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# Unfolding eco-industrial parks through niche experimentation: Insights from three Italian cases

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## Abstract

This article aims to understand and explain how eco-industrial parks can unfold over the traditional industrial production systems. Differentiating between the domain theory and method theory, we present an analytical framing that draws upon the strategic niche management perspective from the sustainability transitions field as the method theory, and then contribute to the field of industrial ecology, which is the domain theory behind eco-industrial development. With the experimentation concept being central to our conceptualisation, we consider the journey of the industrial production systems to become eco-industrial parks as niche experimentation and eco-industrial parks as niches. Employing a qualitative multiple case study, we analyse the experimentation within three cases from Tuscany and Emilia-Romagna regions of Italy. The results of our analyses indicate that the continuous experimentation of the eco-industrial park practices within a broad actor-network, through learning processes, leads to shared expectations and visions regarding economic gains and also the environmental benefits of the industrial ecology practices, which enable the eco-industrial parks to unfold. Still, there is no single rigid model that explains the unfolding eco-industrial parks, because the continuously interacting and interdependent niche-building processes assemble the niche experimentation journey, which is also shaped by the spatial context.

**Keywords:** eco-industrial parks; industrial ecology; experimentation; niche; sustainability transitions; case study.

## 1. Introduction

In recent decades, increasing attention has been given to the sustainability problematique of the traditional linear industrial development model decoupled from the sustainability concerns. The call for a new development model that aims to positively impact economic, environmental and social capitals is a main challenge for various sectors of the industry, including, but not limited to, iron and steel (Karakaya, et al., 2018), biogas (Raven & Geels, 2010), fashion (Karaosman, et al., 2017), food (Smith, 2006), and construction (Ma, et al., 2019).

As one of the salient and promising sustainable industrial development approaches, industrial ecology (IE) emphasises the analogy between industry and nature (Ayres, 2004; Korhonen, et al., 2001) and proposes a paradigm shift through imitating the natural ecosystems by incorporating innovation into the industrial production processes. The present article focuses on a particular IE implementation model: eco-industrial park (EIP) development (Chertow, 2000). The EIP development has been traditionally studied and practically applied to transform the industrial production systems into cyclical systems – so-called industrial ecosystems (Frosch & Gallapoulos, 1989) – to address the sustainability problematique at local and regional scales (Deutz & Gibbs, 2004).

During the last few decades, the EIP development has been widely addressed in the regional development policies. Although there have been successful EIP cases (see Susur, et al., 2019b, for a review on globally-distributed 104 EIP cases), a transition into the EIP development at a wider level has not occurred yet. This may be explained through resistance due to the existing individual-performance-oriented routines within the industrial production systems (Tudor, et al., 2007; Ceglia, et al., 2017; Li, et al., 2015; Romero & Ruiz, 2013). Previously, the IE literature questioned if and how the IE philosophy could bring a real paradigm shift in industrial production routines (Ehrenfeld, 2000; Gibbs, 2009). Narrowing that debate, the present article seeks to understand and explain how the EIPs can unfold over the traditional industrial production systems.

Our methodological approach is twofold. Analytically, we use the strategic niche management (SNM) perspective from the sustainability transitions research field (Schot & Geels, 2008; Smith & Raven, 2012) as our method theory (Lukka & Vinnari, 2014). That perspective has been prominent for analysing novel local sustainability projects, the so-called niche experiments, as the seeds for sustainability transitions (Kemp, et al., 1998; Borghei & Magnusson, 2018). Refining the SNM perspective for our EIP-focused inquiry, we conceptualise the journey to become an EIP as *niche experimentation* and EIPs as *niches*. We then analyse three niche-building processes (Schot & Geels, 2008): (i) the coupling of expectations and visions, (ii) building of networks, and (iii) learning processes, considering the mediating effect of the spatial context.

