Design of an ecosystem to foster systemic eco-innovation. Systemic design for autopoietic local economies

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Systemic design for autopoietic local economies

Abstract

The current global environmental situation, with its interconnected problems, requires holistic approaches to provide a cultural paradigm shift and a different economy to overcome the linear one. Systemic Design (SD) can represent a solution creating opportunities for eco- and system innovation, especially in the manufacturing sector, which will soon face a revolution in the production model. Thus, SD can help achieve environmental and economic sustainability at the local level. A multiple case study analysis on SD projects was developed to understand the significant eco-entrepreneurial opportunities that have emerged and the barriers for their implementation. Finally, an ecosystem is designed to foster systemic innovation based on helix innovation models and identify the facilitator for its creation, namely, the 'local systemic network booster'.

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

Introduction

The current global environmental situation involves interconnected problems, such as waste management issues, increasing pollution, biodiversity loss and climate change, with effects everywhere and for everyone. Linear thinking has produced a linear economy, which is a major issue for the current situation (Gast, Gundolf, & Cesinger, 2017; Littig & Grießler, 2005, cited in Gast et al., 2017). The manufacturing sector will face a revolution in the near future; thus, it needs to reconsider its production models to meet the challenges for a sustainable future (Garetti & Taisch, 2012). Holistic approaches are required to provide a different cultural paradigm to follow (Capra & Luisi, 2014); Capra (1982) has identified this as a 'turning point' for many disciplines, in which they will move away from the linear approach.

Alternative economic models to start the path to a post-Anthropocene era exist, such as the Circular Economy (CE), which wants to close the circle by integrating waste in a productive cycle (European Commission, 2014), and the Blue Economy which takes inspiration from nature, where wastes do not exist and everything is used by a different natural kingdom (Pauli, 2010). Both concepts are based on 'systems thinking' (Ramage & Shipp, 2009), where the relationships between components are more important than the components proper and can produce a different result.

Systemic Design (SD; Jones & Kijima, 2018), a discipline that applies systems thinking in design processes and practice, can represent a solution to the current environmental situation, creating opportunities for eco- and system innovation and producing environmental and economic sustainability at the local level. In the manufacturing sector framework, it acts on the production models by designing out waste, working on input and output and creating relationships between components, resulting in a system that operates in a specific area (Bistagnino, 2011). Its potential for generating new businesses and entrepreneurial opportunities starting from the local resources can contribute to the development of autopoietic local economies. This last concept refers to the 'autopoiesis' defined by Maturana and Varela

(1980) as a property of the living system, referring to continuous learning, adaptation and self-generating and self-balancing properties (Capra & Luisi, 2014).

Despite the high value, positive effects on the geographical context and high potential creation of eco-opportunities and innovation, SD projects implementation is complex because of several factors. This article aims to elucidate the significant eco-entrepreneurial opportunities created by SD projects and the implementation barriers; doing this will help ease, foster and support the realisation of these opportunities. Exploring the relationships between SD, environmental sustainability and entrepreneurship, the main research question is as follows: How can the implementation of opportunities generated by SD projects be best supported to boost territorial CEs?

Methodology

To answer the main research question, the following methodology is used. First, the context is framed based on a literature review on scientific contributions about the topic. Starting from the current innovation dynamics and models in business through the concept of business incubators (BIs) and business ecosystems, the study aims to discover their relationships with territorial approaches and environmental sustainability. Afterwards, the review moves to the design discipline and its role in innovation and sustainable local development, with a focus on the concept of systems thinking and the SD discipline.

Second, a multiple case study analysis (Yin, 2017) is performed on two failed SD projects for sustainable territorial development in which the authors were directly involved. The first is an SD project for a specific territory, while the second is an SD project for a specific production process based in a certain area. From the analysis of the design and implementation process, the main enablers and barriers are extracted to understand the problems related to the project implementation. This analysis also elucidates the significant eco-entrepreneurial opportunities created by SD projects.

The lesson learnt from this analysis allows a theoretical model of an ecosystem to be designed that can foster systemic innovation with a positive and high impact at the local level and create a circular and ecological economy. This process started with the identification and extraction of the main opportunities at the eco-entrepreneurial level created by SD projects, which was also possible thanks to several years of experience the authors had in SD projects. This step allows the identification of the main actors involved in the future ecosystem and the services needed to foster systemic innovation and the creation of interactions between them. The designed ecosystem is based on the quadruple and systemic helix models of innovation identified in the literature review.

Finally, the reasoning on the ecosystem creation reveals the necessity of an ecosystem facilitator (anchor tenant) called the 'local systemic network booster' (LSNB). This early finding is discussed in the last section.

Context: territorial approaches within innovation dynamics, business ecosystems and (systemic) design

Considering innovation as the implementation and commercialisation of something new, from products to services, it occurs in different contexts. Innovation in firms is connected to internal factors, such as the firm's characteristics, and external factors, such as the flows of ideas in a country and from abroad (Pittiglio, Sica, & Villa, 2009). For this reason, large enterprises on the one hand and small and medium-sized enterprises (SMEs) on the other have very different potentials and behaviours towards innovation. Although they are considered '*agents of change through innovative activity*' (Audretsch, 2002, p. 17), limited internal human and financial resources can limit SMEs' innovative effort, forcing them to create links with external actors like other enterprises or public research organisations (Pittiglio et al., 2009).

In the 2000s, the BIs phenomenon emerged in the European context after the spread of the American counterpart (Center for Strategy & Evaluation Services [CSES], 2002), and it can

support the creation of firms that deliver innovative products and services. Identified as '*organisations dedicated to the support of emerging ventures'* (Bergek & Norrman, 2008, p. 21), BIs accelerate entrepreneurship, create economic development, reduce unemployment, train entrepreneurs and offer technological and financial support (Aernoudt, 2004; Barbero, Casillas, Ramos, & Guitar, 2012; Bergek & Norrman, 2008; CSES, 2002; Von Zedtwitz & Grimaldi, 2006). A previous review by the authors (Battistoni & Barbero, 2019) on BI typologies and services has identified a multifaceted phenomenon. Interesting for this research scope are the networking services, both internal (tenants) and external (customers, investors, universities, enterprises, etc.), and the BIs' contributions to regional economic development. Despite their clear role in the creation of economic sustainability, and their recent part in social innovation (Zahra & Wright, 2016), a gap was found in the scientific literature in terms of the BIs' engagement in reaching environmental sustainability (Battistoni & Barbero, 2019). Looking for relationships between the entrepreneurial world and environmental factors, the ecopreneurship movement has emerged as '*the process of identifying, evaluating and seizing entrepreneurial opportunities that minimise a venture's impact on the natural environment and therefore create benefits for society as a whole and local communities*' (Gast et al., 2017, p. 46), a concept analysed by many authors (Bennett, cited in Holt, 2011; Gast et al., 2017; Holt, 2011; Santini, 2017).

The idea of BIs as the actor operating individually for innovation and entrepreneurship development in a specific geographical context is restrictive. Indeed, introducing the concept of ecological ecosystems in business has led to the emergence of the business ecosystem concept (Bassis & Armellini, 2018), which has evolved into different and specific concepts over the years, including those of the 'industrial ecosystem', 'innovation ecosystem', 'digital business ecosystem' and 'entrepreneurship ecosystem' (Bassis & Armellini, 2018; Scaringella & Radziwon, 2018). For the scope of the research, the focus has shifted to the industrial ecosystem (IE) and entrepreneurial ecosystem (EE). IEs are identified in the eco-industrial parks where clusters of enterprises are examined as complex systems, following the industrial ecology concept (Chertow, 1999, 2000; Costa, 2011). Instead, EEs are defined as a 'systemic view of entrepreneurship' (Cavallo, Ghezzi, & Balocco, 2018, p. 2), focussing the attention on the relationships and the effect of the local socio-economic context on entrepreneurs (Cavallo et al., 2018). Many studies have also focused on the definition of EE components as suggested by Stam (2015).

