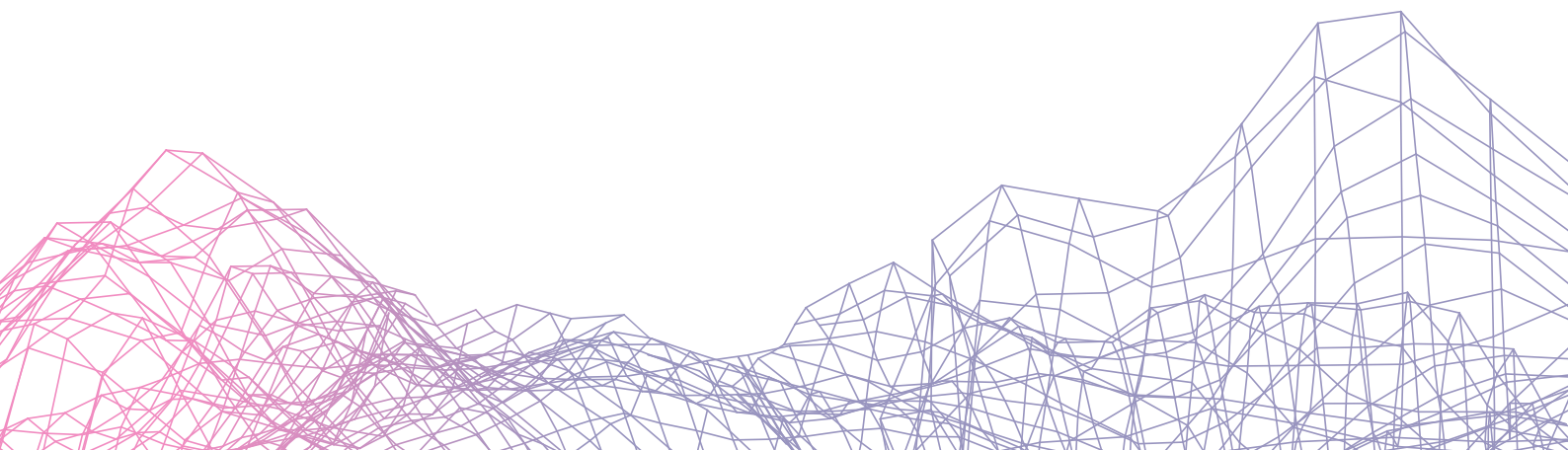

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WORKING PAPER

Systemic design for sustainable territorial development: ecosystem definition to support autopoietic local economies

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Abstract To meet the current challenges to fight global and interconnected problems as waste production, systemic thinking is needed to provide a new cultural paradigm to create Sustainable, Circular and Blue Economies. One action can be done spotlighting the local territory in which we are living every day enhancing cultural and natural resources, indeed of considering it as a place where the products are manufactured, travel everywhere and leave only waste. Systemic Design can provide an answer creating eco-innovation and environmental, social and economic sustainability, especially at the local level. A multiple case-study analysis on previous projects on Systemic Design has conducted to understand the principal barriers in their implementation and their outcomes to reach sustainable territorial development. After the identification of the new opportunities created at the entrepreneurial level, finally, it is designing the entrepreneurial ecosystem of innovation to foster Systemic sustainable projects framed in a specific context of reference.

Keywords: systemic design, ecosystem, manufacturing sector, eco-innovation, sustainable local development.

1. Introduction

Nowadays, the production models should be reconsidered and redesign to meet future challenges and the current need of sustainability at economic, social and environmental level (Garetti and Taisch, 2012). In the current situation made of fast changes and interconnected problems with effects at the global level, holistic thinking is needed to provide a new approach and a cultural paradigm (Capra, 2014) as it has represented a 'turning point' for many disciplines (Capra, 1982). This new point of view should contaminate the linear economy, many times pointed by scholars as one of the enemies of the current society (Gast, 2017; Littig and Grießler, 2005), to produce a shift in production models and creation of economic models to reach a Blue and Circular economy (Pauli, 2010; EU, 2015). This shift can be produced spotlighting the attention on the local territory in which we are living every day enhancing its cultural and natural resources, indeed of considering it as a place where the products are manufactured, travel everywhere and leave only waste.

Systemic Design (SD) demonstrates with many projects to be an approach able to connect the territory, design and environmental issues to create a local sustainable development (Bistagnino, 2011). This research investigates the intersection between systemic design, environmental sustainability and entrepreneurship, and wants to demonstrate the need of the creation of an ecosystem to support the implementation of projects born from SD to overcome the complex implementation of this type of projects in practical terms which threat their success. It is vital to produce eco-innovation and a shift in production models.

To demonstrate the principal thesis firstly was framed the current scientific literature on topic correlated to Systemic thinking, Design, Business Ecosystem and Innovation models. Secondly, was performed a multiple case-study analysis on previous SD projects applied to the manufacturing sectors developed by SD research group to understand the principal barriers in their implementation and their outcomes. This process was facilitated thanks to the direct involvement of authors in these projects. Afterwards, the typologies of new activities born from the application of SD approach to the manufacturing sector in a specific territory are defined. Finally, the ecosystem is designed (ECO-SD) able to stimulate and foster the born and the implementation of eco-innovative systemic projects with the goal to create and support autopoietic local economies.

This research work is complementary to the work presented in Battistoni, Barbero (2019, in press).

2. Literature review

2.1. Systemic Design: innovation, sustainability and territory

The design discipline with its methodology and approaches has confirmed through different applications to be a strategic approach for innovation creation (Bertola, 2003; Celaschi, 2007; Brown, 2009; Franzato, 2011). At the same time, design shows potentialities in increasing the value of a particular geographical area, as the valorisation of the material culture and natural resources represented in many works as De Giorgi and Germak (2008); Bozzola and De Giorgi (2016); Catania (2011).

Some design approaches also represent a solution to reach sustainability (Ceschin and Gaziulusoy, 2016). Between them, SD, as a discipline which include systemic thinking in the design practice, enlarges the borders of the traditional discipline producing a step forward the eco-design (Jones and Kijima, 2018).

SD applied to anthropic production process was mainly defined by Bistagnino (2011) (Battistoni and Barbero, 2017). This approach is mainly developed around five principal guide-lines, in collaboration with Zeri foundation and Fritjof Capra (Bistagnino, 2011). SD intends to create relationship(2°) based on "an output become an input" (1°) for another system as happens in Nature. These links are created acting locally (3°) and connecting the human being with the context of reference(5°). In addition, the systems created are auto-generating (4°) in terms that they are self-reproducing systems. Indeed, SD applied to single productive activities permits to change their core business, transforming the production models in an open system in relations to the other ones. Considering waste as resources, their incomes are improved and increased. Moreover, it permits the creation of new products that can let the born of new economic realities (fig. 1), generating the autopoiesis phenomenon typical of the natural systems (Capra, 2014). All these opportunities can boost sustainable territorial development, creating a local circular economy. To perform this, they required the intersection between the economic, social and environmental aspects involving different