Empirically, we follow a qualitative multiple case study methodology. We bring three EIP cases from Italy, an advanced country in terms of the EIP development (Taddeo, et al., 2012; Daddi, et al., 2016; Taddeo, et al., 2017), and focus on the regions of Tuscany and Emilia Romagna. Following semi-structured interviews and the documentation analysis, we provide a multiple case study that goes beyond a data-driven empirical analysis as we strengthen our theorization and power of interpretation by analytically building on the SNM perspective. As an outcome of our empirical analysis guided by our analytical framing, we derive and present a framework that illustrates the unfolding EIPs through the niche experimentation.

A few earlier studies borrowed from or instrumentally used sustainability transitions frameworks for analysing different scale IE implementations (e.g. Adamides & Mouzakitis, 2009; Gibbs, 2009;

Rotmans & Loorbach, 2009; Verguts, et al., 2016; Susur, et al., 2019a). The present study differs from those previous attempts in several ways through our theoretical and methodological contributions.

With regard to theoretical contributions, firstly, we bring the domain theory and method theory differentiation to the IE literature and sustainability transitions field. More specifically, we illustrate the usefulness of the SNM perspective from the sustainability transitions field as a method theory for the EIP development-related studies within the IE domain theory. Secondly, we systematically strengthen the link between the IE literature and the sustainability transitions field and extend the EIP literature by bringing new interpretation lines drawing upon SNM. Thirdly, our analytical framing differs from above-mentioned previous studies because we focus on how EIPs unfold through the niche-building processes, taking the niche experimentation central to our conceptualisation. We approach the journey to be an EIP as the niche experimentation that would result in an EIP, which is conceptualised as an emerging community involving broad range of relevant actors seeking better sustainability performance in the defined industrial production system through networking and learning processes. We also bring the spatial context as the mediating factor for the EIP experimentation. The internal niche-building processes under the influence of spatial context guide our interpretations and we contribute to the EIP literature in terms of understanding how EIPs can unfold by observing the EIP experimentation in certain contexts.

As for methodological contributions, we seek first and foremost to answer a novel research question. Secondly, we distinguish between the analytical framing and empirical methodology for our research inquiry. Initially, we frame our study analytically while refining and operationalising the method theory. That enables to us to formulate the constructs of our study based on the concepts from the SNM perspective. We then provide our empirical approach in which we follow a qualitative multiple case study through which we select and analyse multiple EIP experimentation journeys. Finally, our empirical methodology allows us to bring a rich set of new insights from two regions in Italy, an experienced country in that field.

Along with those contributions, we further argue that that the IE literature's recently constructed link to the sustainability transitions field still needs be expanded, not only to enrich the theoretical background and expand the boundaries of the field by advancing the knowledge generation, but also to consolidate and extend that debate on the transitional nature of the IE implementations.

The remainder of the article is structured as follows. Firstly, we give the background of transitions into the EIP development and secondly, our analytical framing approach. We then introduce our case study methodology, incorporating the Italian context and a brief description of the selected EIP cases. We then provide the results on the niche processes of the unfolding EIPs. Building on the results, we present the discussions based on our cross-case analysis and provide an overall framework on the EIP experimentation journey of the unfolding EIPs. Finally, we offer conclusions with a summary of the main findings and implications for researchers, policy-makers and practitioners.

## **2. Transitions into the EIP development**

The EIP development is inspired by the IE vision that argues for a transition into a novel industrial paradigm, calling for systemic changes in the dominant industrial production routines (Tibbs, 1992; Ehrenfeld, 2000). This new industrial production system model is about either transforming the existing industrial production systems into EIPs in the form of brownfield projects or, alternatively, designing/constructing new EIPs in the form of greenfield projects (Lambert & Boons, 2002). Although there have been successful EIP cases at various geographies, including but not limited to Denmark

(Valentine, 2016), China (Fang, et al., 2007), South Korea (Park, et al., 2008), USA (Veleva, et al., 2015), the EIP development could not gain the required momentum to bring a fundamental shift into the current industrial production systems at wider geographies.