Some scholars link the ecosystem concept with territorial approaches (Scaringella & Radziwon, 2018). In this framework, authors have contributed to highlighting the effect of territorial context on entrepreneurship, with the coordination of multiple actors (Cohen, 2006) and bringing regional characteristics to the entrepreneurial activities (Audretsch, Falck, Feldman, & Heblich, 2012). The metaphor with the natural world has also been applied to companies: Reeves, Levin and Ueda (2016) define them as complex adaptive systems that evolve through cycles of interactions, emergence and feedbacks and interact with different systems, from business to societal ones. Trying to define the differences between the innovation ecosystem and system innovation, which both have their theoretical basis in system thinking, Bassis and Armellini (2018) define the focus of system innovation in the location (region or country) to which a firm belongs (Patel, cited in Bassis & Armellini, 2018).

According to Scaringella and Radziwon (2018), EE emerges through the interactions of various actors, stakeholders and systems comprehended in the quadruple helix models of innovation, which considers civil society as the fourth actor with the industry, university and government. Indeed, mainly thanks to the Stanford University research group, the models of innovations were identified in the evolution from the dyad (industry–government) to the triple and quadruple helix (Fig. 1). Highly interesting for the research scope is the Triple Helix System of Innovation, in which the components of the triad act as a system with systemic and non-linear interactions (Stanford University, n.d.).

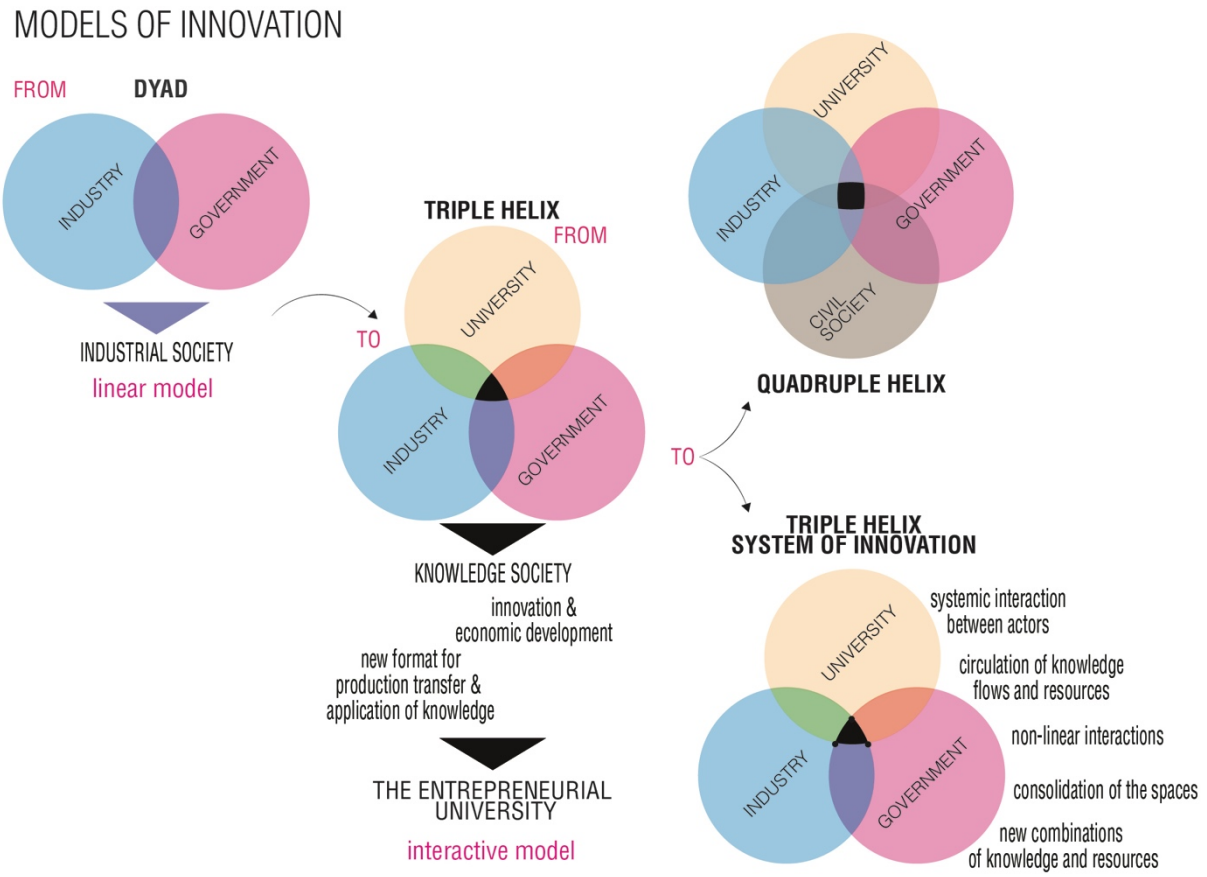

Figure 1. Graphic representation of the evolution from the dyad to the triple and quadruple helix. Retrieved from Battistoni and Barbero (2018); based on the information presented on the Stanford University (n.d.).

Arguing about the governance of business and entrepreneurial ecosystems, the scientific literature identifies the figure of the 'anchor tenant' as the facilitator for the growth and evolution of the ecosystem. A review of this concept in the Scopus database, updated in September 2019, reveals the roots of this terminology in the strategies for opening new large department stores around a famous shop (Agrawal & Cockburn, 2003). Following Agrawal and Cockburn (2003), who explored the hypothesis in regional innovation systems, the anchor tenant is played by a '*large, local R&D-intensive firms*' able to use and push the university research and other local industries, recognising the key role of university research in the regional innovation performance. Referring to the regional material and energy flow, Korhonen (2001) and Korhonen and Snäkin (2001) identified this actor in the powerplant of heat and energy co-generation. The review of the concept by Niosi and Zhegu (2010) find different typologies of anchor tenants, including large innovative firms, research universities or public laboratories. In addition, concerning the governance of EE, Colombelli et al. (2019) refer to the concept of anchor tenants, individuating its transforming role—from a hierarchical role in the birth phase to a more relational role in the consolidation phase. Moreover, they comment that '*the role of an anchor tenant changes over time*' (Colombelli et al., 2019, p. 508). Many contributions also link this concept to the industrial symbiosis and eco-industrial parks; for instance, Sun, Spekkink, Cuppen and Korevaar (2019) focussed more on anchoring as an activity (institutional or physical) than as an actor, while Burström and Korhonen (2001) identified it in the municipality. The review has illustrated the effectiveness of anchoring activities, both for the development of traditional and sustainable business ecosystems, and it

has been selected as an approach to be used in this research. Other disciplines refer to facilitator actors involved in the initiation and development of complex processes, such as co-design processes. In this last case, the facilitator actor is the designer (Lee, 2008).

The design discipline has confirmed its strategic role in innovation creation development with many contributions (Bertola & Teixeira, 2003; Brown, 2009; Celaschi & Deserti, 2007; Franzato & Celaschi, 2017). Moreover, its potential has been shown in the valorisation of the local material culture to increase the value of a certain territory, as stated by many Italian scholars (Bozzola & De Giorgi, 2016; Catania, 2011). Designers are also questioning their role in sustainability because the decisions taken in the design phase can contribute to the ecological cost of the product (McBride, 2011; Valade-Amland, 2011). Design for sustainability, as an established discipline (Bhamra, Hernandez, & Mawle, 2013), is moving its focus from product innovation to service and process innovation (Ceschin & Gaziulusoy, 2016). Between these different approaches, one is SD, and this includes systems thinking in the design process (Jones & Kijima, 2018) enlarging the borders of eco-design. The SD approach to ecological design and sustainable production processes operates through its five principal guidelines, elaborated in collaboration with the Zero Emissions Research and Initiatives (ZERI, 2015) foundation and Fritjof Capra (Bistagnino, 2011): create relationships based on the output that become input for another system as happens in nature, producing self-reproducing systems, acting locally and connecting the human being with the geographical, economic and social context of reference.