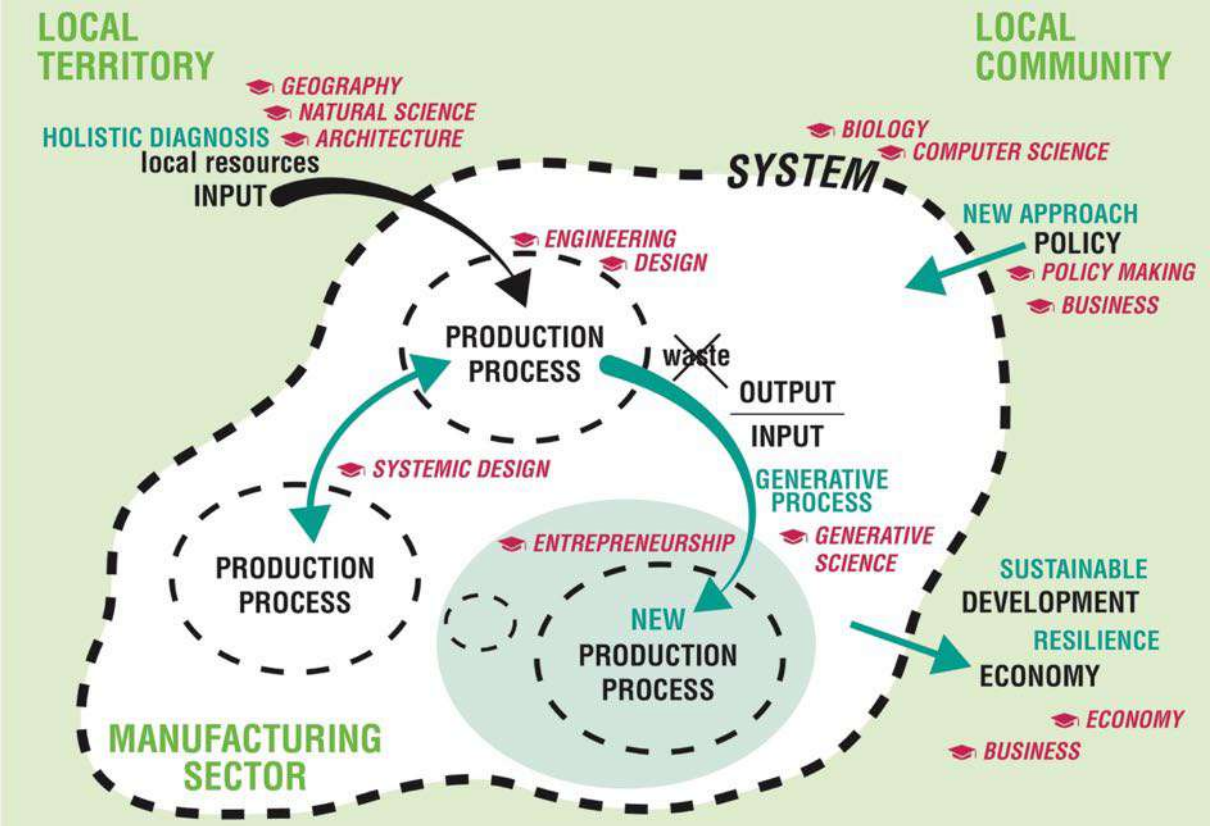

Figura 1 graphic representation on the SD applied to the manufacturing sector and the competences involved in this approach

competences: from technical to humanistic competences (fig. 1.).

2.1. Ecosystem, innovation and territory

As stated by Bassis and Armellini in 2018, Moore (1993, 1996) with his works coined the term Business Ecosystem (BE) defining it as "an economic community supported by a foundation of interacting organizations and individuals" (Bassis, Armellini, 2018, pg. xx) and introducing the concept in the management field. Moore used the biological ecology as a metaphor claims for interactions between existing business in search of innovation (Scaringella and Radziwon, 2018). Moore identified the evolution, adaptability and community as key characteristics of BE, however his Innovation Ecosystem (IE) theory was focused on the firm itself, to help managerial challenges, and the boundaries of the ecosystem ware globally seen (Bassis, Armellini, 2018). Trying to define the differences between IE and System innovation (SI) which both have the theoretical basis in System Thinking, Bassis and Armellini (2018) define the focus of SI in the location (region or country) to which a firm belong, referencing the work of Patel (1994).

Others studies confirm that the concept of the complex adaptive system that comes from biology was starting to be used in the business environment. As stated by Reeves et al. (2016), company, as complex adaptive systems, continues to evolve through cycles of interactions, emergence and feedbacks and they are nested in different systems, from business to societal.

For the multifaceted nature of the concept BE, subsequently in the paper we will use the word of Ecosystem as a metaphor for the way of the Nature act, and not referring to Moore's theory.

During the years the concept of BE is evolved in more concept as "industrial ecosystem", "innovation ecosystem", "digital business ecosystem" and "entrepreneurship ecosystem" (Bassis and Armellini, 2018; Scaringella and Radziwon, 2018), some of which link the ecosystem concept with territorial approaches (Scaringella and Radziwon, 2018), but none of them has links to Moore's theory of IE (Bassis and Armellini, 2018).

For the scope of our research, we are focusing on the Industrial Ecosystem (IE) and Entrepreneurial ecosystem (EE). IEs are identified in the eco-industrial parks created following the industrial ecology where the industrial ecosystems are examined as complex systems (Costa, xx; Chertow, 1999, 2000). Instead, EE is defined as a "systemic view of entrepreneurship" following a recent review on EE by Cavallo et al. (2018). Many studies had focused on the definition on the components of the EE (Cohen, 2006; Neck et al., 2004; Stam, 2015; World Economic Forum, 2013; Feld, 2012; Spiegel, 2015; Isenberg, 2010). About the relation between EE and the territory, Cohen (2006) have contributed to highlight the attention on how the territorial context have impact on entrepreneurship and that entrepreneurship takes place in a precise geographical area with the coordination of multiple actors (Cavallo et al., 2018), and Audretsch et al. (2012) pointed the focus on the relationship between regional characteristics and entrepreneurial activities.

The scientific literature has many times focus on the role of Business Incubators (BI) and their role in EE. A previous work by authors has stated the BIs phenomenon (Battistoni and Barbero, in press). Along the discussion on the meaning, there is the one on understanding the typology of existing BI, their goal and services. Along with different typologies, many authors identified the regional incubators archetype (Barbero J. L. et al., 2012; Aernoudt, 2002; Von Zedtwitz and Grimaldi, 2006).

More recent studies, like the one of van Weele et al. (2018), call for the fourth generation of BIs: "the 'systemic' incubators that aim to transform or create institutions to strengthen the entrepreneurial ecosystem (DiMaggio 1988). Lately in our study, referring to a 'Systemic Incubator' we will not only refer to this definition but mainly to an incubator that can foster the creation of start-ups from systemic design projects.

The intersection between entrepreneurship, environmental and social responsibility is identified in 'ecopreneurship' (Battistoni and Barbero, 2019 in press). The benefits for sustainable-driven business models are starting to be investigated by researchers as Kiron et. al (2013) however their research is focused on profits raised by companies and a Systemic Thinking should be applied to the design of sustainable enterprises to consider sustainable and social factors in business models (Jones and Upward, 2014).

According to, Scaringella and Radziwon (2018) EE emerges through the interactions of various actor and stakeholders creating intersections between different systems considered in the triple helix model of innovation (industry, university and government level to create the knowledge society and innovation and economic development) leading to the quadruple helix model which consider the civil society (Scaringella and Radziwon, 2018). The helix models of innovation had evolved during the years (fig. 2). Very interesting for our study is especially the Triple Helix Systems of Innovation in which the triad is acting as a system with systemic and non-linear interactions between actors (Stanford University website).