Traditional technical understanding on the EIP development has mostly emphasised the EIP practices as the symbiotic exchange of the material assets (water, energy, by-products) (Chertow, 2000) within the firm-based industrial ecosystem networks inside the EIPs. However, the transition into the EIP development requires a systematic engagement of multiple institutional actors into the industrial ecosystems. Those actors include the EIP management bodies (Gibbs, et al., 2005); individual firms in the production systems (Chertow, 2000; Haskins, 2008), which already form complex systems with large number of interacting components (Sopha, et al., 2010); regional champions (Hewes and Lyons 2008); governmental institutions; universities and research institutes (Lowe, 2001). The constellation of those actors and their expectations and visions of what the EIPs should deliver to the surrounding context may vary from region to region (United Nations Industrial Development Organization, 2014). Moreover, the spatial context also mediates the EIP development, as changes do not occur in a vacuum and are embedded in their social, technical, institutional and political environments (Baas & Huisingh, 2008; Baas, 2008). The traditional technical-oriented EIP development approach is not competent enough to understand and explain the complex dynamics among this wide range of actors (Gibbs, 2009).

Therefore, a systemic approach is needed to stress the engagement of diverse actors into the industrial ecosystem network through the IE-informed and IE-inspired EIP practices. Those practices can aim to exchange material assets and also non-material assets such as knowledge, information and expertise (Lombardi & Laybourn, 2012) among the actors of the broad industrial ecosystems. With such an approach, the EIP development will not result only in incremental innovations for the involved firms (such as process optimisation, eco-efficiency, recycling, reuse, etc.) – as it was previously criticised for doing (Truffer & Coenen, 2012; Gibbs, 2009) – but could also bring systemic innovations for broad range of institutional actors through long-term fundamental changes in industrial production routines (Doranova, et al., 2012; Organisation for Economic Co-operation and Development, 2012; Machiba, 2010).

That argumentation also constructs the potential link between the EIP development and the sustainability transitions field. The next two sections explain how we methodologically contribute to that link in analytical and empirical grounds.

### **3. Analytical framing**

The research on sustainability transitions has received increasing attention in the field of innovation studies in recent decades, leading to calls for a need of radical and systemic changes in the existing production and consumption routines, given the important risks associated with ongoing environmental challenges (Kemp, et al., 1998; Geels, 2002; Truffer & Coenen, 2012). The field provides comprehensive analytical frameworks to understand and explain the sustainability transitions through different innovations, and the SNM perspective is one its most salient frameworks (Markard, et al., 2012).

The *niche* and *experiment* concepts are central to SNM's theoretical and practical foundations (Borghei & Magnusson, 2018; Weber, et al., 1999). With an evolutionary perspective, the SNM studies reason that the experiments that refer to the sustainability-oriented local projects are key elements for building the niches, and that niches gain momentum in time through continuous experimentation and bring the desired sustainability transitions (Geels, 2002). The experiments contribute to the niches

through three internal niche-building processes: coupling of expectations and visions, building of social networks and learning processes (Schot & Geels, 2008). Niches can be understood as the innovation incubators in which a community with shared expectations and visions emerges and provides the direction of the desired transitions (Geels & Raven, 2006). That community provides the conditions for the successful penetration of the sustainability-oriented innovations into the mainstream practices by mediating the expectations and providing the resources required for further local projects; this mediation is also shaped by the external environment and the context (Raven & Geels, 2010)

Taking the *experimentation* concept central to our analytical approach, we frame our study by drawing upon the foundations of SNM. As such, we use the SNM perspective that originates from the sustainability of transitions field as the method theory, because it can explain how EIPs can unfold over the traditional industrial production system through the EIP practices. This enables us to answer our research question in the IE research field, which is actually our domain theory. This also brings an interdisciplinary research approach to our study (see Lukka and Vinnari, 2014, for further understanding on method theory and domain theory differentiation).

We challenge the SNM perspective while operationalising it for our EIP-focused inquiry. We start conceptualising the journey to become an EIP as niche experimentation and EIPs as niches. That means we focus on the experimentation as a journey that involves the planning and implementation of various EIP practices within the industrial production systems, instead of focusing on the projects/experiments, as SNM studies have traditionally done. We propose that experimentation of the EIP practices may, in time, replace the existing individual-performance-oriented routines of the industrial production systems and EIPs can unfold as niches following the IE-inspired collective-benefit-oriented routines.