The application of SD specific methodology in different projects demonstrated its ability to create innovation for sustainable local (Bistagnino, 2011, 2017) and rural development (Barbero, 2018). Starting from a deep holistic analysis of the context of reference with desk and field researchers—the Holistic Diagnosis (HD; Battistoni, Giraldo and Barbero, 2019)—a different production model is planned to design out waste and create new connections with local actors through flows of energy, matters and information, involving new stakeholders. Acting on a different cultural paradigm—systems thinking—this process can create new opportunities that consider economic, environmental and social sustainability and can stimulate the entrepreneurial system for their implementation. Moreover, it can guide a sustainable local development of the context where the production model is placed, shifting the goal of the productive system from individual ways of acting to collective ones, focussing on collective needs rather than the economy in the first place. Development that '*meets the needs of the present without compromising the ability of future generations to meet their own needs*' (Mitlin, 1992) not only focusses on economic growth but also operates within nature's limits as ecological economics dictates (Daly & Farley, 2004). This different design process includes various concepts at the theoretical level that require the collaboration of experts from diverse background disciplines—from technicians to economists and humanists—to build interdisciplinary design teams, as represented in the scheme in Fig. 2. The complexity reached in these projects indeed requires a co-design process involving multiple actors and multistakeholders for their multilevel scale of impact, from entrepreneurs to academics and policymakers. All these factors complicate the implementation process, which cannot follow a linear process but includes multiple contributions in every stage, evolving through multiple feedback loops as it is happening in the evolution of natural ecosystems.

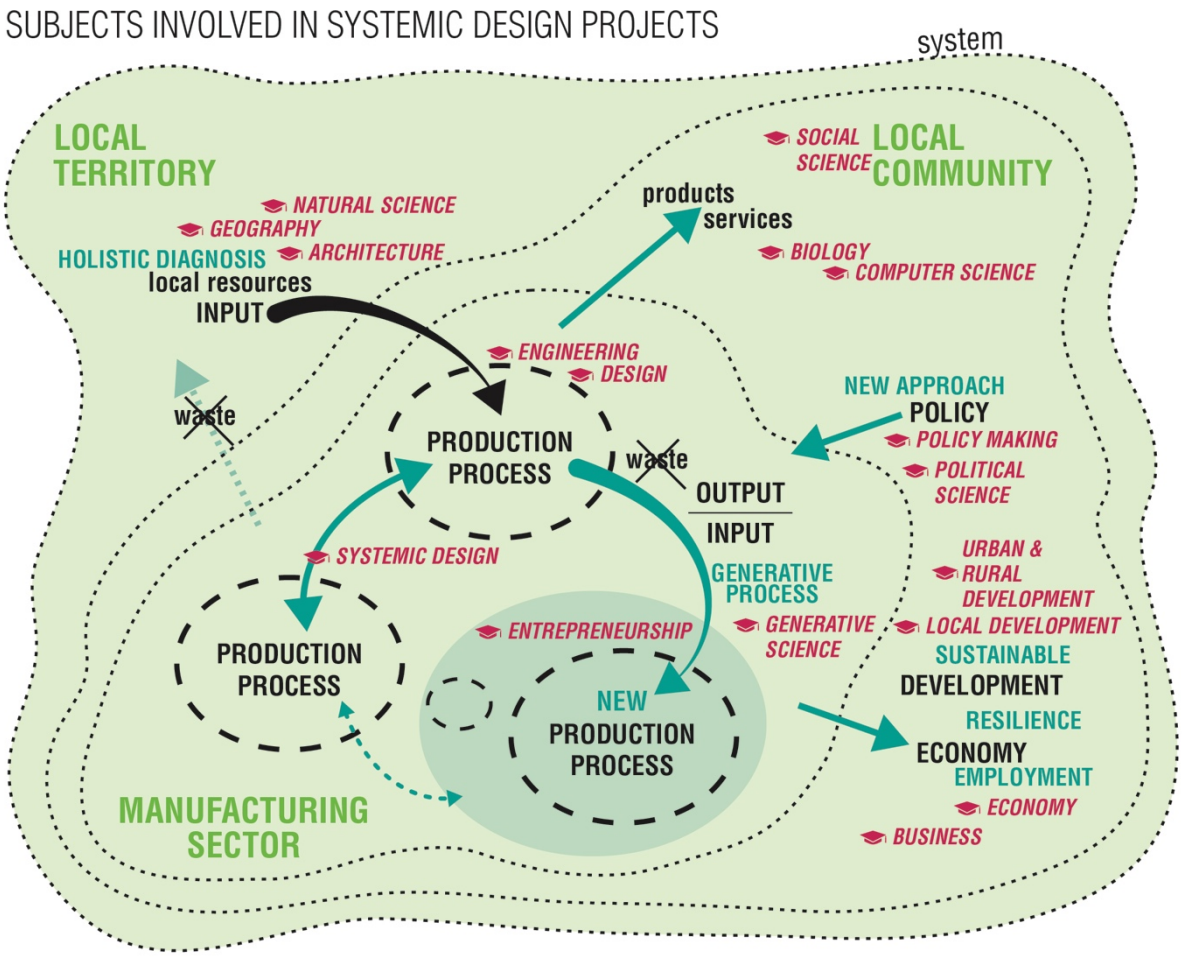

Figure 2. Different disciplines involved in a Systemic Design (SD) project for the manufacturing sector. Based on the image presented in Battistoni and Barbero (2018).

Multiple case study research: SD for territorial development

Although the literature around SD projects highlights their characteristics to reach a sustainable local development, at the same time, they can be seen as barriers for their implementation. With a multiple case study (Yin, 2017) on two failed SD projects aimed at fostering sustainable development in the context of reference, the main enablers and barriers around the project implementation are identified and analysed to understand the main problems for their application. The enablers as defined in the HD and for the project are identified in terms of geographical and socio-economic factors. The barriers are related to the context, internal factors for the project and the implementation phase.

The projects fit into the two following categories: (1) a project for a specific territory and (2) a project for a specific production process based on a certain territory. In the first case, the project considered the total territorial area from the beginning of the design phase, including all the production processes located there. In the second, the project was conducted for a single production process, but subsequently, enlarged its focus in the context of reference.

SD project for a specific territory

In this project, the SD approach was applied in a valley of the Italian Alps in the Piedmont Region in Italy, 20 km from Torino (Battistoni & Daghero 2013, 2017; Fig. 3). The project was developed by the designers of the research group on SD in Politecnico di Torino and started due to the city mayor's desire for a sustainable future vision for the area.