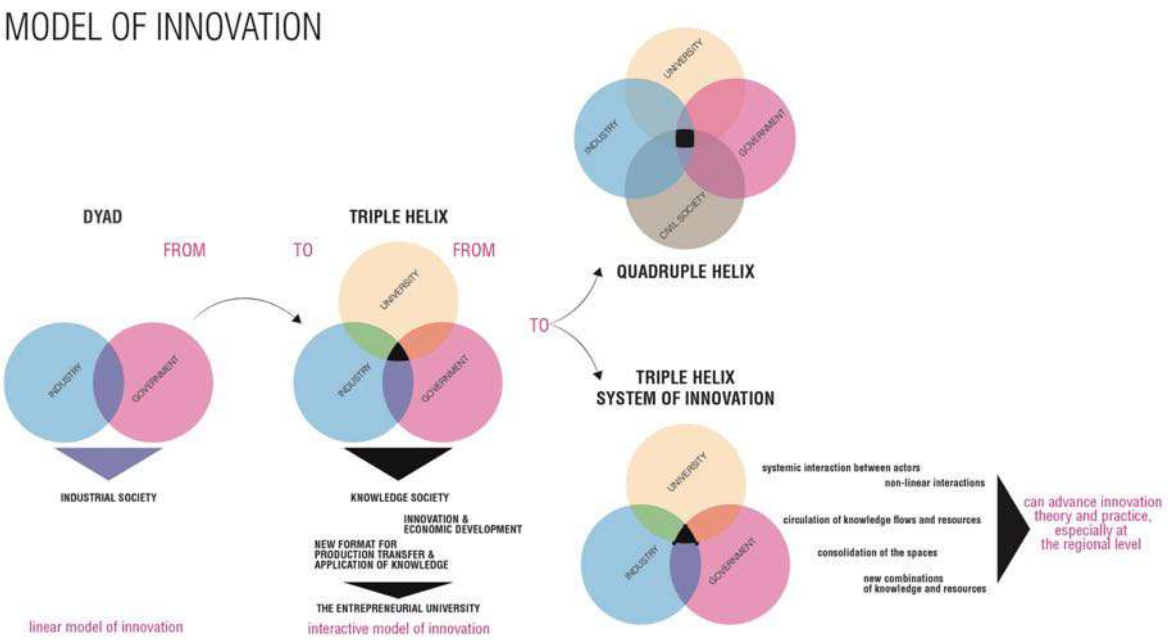

Figura 2 graphic representation of the evolution from the Dyad, to the triple helix and quadruple helix

Literature has also focused on the relationship between BIs and governments and their roles (Kautonen et al., 2017; Cavallo et al., 2018; Stam, 2015; Scaringella and Radziwon, 2018)..

3. Case-studies on SD for territorial development

Although the literature has highlighted important characteristics of SD projects to reach a sustainable development (Bistagnino, 2011; 2016) at the same time, they can represent the barriers to their success and implementation. We will focus on two SD projects which fit in two categories for their high level of complexity which didn't permit their implementation: (1) project for a particular territory; (2) project for a particular production process based in a particular territory. We performed a multiple case-study research (Yin, 2014) highlighting for each case the main pros and cons to understand the main barriers reasons.

3.1. SD project for a particular territory

In this project, the SD approach has been applied in a mountain Valley in Piedmont Region, Italy (Battistoni & Daghero 2013; 2016). The project design new sustainable production model for every 24 typologies of enterprise taken in consideration, creating at the end a complex system able to generate territorial development not only at economic level but also at environmental and social one. The project demonstrates to be able to create: (1) 26 typologies of new activities as shown in fig. 3); (2) several environmental benefits as the reduction of the use of the drinkable water of 80%; (3) a substantial economic profit. After a considerable consensus by the local policymakers, the project wasn't implemented.

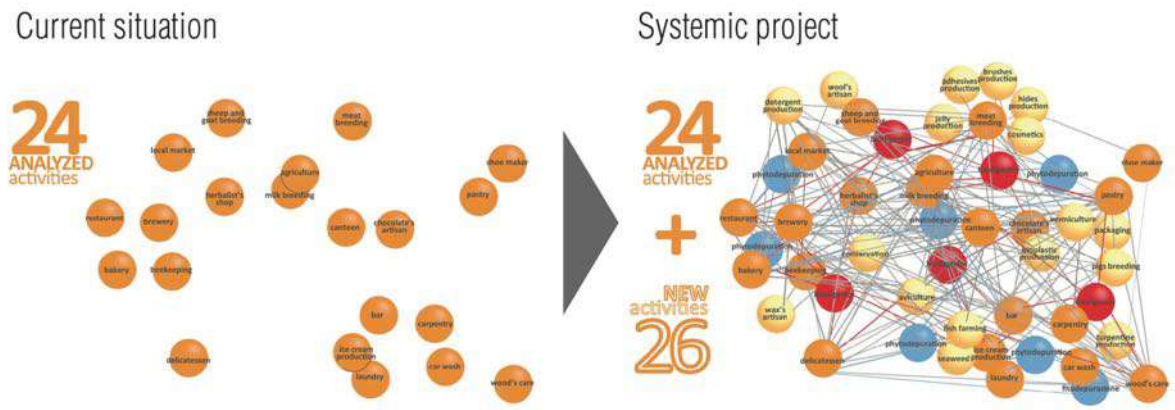

Figure 3 development and design of the complex system. In the visual representation are present only the principal relationships between the components. In orange are represented the current activities, in yellow the new one.

In table 1 is presented an analysis of the pros and cons of the project for its implementation.

Tab. 1. Pros and cons of the project implementation

BENEFITs (pros)	Initial support from city major
	An alpine Valley plenty of natural resources
	High sense of community between citizens
	Presence of only micro-small enterprise
	Close valley (at geographical level)
	Rich Valley

	Strong relation between nature and inhabitants
PROBLEMs (cons) related to the project (internal):	Lack of commitment by the activities' owner along all the project
	Most the activities involved are from the 1° sector (agriculture and breeding), owned by old people and with no inclination to investments
	Close valley (at social level) and reduce openness to innovation
	Difficulties in understanding the importance of the project
	Sleeping Valley: most of the people who live there, work out from the Valley
	Lack of external founding, despite the major commitment
	The city major changed few months after the project
	Difficulties in understanding the complexity of project
	Lack of awareness on the importance to change (no Valley in crisis)
	Lack of strong commitment by the entrepreneurs
	Top-down approach (not coming from the citizens or enterprises)
	Lack of a feasibility study of the project, only economic forecast

3.2. SD project for a particular production process based in a particular territory

In this case study, the SD approach was applied to a particular production process, food factory (Barbero & Battistoni, 2016). The project, done in collaboration with the industry and the Systemic Design research group, guide the enterprise towards a systemic production model. The project worked on the re-connection of the food production with local resources and know-how acting on the change of ingredients, re-designing a typical traditional product which can become a symbol of the region and the cares about the consumer's health. Involving local products in the new recipe, the factory starts acting as a re-activator of the local agriculture and manufacturing sector, increasing relationships which can have cascade impact for all the region and starting up also other business (fig. 4), creating sustainable territorial development.