To understand how the EIPs unfold, we propose to follow three internal niche-building processes of SNM while analysing the EIP experimentation journey. We argue that the experimentation of the EIP practices may lead to unfolding EIPs through those niche-building processes. The emerging community that would provide support for further EIP practices is key to our conceptualisation and is not limited to the network of the involved firms in the industrial production system. We argue that emerging community involves all relevant institutional actors that have an impact on other actors in the making of the unfolding EIPs.

While developing the following constructs, we build on the conceptual foundations of the SNM perspective (see Schot and Geels, 2008; Raven and Geels, 2010; Weber, et al., 1999). The first process under focus is the *coupling of expectations and visions*. The expectations and visions of the involved actors shape the progress of the experimentation, and if they are shared by the majority of the related actors, then the success of an unfolding EIP is more likely. These expectations and visions also create the basis for a shared understanding on the future EIP practices. The second process is about *network building*. This process facilitates interactions between different actors and is particularly important for the EIP experimentation as the EIP practices are based on material and non-material resource exchanges between the industrial ecosystem actors. *Learning*, as the third process, generates the required knowledge for the involved actors to continue experimentation of the EIP practices more effectively. Learning processes can improve the actors' capacity to understand the IE-informed EIP development by providing them the relevant information and experiences. Internalising and digesting that knowledge can lead to changes in actors' value framing, which is required for successful experimentation.

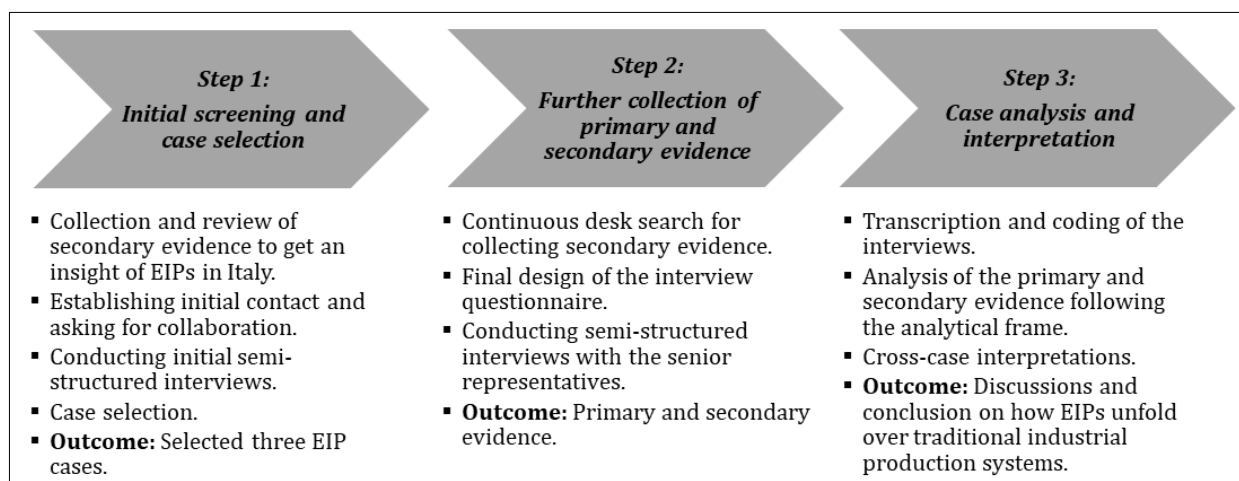
Finally, we argue that the *spatial context* may further support or hinder the incubation of the EIP practices throughout the experimentation. This creates the need to consider the policies and regulations

of central and regional government, regional culture, available markets, industrial structures, already-existing networks, etc. Therefore, the regional context and its relationship to the national context are also embedded in our framing as the spatial context that may mediate the unfolding EIPs.