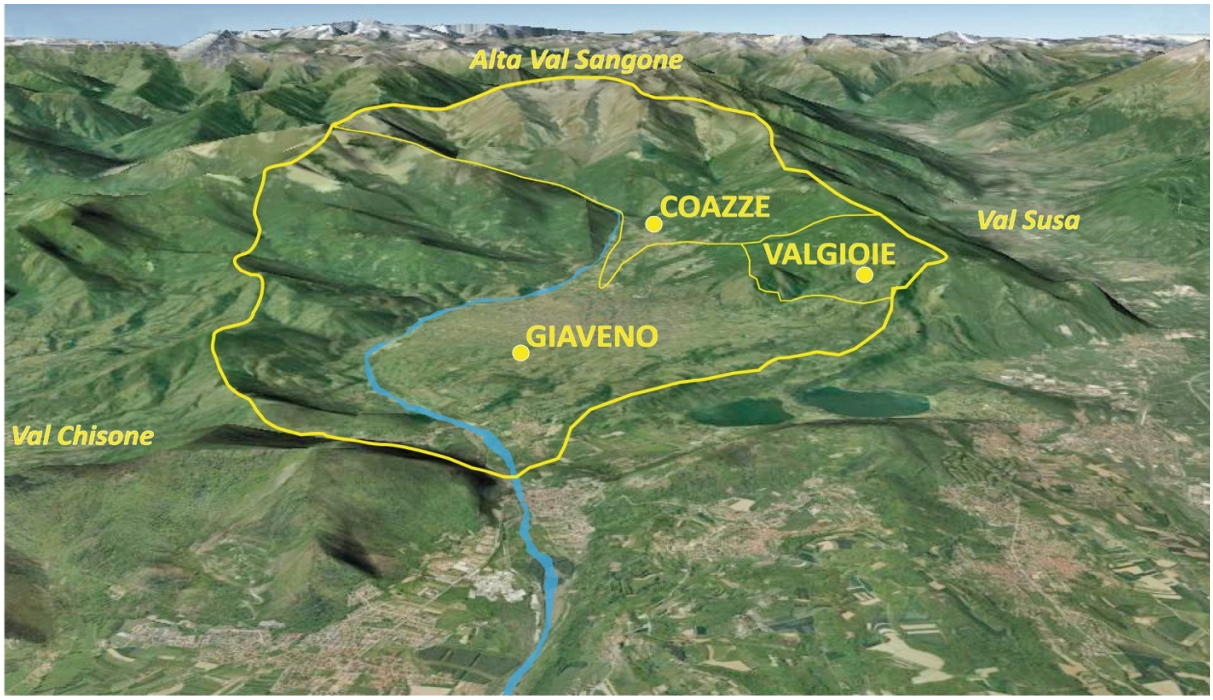

Figure 3. A visual representation of Sangone Valley using a view from Google Earth. Retrieved from Battistoni and Daghero (2013).

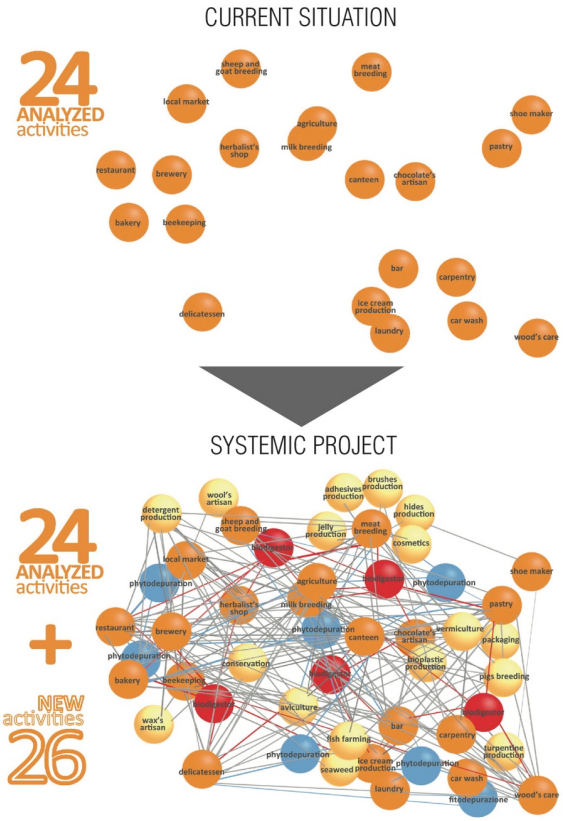

Figure 4. Development and design of the complex system. In the visual representation, only the principal relationships between the components are presented. Current activities are presented in orange and new ones in yellow, in blue the phytodepuration and in red the biodigestors. Adapted from Battistoni and Daghero (2017).

The project started with the HD of the area at the geographical, economic and social levels. In the meantime, field research was carried out for analysing the production models of twenty-four typologies of enterprises located in the area, from primary productions like breeding livestock for milk to transformation actors like a pastry shop. The analysis of the current situation framed a valley where every activity was working independently. The design of a new sustainable production model for each production activities involved applying the SD guidelines, based on real data collected from field research. This permitted a specific project to be created for each activity. Then, considering all the activities in the analysis, a complex system was designed that could generate territorial development at the economic, environmental and social levels for waste reduction, community involvement and new job creation (Fig. 4). The analysis of the project effect reveals the potential to create new entrepreneurial opportunities: twenty-six typologies of new activities were created from the relationships of energy and matter among the twenty-four activities considered (Fig. 4). One example is the fruit conservation activity to preserve forest and agriculture products, such as fruits, chestnuts and mushrooms. Moreover, along with environmental benefits like the 80% reduction in the use of drinkable water thanks to a decrease in use and the phytodepuration process, a substantial economic profit was created. (The earnings before taxes increased by more than 700%). After the presentation of the project to the community and the producers with an exhibition (Fig. 5) and videos (Systemic Design Lab Politecnico di Torino, 2018), despite the support of the municipality, the project failed right after the start of the implementation phase.

Figure 5. Frame of the video done for the project dissemination. It represents a picture of the exhibition made in the Giaveno city centre. Retrieved from the video published in Systemic Design Lab Politecnico di Torino (2018).

The results of the analysis of the enablers and barriers to the project implementation phase are presented in Table 1.

Table 1. Enablers and Barriers of the project implementation phase. Based on Battistoni and Barbero (2018).

ENABLERS	Alpine valley with plenty of natural resources	Geographical factors
	Close valley (at geographical level)	
	High sense of community between citizens	Socio-economic factors
	Presence of only micro–small enterprises	
	Rich valley	
	Strong relationships between nature and inhabitants	
	Support from city mayor	Political factors
	Deep and long research phase related to the context resources and dynamics	Factors related to the project
	Developing of forecast for the environmental and economic impacts	
BARRIERS	Close valley (at social level) and reduced openness to innovation	Factors related to the context
	Sleeping valley: most people who live there, work outside the valley	
	Most of the activities involved are from the primary sector (agriculture and breeding), owned by old people with no inclination to investment	
	Lack of a feasibility study of the project, only economic forecast	Factors related to the project
	Lack of commitment by the activities' owner throughout the project	
	Top-down approach (not coming from the citizens or enterprises but from the political party and academy)	
	Lack of co-design process	
	City mayor changed a few months after the project	Factors related to the implementation phase
	Difficulties in understanding the complexity of the project by those who have to take action	
	Difficulties in understanding the importance of the project	
	Lack of awareness on the importance to change (no valley in crisis)	
	Lack of strong commitment by the entrepreneurs	
	Lack of funding, despite the city mayor's commitment	

SD project for a specific production process based on a certain territory

In this case study, the SD approach was applied to a specific production process—a large French biscuit factory that emerged from a family business (Barbero and Battistoni, 2016). The project, carried out by the SD research group in collaboration with the industry, started with the HD of the territory where the factory is located (Fig. 6) and the analysis of the current production model (Fig. 7). This study was performed thanks to field visits and collaboration by the employees, and it raised the employees' awareness of the current situation, thereafter guiding the enterprise towards a different and systemic production model.

The industry was acting following a linear economic model, producing tonnes of standard biscuits every day (more than 300 million packets/year), using worldwide raw materials and shipping the final product everywhere without considering the environmental impact, especially in the area where they are located, or the social effects, such as consequences for public health. The project mainly acted on the recipe of the biscuits, re-creating the connection between food production, local natural resources and the know-how of the region. The re-design of a typical traditional biscuit, the 'sable', was done with the goal of becoming a symbol of the region and showing that the industry cared about consumers' good health.

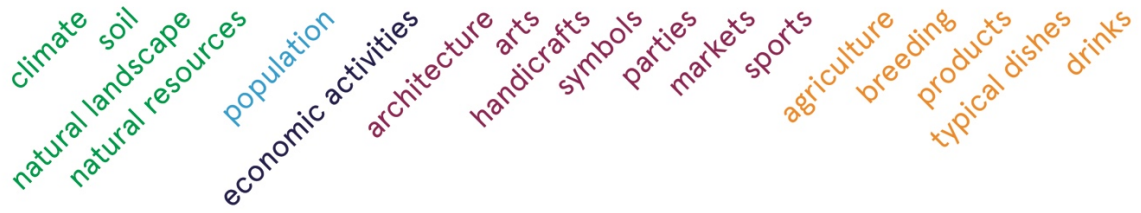

Figure 6. Categories analysed in the Holistic Diagnosis (HD) of the project context.