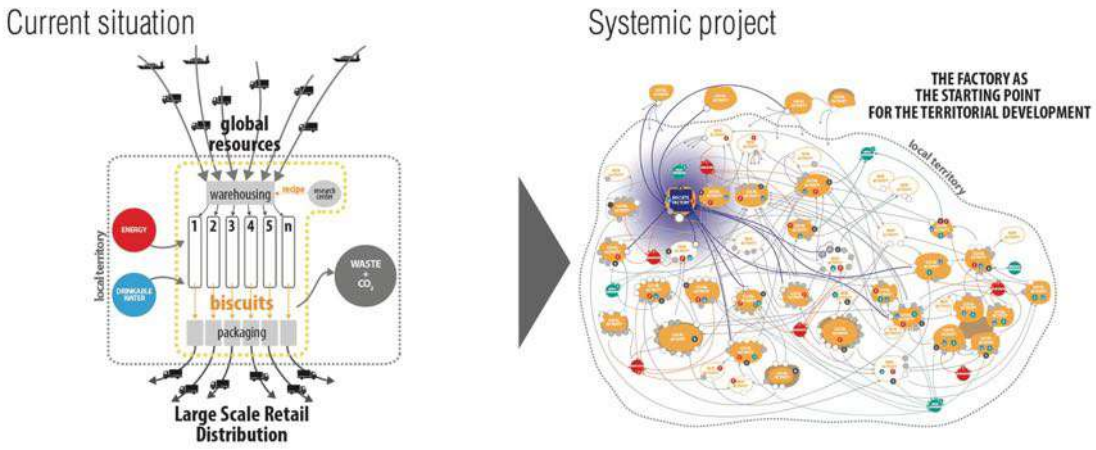

Figura 4 visual representation of the shift proposed by the Systemic Design project. Graphic review of the picture published in Battistoni, Barbero 2016

In table 2 is presented an analysis of the pros and cons of the project for its implementation.

Tab. 2 pros and cons of the project implementation

BENEFITs (pros)	No problem in economic investments
	Interest for innovation projects
	Internal research centre
	Industry which in the past started as a little biscuit maker in the same location (has a recognisable role in the area)
	Thanks to innovation in management, the employees are listened by the CEO, and their ideas are taken into consideration
PROBLEMs (cons) related to the industry (internal):	Lack of commitment by the industry along with all the project duration (or at least by the CEO along the project duration) - Change of CEO during the project
	Sharing of internal data to external people (even researchers involved in the project)
	Lack of data on the specific quantity of the different input and output
	Difficulties to understand the importance of the project over the economic benefit
	Large industry which must preserve many job places, it acts with caution
	Reduced openness to collaboration with other industries
	Lack of awareness by the CEO on the area where they are located (better situation among employees)
	Focus on its own production and lack of awareness on what is happening outside (especially on agriculture topic)
	Lack of awareness on the implications of their actions on the environment and consumer's health
	Lack of future visions on the environmental situation
	Difficulties in managing the complexity of the projects
	Resistant to change

4. Results

Thanks to the precedent case studies analysis, is possible to draw many results: from the state-of-the-art of territories to the major implementation barriers faced by SD projects to the definition of the many opportunities created by SD project for a new kind of entrepreneurship, to the draft of the ecosystem requires to ease the implementation of the new typologies of enterprises.

4.1. Territory: state-of-the-art

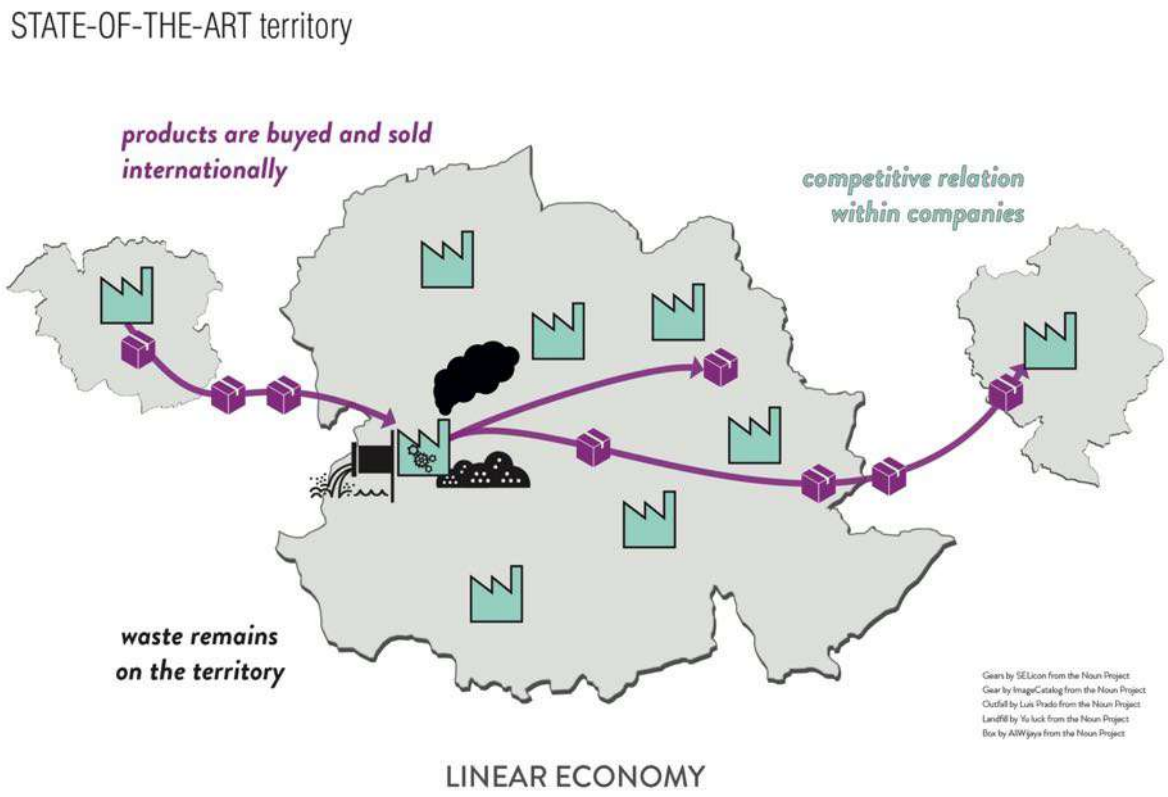

Figura 5 grapic representation of the state-of-the-art of territories, considering the behaviour of the productive sectors

From the analysis of the current situation performed in every projects, it is possible to frame the state-of-the-art of our territories based on the behaviour of the productive companies located in them, as shown in fig. 5. Usually, the companies are processing different typology of matters which comes from many different territories and sell their products at the global level in a competitive ecosystem. Under this behaviour, there is a lack of awareness about the implications of our action on the environment. Indeed, there is an exploitation of the of the energy and the human capital needed for the manufacturing process and on the territory where the company is settled remains only waste and pollution (in water, soil and air).

4.2. SD projects implementation barriers

Another result that is possible to obtain for the case-study analysis is the barriers to SD projects implementation (tab 3). At the basis, SD projects require a cultural paradigm shift (Barbero,2016), from the linear to the systemic thinking, from competition to collaboration, identified by Capra (1982) “the turning point”. Besides, complexity resulted to be one of the SD projects fundamental characteristic as they focus on the relationships between components instead of the single entities and on the resources which go in and out of a production process. Complexity can represent an obstacle to overcome for the human linear way of thinking developed with the industrial revolution.