#### 4. Empirical methodology

We adopted a multiple case study methodology to understand and explain how the EIPs can unfold over the traditional industrial production systems. The case study method is particularly useful for answering *how* questions in order to understand and explain complex phenomena like the EIP development. Multiple cases can provide stronger grounds as they enable cross-analysis and comparison, which can bring a more reflexive interpretation through the discussions (Yin, 2014; Alvesson & Skoldberg, 2009; Eisenhardt & Graebner, 2007).

We chose Italy as our empirical context as it has advanced geography in terms of the EIP development (Taddeo, et al., 2012; Daddi, et al., 2016; Taddeo, et al., 2017), which means it can provide appropriate grounds for conducting an insightful case study considering our research objective. Throughout the study, we used multiple primary and secondary evidences considering the data triangulation of the case study (Denzin & Lincoln, 2005; Eisenhardt & Graebner, 2007). Overall, we followed a structured case study methodology following three main steps (see **Figure 1**).



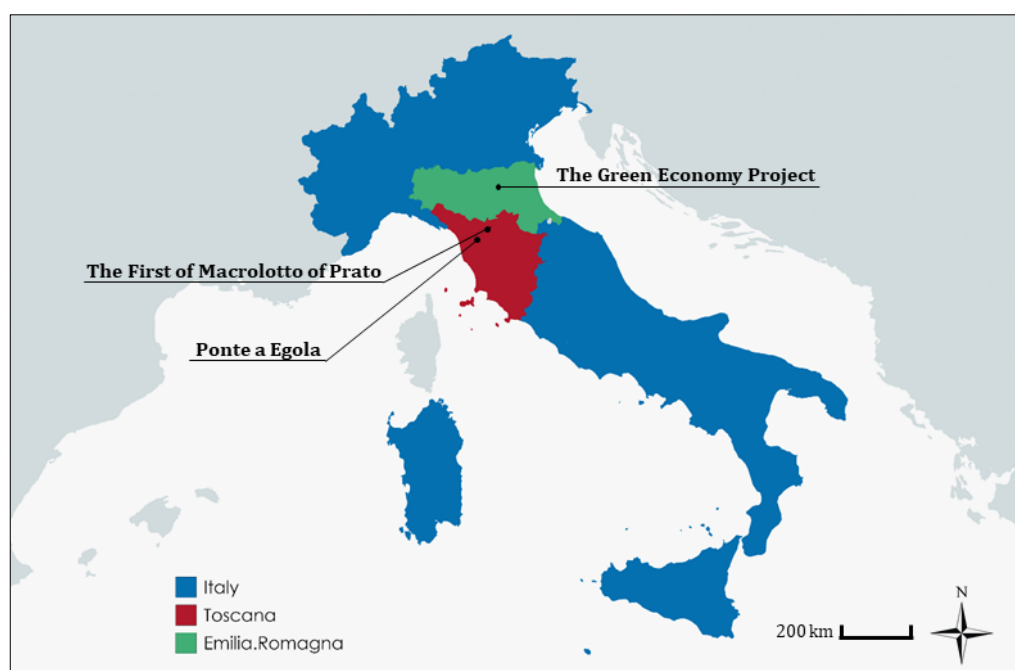
**Figure 1.** Case study methodology steps.

We started the first step – *initial screening and case selection* – by reviewing the secondary evidence collected through the desk search in order to obtain insights into the general background with respect to the EIP development in Italy. We then screened the identified Italian EIP experiences by conducting brief semi-structured interviews and analysing the collected secondary evidence. That screening was steered by criteria including the existence of the management body in EIP and its size and age, as well as willingness to collaborate for our research study. At the end of this step, we ended with three cases: The First Macrolotto of Prato, Ponte a Egola, and The Green Economy and Sustainable Development Project, which emerged in Tuscany and Emilia Romagna regions of Italy (see **Table 1** and **Figure 2** below for general characteristics of the cases).