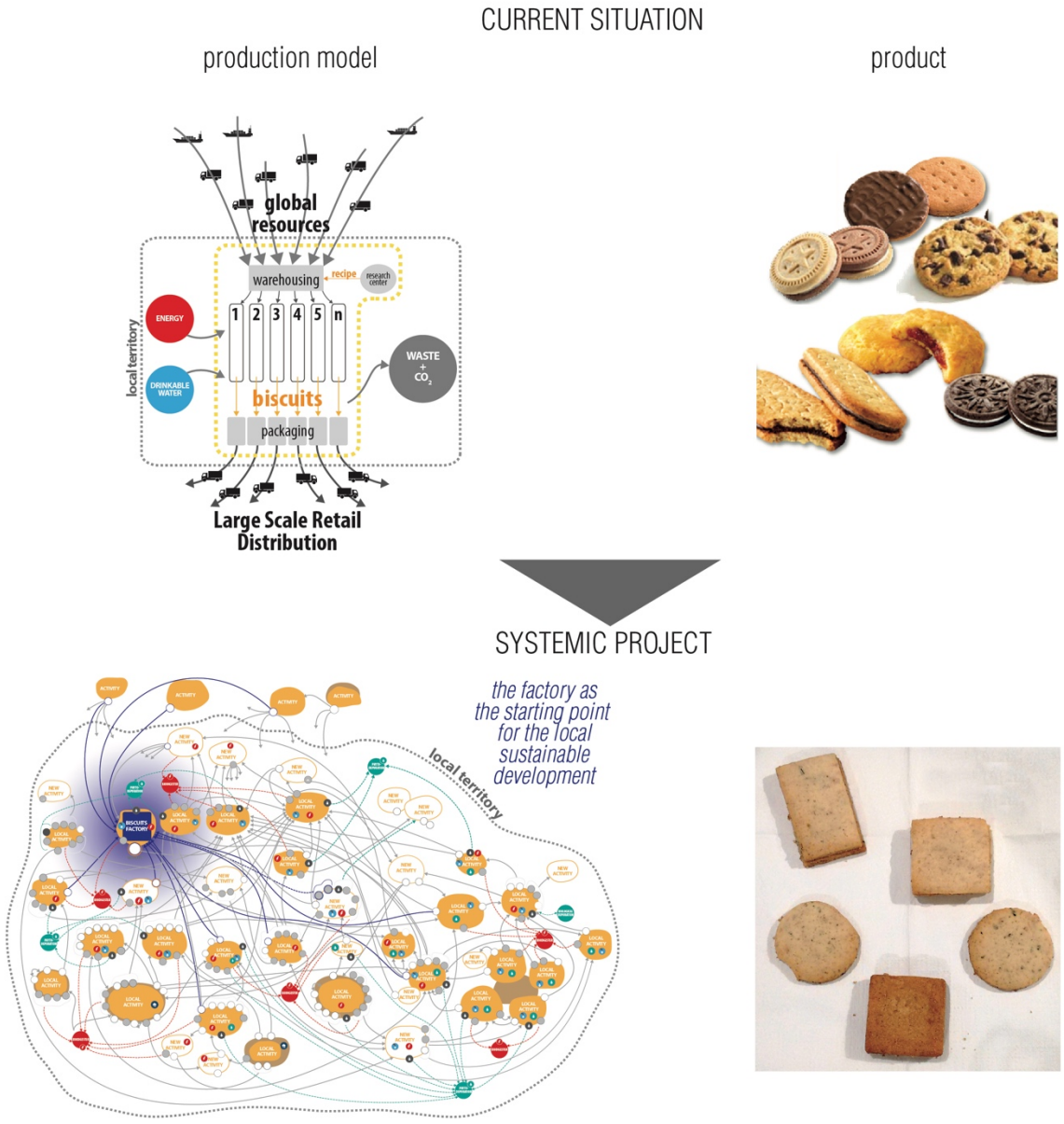

Figure 7. Visual representation of the shift proposed by the Systemic Design (SD) project. Adapted from Barbero and Battistoni (2016).

A study on the opportunities for solving internal environmental problems, such as broken biscuits or heat production by the oven, was carried out. Moreover, the suggestion of using local

ingredients, such as milk, eggs, fruits and spices—creating relationships with local producers—allowed the factory to start acting as a re-activator of the local agriculture and manufacturing sector (Fig. 7 – bottom part). This could have reduced the company's environmental impact, created new businesses for other local entrepreneurs, and led to a more sustainable territorial economic development for all the region. The factory tried to produce the first prototype of the new biscuit (Fig. 7 – bottom part), but it did not decide to go on with the project implementation.

Table 2 presents an analysis of the enablers and barriers related to the project implementation phase.

Table 2. Enablers and Barriers of the project implementation phase. Based on that published in Battistoni and Barbero (2018).

ENABLERS	No problem in economic investments	Factors related to the industry
	Interest in innovation projects	
	Internal nutritional research centre	
	Industry that 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 heard by the chief executive officer (CEO), and their ideas are considered	
	Agricultural region with many production activities	Factors related to the context
	Co-design process with employees and CEO thanks to frequent meetings	Factors related to the project
BARRIERS	Lack of commitment by the employees and long project duration	Factors related to the industry
	Change of CEO during the implementation phase of the project	
	Difficulties in sharing internal data with external people (even researchers involved in the project)	
	Lack of data on the specific quantity of the different inputs and outputs	
	Difficulties understanding the importance of the project over the economic benefit	
	Large industry that must preserve many jobs; it acts with caution	
	Reduced openness to collaboration with other industries	
	CEO's lack of familiarity with the area in which the company is located (better situation among employees)	
	Focus on production and lack of awareness of what is happening outside (especially on agriculture topics)	
	Lack of awareness of the implications of their actions for the environment and consumer health	
	Lack of future visions on the environmental situation	
	Difficulties in managing the complexity of the projects	

	Resistance to change demonstrated by the people	
	Very ambitious	Factors related to the project
	Did not consider the transition to the different production models	
	Lack of in-depth feasibility studies	

Results

SD project implementation barriers

The preceding case studies analysis elucidated the significant barriers faced by SD projects in their implementation process, which are summarised in Table 3. The principal one seems to be that SD projects require a cultural paradigm shift from linear to systems thinking, from competition to collaboration (Barbero, Bistagnino, & Peruccio, 2017), as identified by Capra (1982), but a resistance to change often emerges in human behaviour. Moreover, the system design is complex as one of its fundamental characteristics, based on the many relationships that are created between the components, is the need for involvement of many actors and stakeholders, including in the design phase with co-design practices. The need for the project to act over the three facets of sustainability—environmental, economic and social—makes SD projects multidisciplinary and interdisciplinary. Thus, the involvement of other competencies next to the design one is required, in practical terms, creating difficulties in the realisation of the project.

Projects also need a general overview of the regional context, considering the effect not only on the production model but also on the territory in which they are located. This makes them difficult to understand for the enterprises, which usually lack a long-term vision for them and the environment.

Focussing on the manufacturing sector, the problems increase. First, changes in the production model to address sustainability requirements require radical choices and strong decisions, raising the need for large investments or external funding, which are not easy to find. Moreover, talking about inputs/outputs and avoiding waste, which have to flow among the components of the system, the current legislation on waste sometimes limits these types of relationships. These results on the implementation barriers are in line with those identified by Rizos et al. (2015) discussing the barriers found by SMEs in the implementation of CE business models—the company's environmental culture, a lack of capital, a lack of governmental support/effective legislation, a lack of information, the administrative burden, a lack of technical and technological know-how and a lack of support from the supply and demand network.