Moreover, talking about input/output and not resources/waste they need a complete change on the cultural paradigm and point the focus more on qualitative aspects than quantitative ones. The current legislation on waste is limiting the relationships made by flow of matters. Another consideration is that SD projects are community-oriented, territorial-oriented and environment-oriented more than profit-oriented and producing sustainability they require the competences of different disciplines, multiple actors and stakeholders, both in the design phase than in their implementation, being multidisciplinary and interdisciplinary projects. Finally, they require financial support, human resources and project management as all the projects. Luckily, the current emphasis on the Circular Economy from the European Union is helping to bridge the cultural gap since 2015 (EU, 2015).

4.3. Identification of the typology of new activities that can potentially born

The application of SD approach to the manufacturing sectors can support the creation of new opportunities to obtain a sustainable local development that can be turned in new enterprises. These opportunities are defined as:

- Action on the entire production model to produce a shift from the linear one to a circular and systemic one;
- Spin-off creation by:
    a. new opportunities discovered inside one production model;
    b. the opportunity given by a single output well-known by research community - depending on output quantity it can born from the collaboration of similar industries or just by one;
- Start-ups/new enterprise, created by:
    a. Systemic designer which become eco-entrepreneurs which idea come from different past experiences;
    b. eco-entrepreneurs after a training on SD approach, which idea come from the scan of regional opportunities (HD) for:
        i. business profit (e.g. production of a new kind of product from something that now is considered waste;
        ii. non-profit business (e.g. biodiversity and biological ecosystem protection and restoration);
        iii. business profit with the goal of community involvement increasing awareness through the creation of activities as workshops (e.g. working on waste perception);
        iv. business profit with the goal of citizens and awareness improvement (e.g. buying group for local products)
        v. benefits for the entire territories (e.g. creation of a fab-lab for the recovery of local know-how);

c. collaboration of different industries and systemic designers to manage one of the companies' problems (e.g. to manage the sharing of technical instruments or machines);

- new clusters: association of industries with close collaboration in the same area (same goal with eco-industrial park concept (Chertow, 2000).
- Research projects:
    a. on particular local output not well-known by scientific community, to advance the scientific knowledge and with possible new business opportunities creation;
    b. to provide the redesign of products following 'ecodesign' (Lanzavecchia, 2012) and 'design by components' (Bistagnino, 2008) approach, thanks to the competences of systemic designer involved.

4.4. Ecosystem definition

Missing contributions by the scientific literature on the definition of the ecosystem which can sustain SD projects, the design of a systemic entrepreneurial ecosystem is necessary (ECO-SD). Its goal is to stimulate and foster the born and the implementation of eco-innovative systemic projects to obtain a sustainable regional development. It is represented in fig. 6. This definition represents a step over the one presented in a previous conference paper (Battistoni and Barbero, in press).

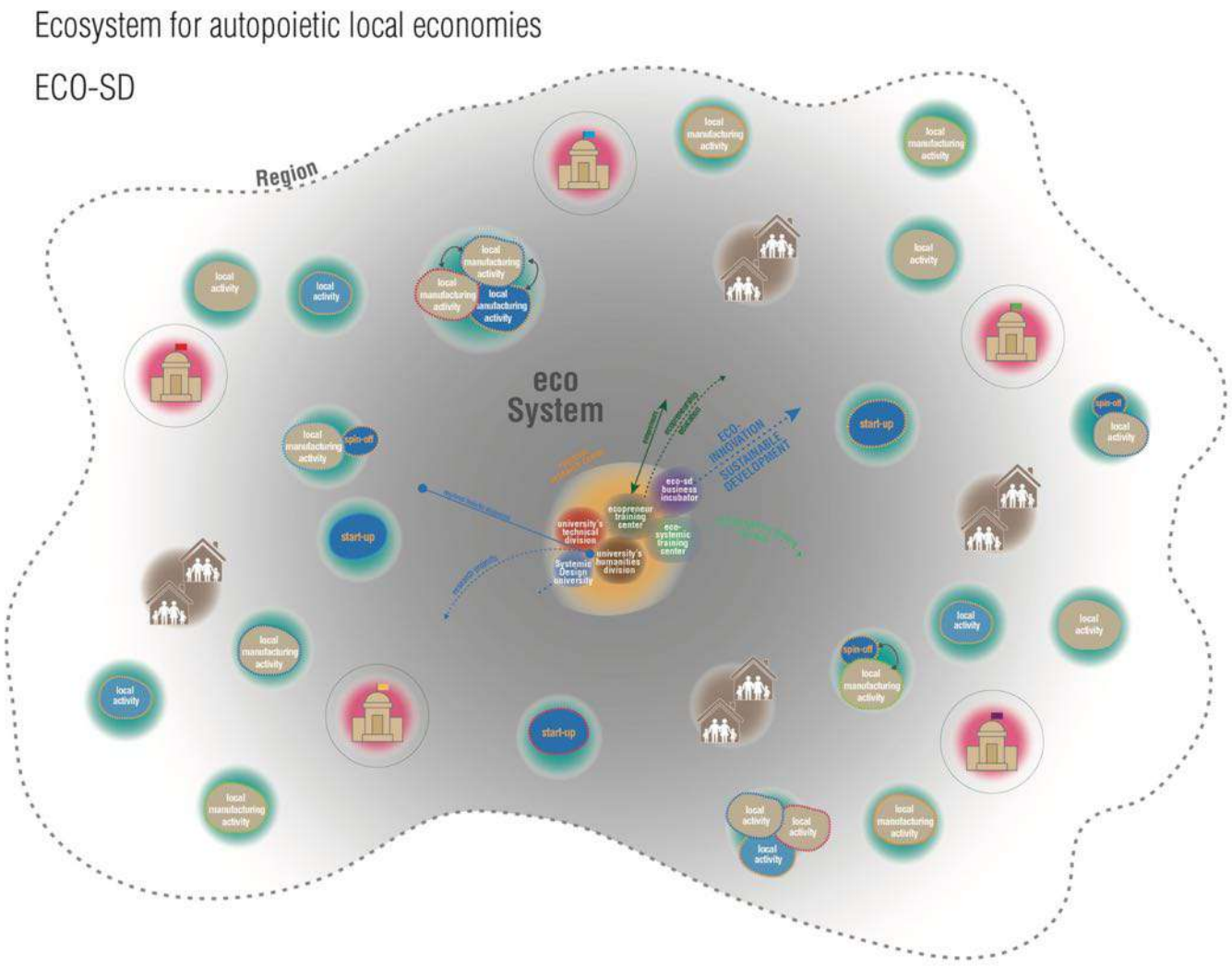

Figura 6 graphic representation of the ECO-SD

Looking at the territory and its productive sectors with a systemic approach, shifting the attention from the single actors to the relationships that are possible to create among them, is possible to obtain different results. As the theory of system suggests "the whole is *greater* than the sum of its parts" (Aristotle), or better "the whole is *other* than the sum of its parts" from Gestalt theory (Koffka). This shift can let emerge several new opportunities and potentialities linked to a development which is far away from the current economic evidence, centred exclusively to the increase of the GDP. Acting in this way is possible to answer to the real needs of a specific area, with the final goal to act on the cultural paradigm, obtaining a real sustainable development.