**Table 1.** General characteristics of the cases.

Characteristics	The First Macrolotto of Prato	Ponte e Egola	The Green Economy Project
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Location	Tuscany	Tuscany	Emilia Romagna
Companies involved in the experimentation	380	160	13
Management body	CONSER Confindustria Toscana Nord	Cuoio Depur Tannery Consortium of Ponte a Egola	ENEA ASTER
Financing	Public/Private	Public/Private	Public/Private
EIP characteristics since	1990	1970	2013



**Figure 2.** The selected EIP cases in Italy.

In the second step – *further collection of primary and secondary evidence* – we conducted semi-structured interviews with the senior representatives of the cases and secondary data involved the collected documents including programme reports, policy statements, company data, and relevant publications. Initially, we finalised the design of the semi-structured interviews to be conducted with the relevant interviewees who had been actively involved in the EIP experimentation journey of each case. The interviews included two semi-structured question sections. The first of these sections was designed following the contours of our analytical framing, asking about the niche-building processes, also including the background of the experimentation of the EIP practices. This section remained the same for all conducted interviews. The second section included specific questions for each case based on the already-outlined overview of its context as a result of the initial screening and case selection step. This enabled us to design in-depth questions based on a more solid background and appreciated by the interviewees as an indication of our particular interest in their case.

For the First of Macrolotto of Prato, interviews (n=2) were conducted with two senior members of Confindustria Toscana Nord, which has been in charge of the environmental management. For Ponte a Egola, interviews (n=3) were conducted with senior representative of Tannery Consortium of Ponte a Egola, the entity that has been in charge of the environmental management since the settlement of the industrial production system. Finally, for the Green Economy Project, interviews (n=2) were conducted with the senior representative of ASTER, which has been the entity in charge of technical coordination



of the experiment as a part of the consortium for the innovation and technological transfer in the Emilia-Romagna region. The interviews not only served as the primary data source, but also ended in reliable secondary evidence provided by the interviewees, which enforced the data triangulation. In **Table 2** below, we summarise the source of primary evidence as well as our main inventory of the collected secondary evidence.

**Table 2.** Sources of primary and secondary evidence.

<b>Case</b>	<b>Source of primary evidence</b>	<b>Main secondary evidence inventory</b>
The First Macrolotto of Prato	Interviews with senior members of Confindustria Toscana Nord.	<ul style="list-style-type: none"> <li>– Report: The First Industrial Macrolotto of Prato-Sustainability Analysis, LIFE-SIAM Project (ENEA, 2006).</li> <li>– Report: Declaration of Sustainability of The First Industrial Macrolotto of Prato, LIFE-SIAM Project (CONSER, 2007).</li> <li>– Report: Guide to eco-innovation, sustainability policies and operational projects in Ecologically Equipped Productive Areas, LIFE Project (La Rete Cartesio, 2013).</li> <li>– Report: The Ecologically Equipped Productive Areas in Italy – State of the Art and Perspectives (ERVET, 2010).</li> <li>– Archives found in the official website of CONSER.</li> </ul>
Ponte a Egola	Interviews with senior members of Tannery Consortium of Ponte a Egola.	<ul style="list-style-type: none"> <li>– Report: Environmental Analysis on Productivity of Ponte a Egola (CuoioDepur &amp; APEA, 2016).</li> <li>– Report: GreenItaly - An idea for the future to face the crisis (Unioncamere &amp; Symbola, 2010).</li> <li>– Report: The District of Tannery and Leather (CuoioDepur, 2016).</li> <li>– Presentation: EEPA as new realty for Ponte e Egola (Natali &amp; Gradilone, 2015).</li> <li>– Archives found in the official website of The Tannery Consortium of Ponte a Egola, Cuoio Depur, and APEA Ponte a Egola.</li> </ul>
The Green Economy Project	Interviews with the coordinator of the project from ASTER.	<ul style="list-style-type: none"> <li>– Integration of industrial processes in a perspective of circular economy (Mencherini, 2016).</li> <li>– Industrial symbiosis in Emilia-Romagna region: Results from a first application in the agro-industry sector (Cutaia, et al., 2015).</li> <li>– Archives found in the official website of ENEA.</li> </ul>