Luckily, the current emphasis from the European Union on the CE has been helping to bridge the cultural gap since 2014 (European Parliamentary Research Service, 2014), with new policies formulated to ease the CE implementation.

Table 3. Summary of the principal implementation barriers faced by Systemic Design (SD) projects.

PRINCIPAL IMPLEMENTATION BARRIERS	Complexity	Related to the project
	Need for a shift from competition to cooperation	
	Need for the collaboration of different partners and stakeholders	
	Need for the involvement of multiple experts next to designers, as economists and natural scientists	
	Need for a co-design phase	
	Need for a balance between top-down and bottom-up approaches	
	No exact indication on 'where to start' and 'how to start'	
	Lack of a real feasibility study	
	Lack of a long-term vision, and consequent lack of funding	Related to citizens, entrepreneurs and policymakers
	Lack of awareness on the environmental situation	

Potentialities for new opportunity development

Despite the implementation barriers, SD projects have a great potential for lowering the environmental effects of production processes and increasing the social and economic ones. Especially, many opportunities can be born from applying the SD approach to the manufacturing sector in multiple respects, as illustrated in Fig. 8.

Acting on a specific production model, SD can produce a shift from a linear to a systemic and circular one, transforming a profit and waste producer to a profit and value creator. Moreover, in the case of opportunities for new businesses, they can be developed internally, creating spinoffs; for instance, they can be used for the transformation of a single well-known output by the research community and competencies can be found inside the geographical area where the production is based (e.g., broken yarns can be regenerated via weaving into new yarns). Otherwise, opportunities can be developed in a new enterprise/start-up that can solve a specific problem of one industry or a specific industrial district or geographical area (e.g. the management of hazelnut shells in an area with particularly dense hazelnut cultivation and processing). To manage the outputs, industries can also create clusters if there are conditions of proximity, with the same goal as the concept of the eco-industrial park (Chertow, 2000)—sharing output–input, as well as, for example, technical instruments or machines.

Projects with the focus on modelling production processes can also lead to the creation of research projects that can insist on a specific output that is not well known by the scientific community and produce advances in the scientific knowledge and future possibilities for new businesses. Moreover, research projects can be focussed on the re-design of products, packaging or services following several approaches provided by design for sustainability as 'eco-design' (Lanzavecchia, 2012) and 'design by components' (Bistagnino, 2008). In addition, education projects can be developed to improve awareness of systems thinking, which is potentially composed of future designers, researchers, entrepreneurs, customers and so on.

The HD of the territory, if performed at the territorial level as in the RETRACE project (Battistoni & Giraldo, 2017), can represent a guide to find problems and gaps to overcome. Moreover, seeing the problems as the leverage for the change creates the basis for new projects and enterprises, both in terms of for-profit (e.g. creation of a fab-lab for the recovery of local know-how) and non-profit ones (e.g. biodiversity and biological ecosystem protection and restoration), or for policymakers to direct future policies and solve real problems.

These potentialities for new opportunities lead to the definition of the actors involved (Fig. 9) and the services needed to ease their implementation (Fig. 10). These processes involve all the figures present in the industries, academies, governments and communities. All the actors converge to the principal beneficiary, which is the area in which they live, act and engage in the local community. The territory indeed becomes an actor with a specific need to be respected.

The implementation of the opportunities specified above can occur only if relationships between the systemic designers and the current actors involved in innovation are created, specifically, these should involve the industries and entrepreneurs creating clusters/spinoffs/start-ups, researchers and policymakers. To develop eco-entrepreneurial opportunities, training in ecopreneurship can allow the creation of systemic designers/ecopreneurs or the evolution of current entrepreneurs into ecopreneurs with training in systems thinking.

Conceptual model definition: ecosystem for sustainable and circular local development

The definition of the implementation barriers and opportunities created by SD projects, followed by the outlining of the actors and services needed, have permitted the design of a conceptual model of the ecosystem. This new entity has the goal of fostering and boosting the implementation of SD projects in a certain geographical area to obtain sustainable and circular local development.

Starting from the innovation models of the quadruple and systemic helix cited in the literature review, the systemic helix for sustainable and circular local development represented in Fig. 11 is developed. It comprises the following components:

- The university, represented by the technical and humanities division;
- The government, represented by the different levels (from city to region and nation) that act on a specific geographical area;
- The industry, composed by the three typologies of enterprises (micro and small, medium and large); and
- The civil society, which is not a single entity but diffuses within all the others.

Along with these actors, it is necessary to include another one able to deliver education and consulting on ecopreneurship. Moreover, there should be one on SD education, research and project development, such as an ‘SD division’. Both these actors are placed between the ‘university’ and ‘industry’ actors of the triad due to their duality.

The four components act as a system. Figure 11 represents the systemic and non-linear interactions between them. The knowledge flows and resources circulate to create the knowledge society. The government, for example, receives feedback from the other actors to improve and deliver better and participatory policies. In exchange, this actor delivers funds to improve the research and development processes. Thanks to the collaboration with the university, industry can design, produce and deliver sustainable products and services. The actor focussing on ecopreneurship trains new ecopreneurs for the industrial sector with university support. Each actor creates job placements, hiring people from civil society, and the university is creating future citizens and leaders aware of the current problems for sustainable development.

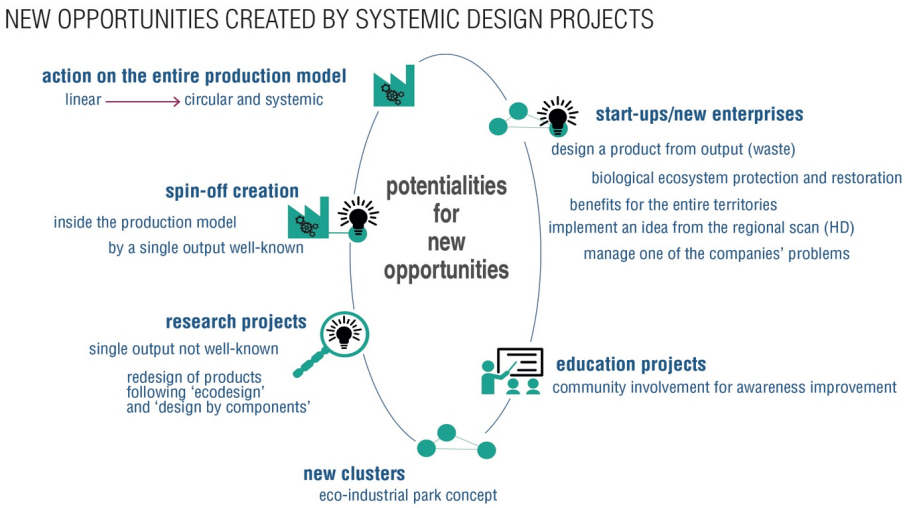

Figure 8. Graphic representation of the potentialities for new opportunity creation.

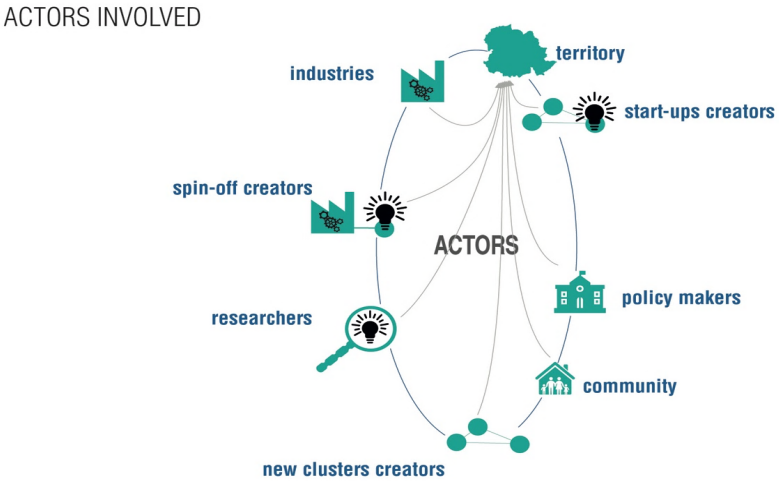

Figure 9. Graphic representation of the actors involved in the ecosystem.