ECO-SD incorporates the characteristics of the EE and the different models of innovation, the triple helix system of innovation and the quadruple helix, cited before. A graphic representation of the actor involved in ECO-SD is present in fig. 7. The university level is represented by the technical and humanities division and also includes the university on SD which include technical and humanities skills. The government is represented by the different levels (from city to regional and national) which act on a specific territory. The industry is represented by the three typologies of enterprises (micro and small, medium and large). The civil society is present not as a single entity but in relation with all the others, being everyone represented by human beings that act as a civil society once that their work end.

The heart of ECO-SD cannot be identified only in the current BIs which are concentrated mainly on the economic sustainability of the projects and the training of the future entrepreneurs within linear economy benchmarks. Instead, it is represented by the Regional Research Center (RRC) (fig. 8) which present the intersection between the universities, the training centre on ecopreneurship and systemic approach. RRC acts as a guide: starting from the execution of the HD (Battistoni and Giraldo, 2017), it can identify the current significant problems and the sectors where projects are needed. Opening the way to the innovation of process, production models, products and services, they are therefore designed by multidisciplinary groups where the designers collaborate with other scholars and experts coming from the natural, social and economic science, acting as “mediator” (Celaschi, 2008), fostering the dialogue and the contamination. Working together for the implementation of the new projects, they should maintain the link with the local actors, not exclusively coming from the productive sector but also from the decision-making, to assure a local sustainable development.

In close relationships with RRC works the ECO-SD incubators, a systemic incubator with the goal to foster the born and the reproduction of productive processes and act as an open system. In here, also the economists should think in another way as Raworth suggested (Raworth, 2017) and work in close relationship with the Ecopreneur Training Center. In the ECO-SD incubators, the attention is on the flow of information, matter, energy and people which create relationship both inside every single process and within them, and within the context of reference where it is placed as shown in fig. 9.

All the opportunities created in the ECO-SD can lead to the creation of different typologies in the same territory as the one represented in fig. 10. Along the one which are created thanks to the ECO-

SD inc there are the one which has been affected by the ECO-SD RRC only by trainings or the one that has not received any supports.