In the third step – *case analysis and interpretation* – we primarily transcribed and coded the semi-structured interviews. For the analysis, we followed our analytical framing, focusing on the coupling of visions and expectations, the social network building, the learning processes and spatial context behind the experimentation of the EIP practices in each case. Our methodological choice to conduct a multiple case study provided suitable grounds to theoretically replicate the instrumental application of our conceptualisation in more than one setting (Yin, 2014). We were able to aggregate and cross-discuss the insights from three experimentation journeys that have allowed us to outline an overall framework to understand and explain how the EIPs unfold over the traditional industrial production systems and to draw conclusions through comprehensive interpretations and relevant implications.

We should also recognise some methodological limitations. The potential recall bias (Miles, 1979) that may emerge from retrospective insights of the interviewees was considered throughout the study. Another limitation was that the case studies did not involve any direct observation of the niche-building processes in the making of the experimentation. We have addressed those limitations by triangulating the insights and experiences of the interviewees by the secondary data sources to complement our analyses and interpretation, as also suggested in Gioia, et al. (2010) and Eisenhardt and Graebner (2007).

Moreover, considering the traditional validity approach through the generalisability criteria, it is worth noting that a study designed similarly to ours may end in varying findings in other country contexts and even in other Italian regions. This is because each sustainability transition journey may carry particular characteristics due to different constellation of involved actors, their experiences and also the future expectations (Garud & Gehman, 2012). Therefore, we underline that our empirical methodology, guided by our analytical framing, serves for the research validity in terms of the transferability criteria instead of generalisability (Guba & Lincoln, 1994). The overall conceptualisation and the theoretically guided results and discussions of this study can provide the foundational grounds for understanding and explaining the unfolding EIPs in other contexts for researchers and can provide relevant implications for practitioners and policy-makers. However, each sustainability transition journey requires a tailored research inquiry and action- and/or policy-oriented strategy considering its specific context-dependent characteristics.

## **5. Case study background**

### **5.1. *The Italian context***

The landscape provided by the European Union, which has been encouraging Member States to increase the environmental performance of its territories, has nurtured the Italian context to boost the transition of industrial production systems into more sustainable and eco-compatible spaces. Along these lines, the Ecologically Equipped Productive Areas (EEPAs) was the first initiative introduced by the Italian Government in 1998 (Tessitore, et al., 2015), and the first concrete attempt in Italy to search for a new industrial production model through the application of the IE principles on the EIP development model (Daddi, et al., 2015).

Although the EEPAs initiative was introduced at the national level, it did not accumulate into national guidelines and each Italian region has disciplined its implementation considering its specific regulatory, geographic, industrial, technical and socio-economic characteristics. Nine out of 20 Italian regions have indicated an intention to experiment with the Italian version of the EIP development through the EEPA certification. Of these, five regions (Emilia-Romagna, Liguria, Marche, Piedmont and Tuscany) have started the regional implementation, and the other four regions (Abruzzo, Apulia, Calabria, and Sardinia) have been developing related policies and strategies (Taddeo, 2016).

The Italian EIP development pattern has also been influenced by initiatives other than EEPAs. In particular, the Eco-Management and Audit Scheme (EMAS) has been contributing to the involvement of industrial clusters in the district level EIP development since 1993. The EMAS Cluster Certificate by the Italian National EMAS Competent Body has been a special recognition for the clusters that implement EIP management models (Daddi, et al., 2016).

In the present article, the selected cases for observation of the EIP experimentation are from the regions of Tuscany and Emilia-Romagna. Considering their approaches to the EIP development, both regions aim to increase the environmental performance of their territories while maximising the