Figure 10. Graphic representation of the services needed for the actors in the ecosystem.

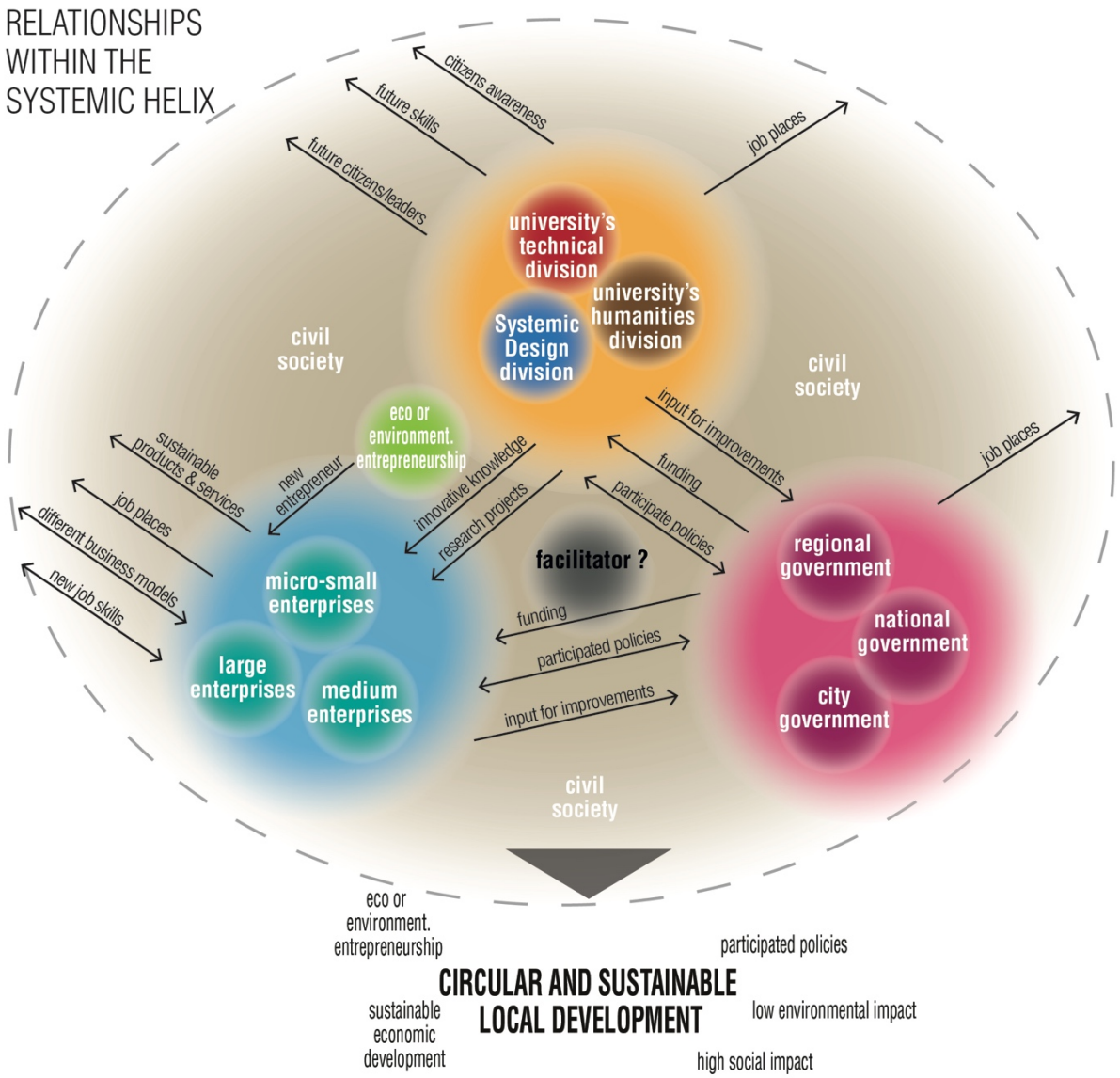

Figure 11. Graphic representation of the systemic and non-linear interactions between the components of the helix for a circular and sustainable local development. Based on the image in Battistoni and Barbero (2018).

In this framework, is it necessary for there to be an actor that can play the role of facilitator to permit the creation of these relationships? The previous literature on business and entrepreneurial ecosystems theorises the figure of a central actor that can fuel the creation and growth of the ecosystem and the collaborations and relationships between the different actors, considering a specific geographical context. This is identified in the 'anchor tenant' hypothesis. In the conceptual model proposed in this article, the role of facilitator is identified in the LSNB.

The LSNB

The heart of the ecosystem, which has the goal of easing the implementation of sustainable entrepreneurial opportunities uncovered by systemic projects, cannot be identified only in a BI as the current definition focusses on the economic sustainability of the projects in a linear economy context. Rather, it must be able to fill current gaps and ease the transition to a different economic model, providing services like the following:

- Training future entrepreneurs to deal with current and future challenges, considering the complexity of the problems and tackling the environmental situation;
- Guiding and support the design phase of the new entrepreneurial opportunities identified with co-design processes and multidisciplinary projects;
- Supporting and easing the implementation of the opportunities for innovative and sustainable products, services and processes that tend to zero emissions and respect the natural capital, as well as being provided by firms with different business models;
- Supporting the transition from linear to systemic production models of the existing firms via co-design processes and multidisciplinary projects;
- Delivering educational projects; and
- Supporting multidisciplinary research projects.

To provide this, the entity considers the collaboration within an incubator, training centre and university division. The component called the 'incubator' is the closest to the industry sector and is intended to incubate and develop new opportunities for the creation of spinoffs, start-ups and clusters (purple in Fig. 12). It is placed beside the ecopreneurship and the ecology-systemic training centres (green in Fig. 12), which collaborate with the university's divisions (orange in Fig. 12), both humanities and technical ones. SD division is located between them because the design discipline considers both technical and humanities contributions (Celaschi & Formia, 2010). The collaboration with the three divisions supports the design phase of multidisciplinary projects and research. Acting together, the university and training centres train and create systemic designers and ecopreneurs, who have the competencies to implement new businesses for innovative products, processes and services through their collaboration, working in multidisciplinary teams. The designers can also act as 'mediators' (Celaschi, 2008) between the different disciplines fostering the dialogue and interweaving among them.

The three components work together to follow a complete process, from the idea creation to the design phase, feasibility study and implementation phase. The new entities incubated are also designed to create networks among them, mainly based on flows of information but including flows of people, money, energy and matter.

The facilitator of the ecosystem is defined as the LSNB, and it works for boosting new systemic businesses and for regional sustainable development. Acting as an open system, it spreads knowledge through education, disclosure and research projects, both inside and outside the ecosystem, involving manufacturing activities, the civil society and policymakers to build the future sustainable society. It also acts as a guide thanks to the execution of the HD, involving the following steps: analysing the territory as a system, identifying the current problems to solve and sectors that need support or research projects and giving indications to researchers and policymakers. LSNB is placed at the heart of the ecosystem and acts as the anchor tenant to facilitate the creation of the ecosystem and boosting the generation of networks (Fig. 13). The net created between all the different actors is implicit in the grey colour in Figure 13.