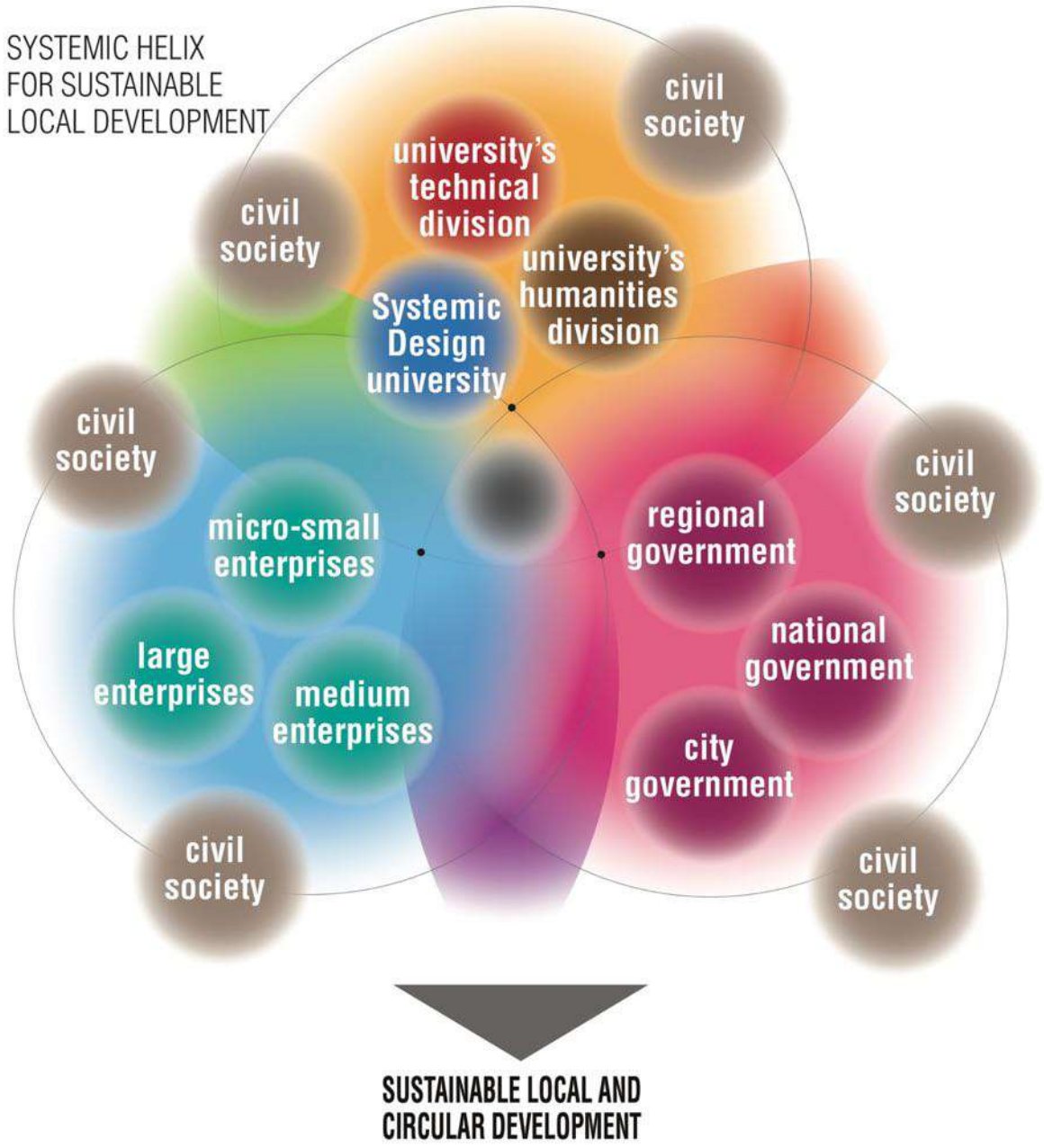

Figura 7 graphic representation of ECO-SD

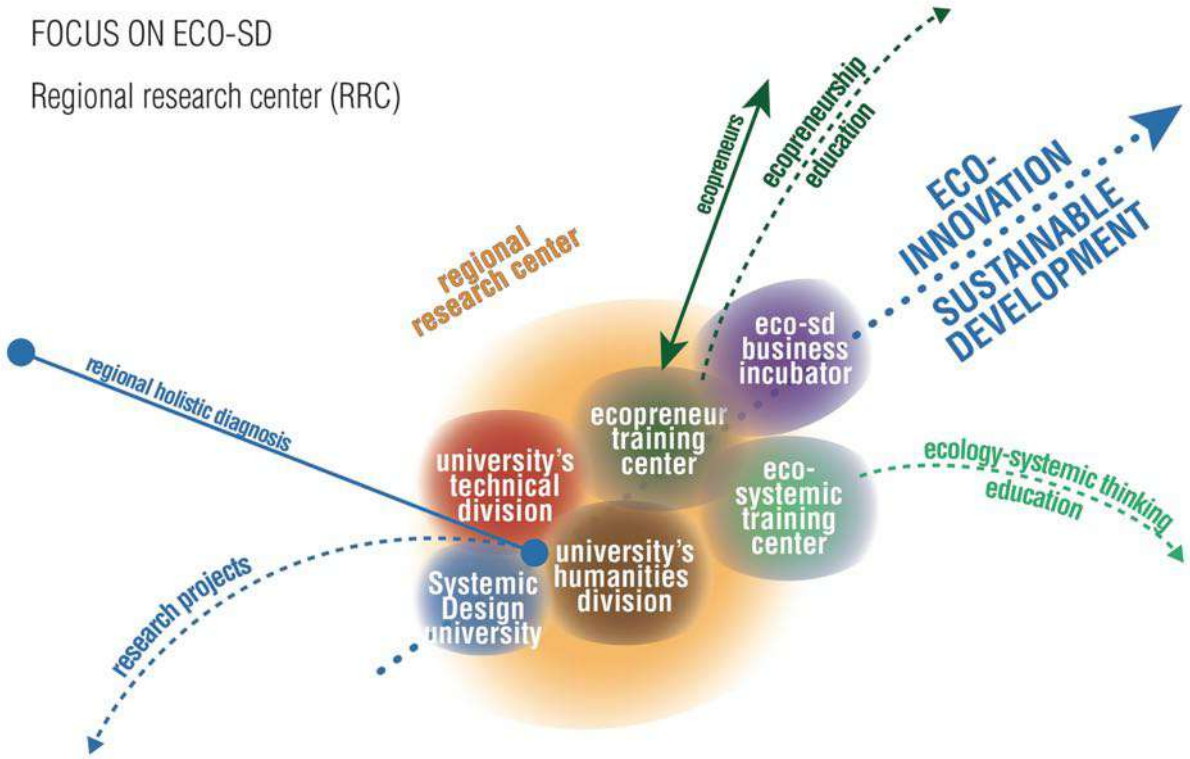

Figura 8 graphic representation of the RRC inside the ECO-SD

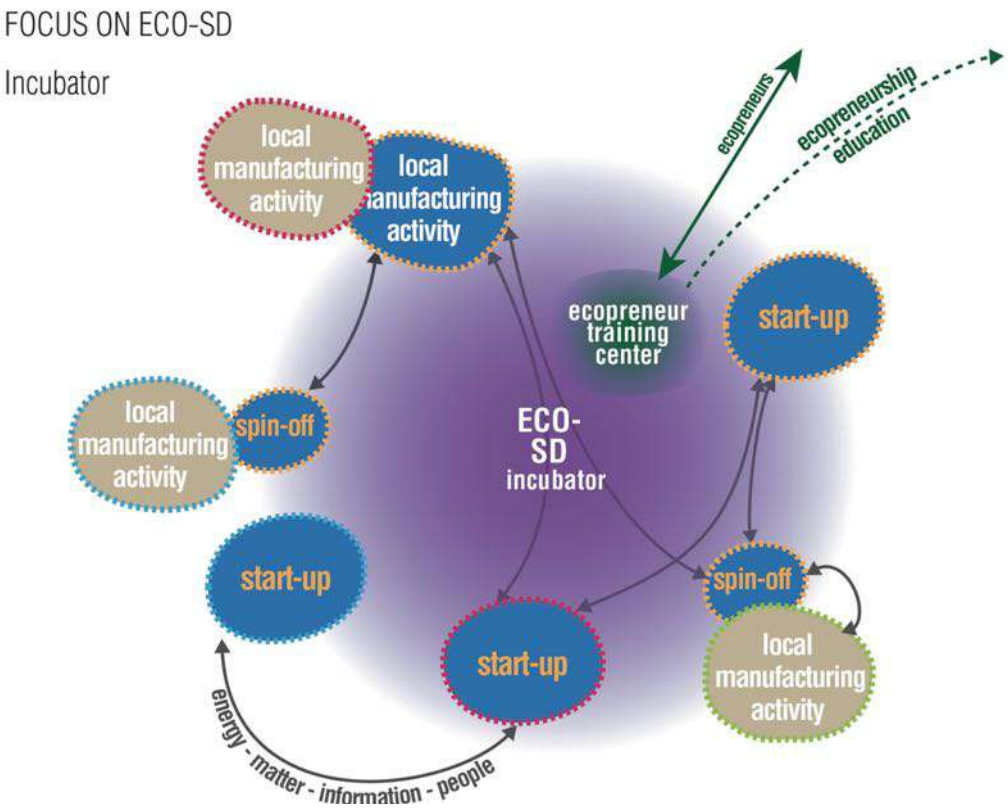

Figura 9 graphic representation of the ECO-SD incubators and the possible new start-ups created.

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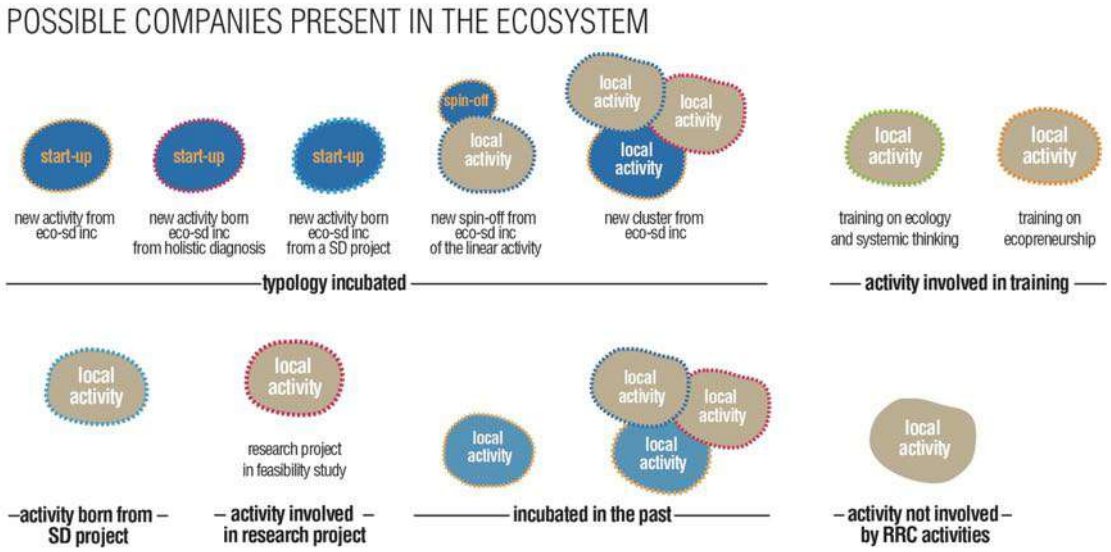

Figura 10 possible typologies of companies presents in ECO-SD

5. Discussion and conclusions

The different results of this research were necessary to the definition of the main result, the ECO-SD. It finds roots in previous studies on helix models of innovation and on EE and in a previous study by authors which has shown its limitations. In this new definition, in the ECO-SD is present the ECO-SD inc which continues to focus on the economic sustainability of the ideas and business models received. As previously stated by van Weele et al. (2018), incubators are evolving entering services more related to the idea creation, which by our opinion, should be an action done in collaboration with multiple actors, comprehending designers as they are trained and worked to frame new ide and opportunities by currents problems and necessities.

In the graphic representations in fig. 6 the net which is creating between all the different actors is implicit in the grey colour. A future research, which now is only is a tentative attempt represented in fig. 11, is to find all the relationships created by the ECO-SD between the different actors and the outcomes created by them. The principal outcomes created by ECO-SD can be represented in the 'sustainable local and circular development', which subsequently can be split in the creation of ecopreneurship, sustainable economic development, low environmental impact, high social impact and participated policies. Further studies should be concentrated also on the future vision about what this ecosystem can create in the local territory as represented in fig. 12. Another future research will be to find and analysis case-studies where similar realities to ECO-SD are already in action thanks to similar goals which are not present in the scientific literature. This step will help to define better the hypothesis done in this study and it will be into a real context of application. The

most likely and eased to implement is related to the Torino municipality in Italy where the Systemic Design research group is located and already working.