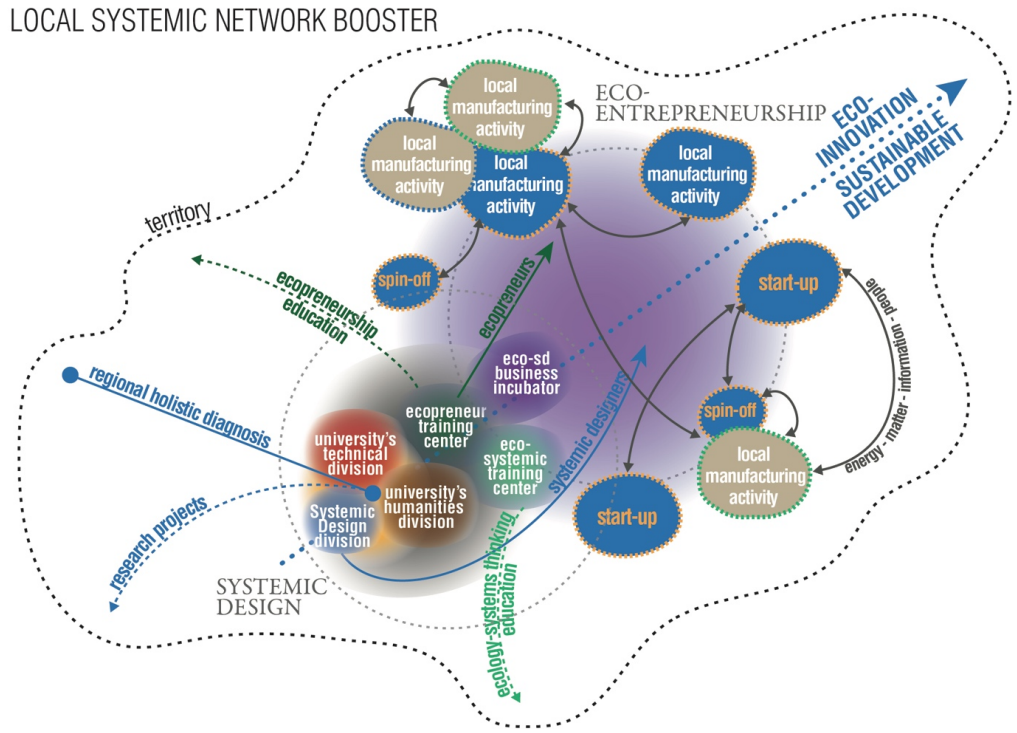

Figure 12. Graphic representation of the local systemic network booster (LSNB).

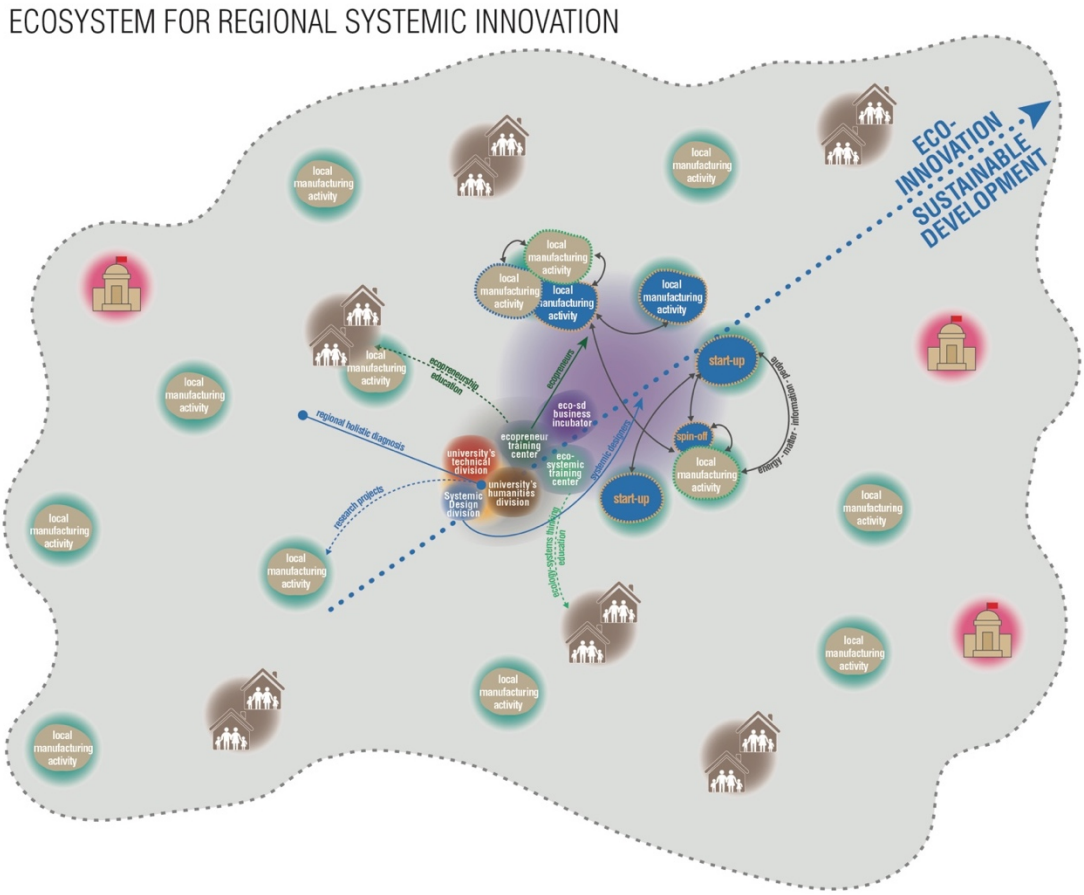

Figure 13. Graphic representation of the ecosystem for the regional systemic innovation. The grey colour represents the net of relationships.

Discussion and conclusions

Focussing attention on the territory and its productive sector with a systemic approach, it is possible to shift the lens from single actors to the relationships that can be created among them. The result obtained is different from the original components; as systems theory suggests, 'the whole is greater than the sum of its parts' (Aristotle), or better, 'the whole is other than the sum of its parts', as stated in Gestalt theory (Koffka). This shift can lead to a different development model that is far from the current evidence, which centres only on the increase of the gross domestic product, and supports economists acting in another way (Raworth, 2017).

The ecosystem that starts to act differently, facilitated by the LSNB, wants to foster and boost the implementation of business opportunities created by SD projects. It finds its root in the helix innovation models and the concept of the business ecosystem, especially the entrepreneurial type. The facilitator/anchor tenant is identified in the evolution of current business incubators, considering van Weele et al.'s (2018) view that incubators are central in the entrepreneurial ecosystem, and are evolving their services that now are also related to business idea creation. It continues to act as a current incubator of ideas and projects, supporting their economic sustainability while focussing on their environmental and social impact. It should be developed in collaboration with multiple actors, including designers and systemic designers, who are trained and usually work to frame new opportunities from the analysis of current problems and needs (Bertola & Teixeira, 2003; Brown, 2009; Celaschi & Deserti, 2007; Franzato & Celaschi, 2017). As Sanders and Stappers (2014,p. 27) recall, the traditional role of the designer has changed from exploring '*how to design what the client asked for*' to *'what to design*', and in the near future, it will be to '*work to help ensure that what is designed makes sense in the future lives of people*'. The primary outcome created by this systemic ecosystem is sustainable and circular local development, which is the consequence of the creation of ecopreneurship, low environmental impact, high social impact and participatory policies.

The conceptual model presented in this article is an early finding and a theoretical definition. It needs to be further explored by future studies to prove its effectiveness in solving the highlighted problems and its real contribution in practical terms. Moreover, it is necessary to explore the role of non-profit organisations in the ecosystem and in the LSNB for their importance as catalysts of change, as these organisations are usually close to people and active in local contexts. Future research is also necessary to focus on finding similar cases in real life due to the gap found in the scientific literature. This step can help better define the hypothesis in this study and understand how this concept can be implemented in real contexts of application, considering their characteristics. Indeed, a future research question is as follows: Should the LSNB be the only one in the territorial context, or are multiple facilitators necessary? Moreover, future considerations should concentrate on a more in-depth analysis of the outcomes for the region and obtain a draft of the territory in the second stage, once the facilitator is acting.

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