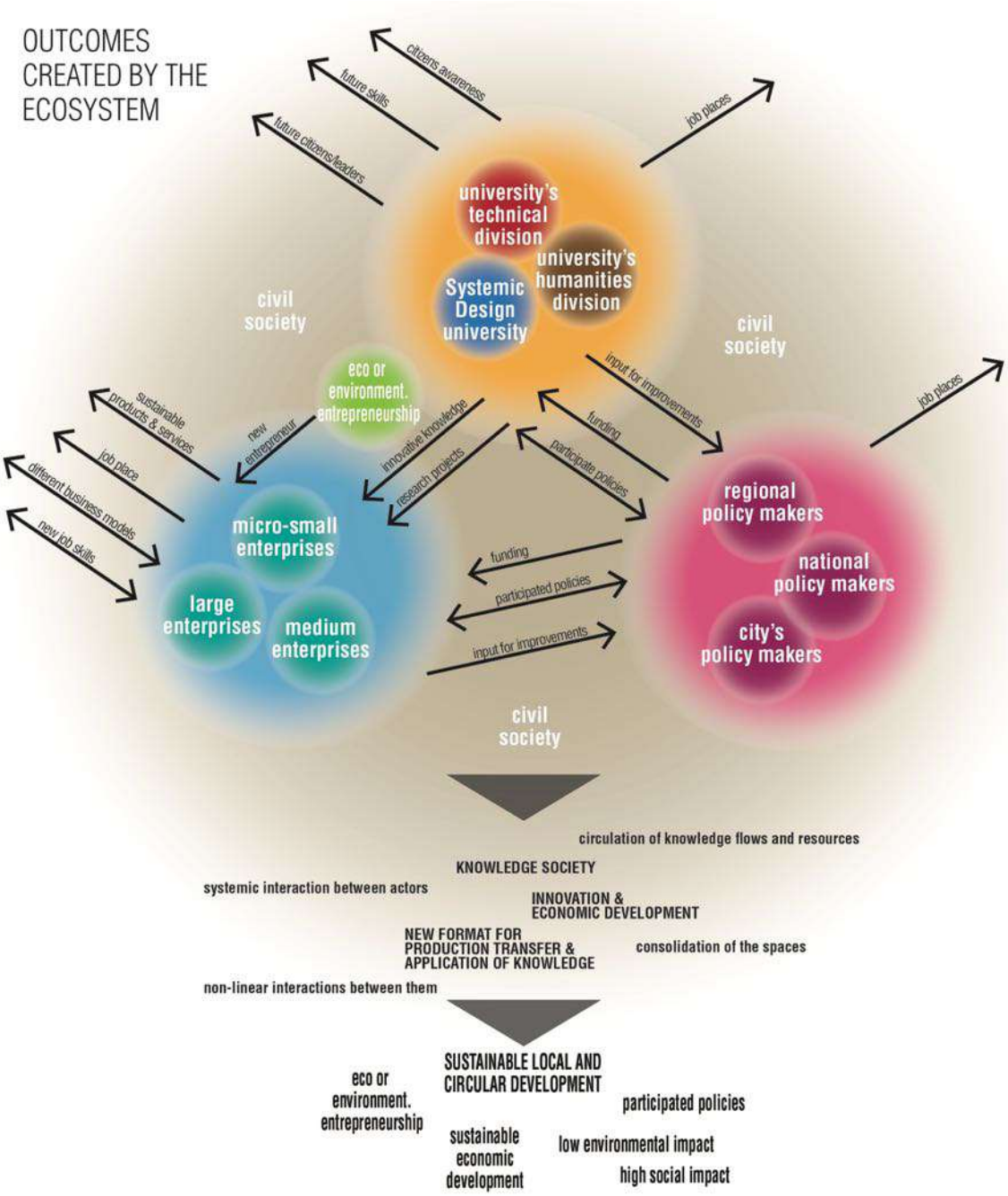

Figura 11 graphic representation of the relationships between the different actor in the ECO-SD and the outcomes that these relatinships create.

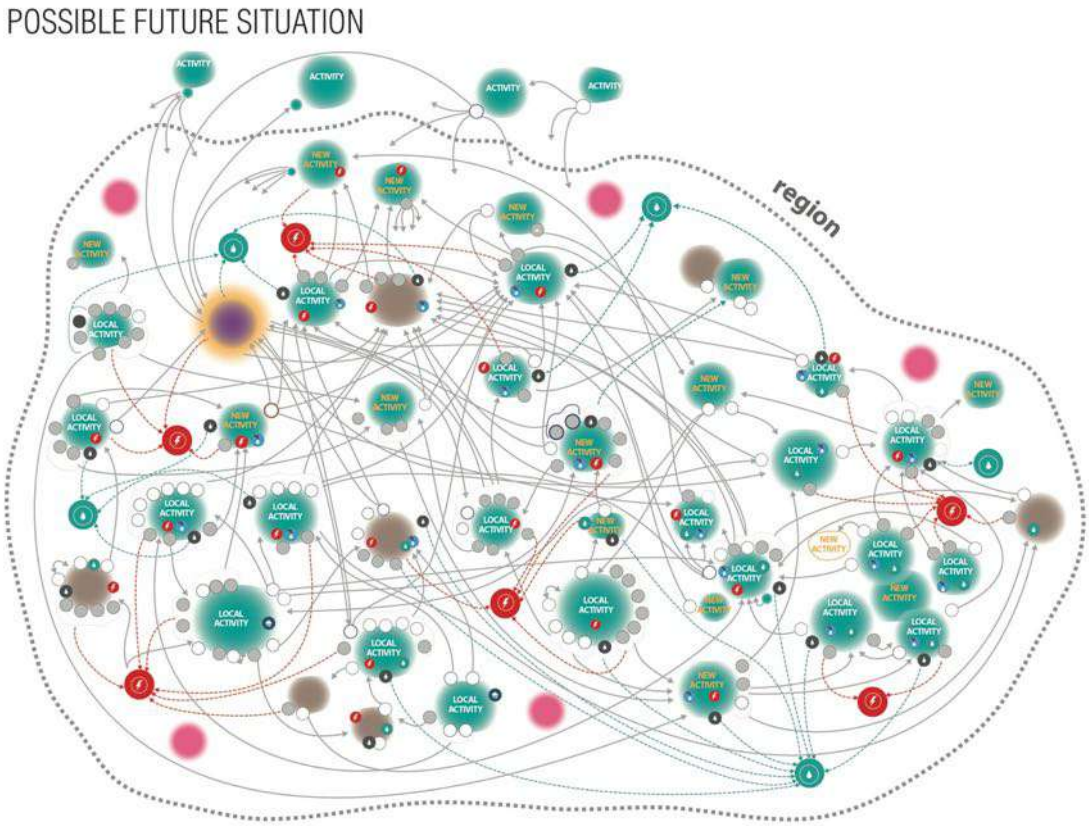

Figura 12 graphic representation of the possible future situation inside the region

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