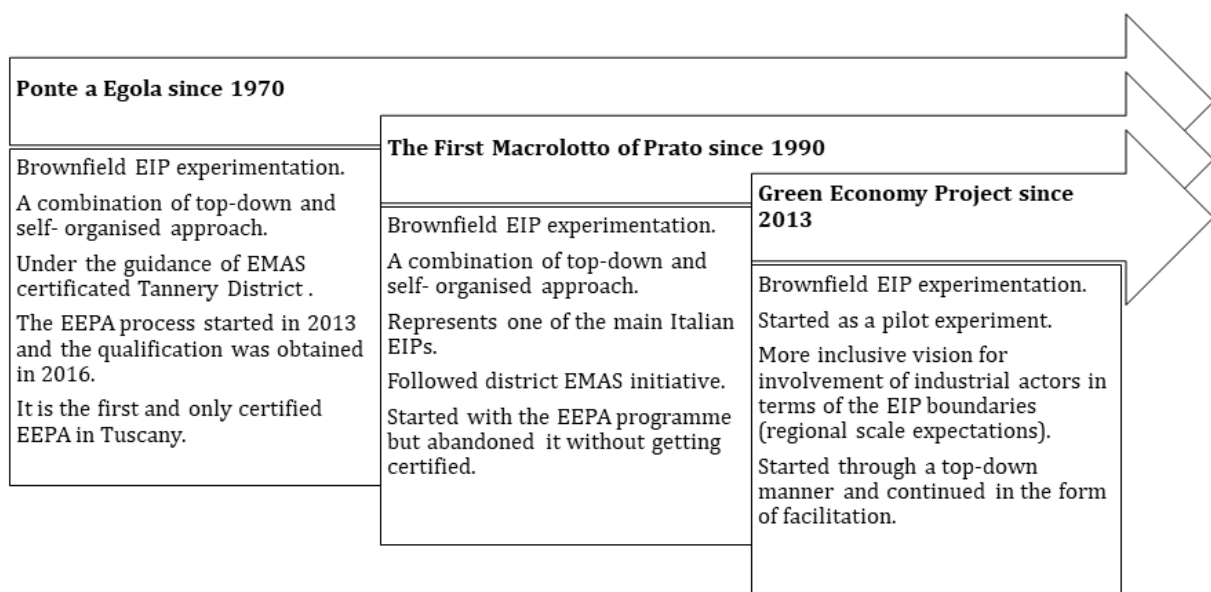
economic benefits. Moreover, both regions have introduced the related regulations and resolutions into the force relatively close to each other, compared with other regions.

## 5.2. Brief description of the cases

**The First of Macrolotto of Prato** specializes in wool production and has been an important economic hub for the development of Tuscany region since 1990. It represents one of the main Italian EIPs considering its history of continuous environmental improvements under the influence of the district EMAS initiative. It started with the EEPA programme but abandoned it before becoming certified. Its main EIP characteristics are related to the centralized environmental services, its wastewater recycling plant and the reputable performance of its management body as a facilitator of the EIP practices. The brownfield experimentation in this case has evolved through a combination of top-down and self-organised EIP practices (see Chertow, 2007, for further reading on the differentiation of self-organised and top-down approaches).

**Ponte a Egola** is an older and smaller industrial production system in Tuscany, which was established in 1970. As in the first case, the emergence of the brownfield EIP experimentation has been observed as a combination of top-down and self-organised approaches. The EIP experimentation has been highly influenced by the EMAS-certificated Tannery District to which Ponte a Egola pertains. Under the vision of the Tannery District, many efforts have been put into the recovery and reuse of by-products and the use of shared facilities. On the other hand, the top-down planned EEPA programme has also been followed for improving the green areas, waste management, shared infrastructure and services, and energy efficiency at the system level. The EEPA process started in 2013 and the qualification was obtained in 2016. It is the first and only certified EEPA in Tuscany.

Finally, **Green Economy and Sustainable Development Project** started in 2013. It differs from the other two cases because this brownfield experimentation did not identify a specifically bounded industrial production system and aimed to involve variety of industrial actors located in Emilia-Romagna region. It started through a top-down manner and continued in the form of facilitation aiming to boost the EIP practices among the located companies, research and development centres, and other regional formal and informal actors. **Figure 3** below describes the cases.



**Figure 3.** Brief description of the selected cases.

## 6. Case analysis through the niche-building processes

### 6.1. *Coupling of expectations and visions*

During experimentation in *The First Macrolotto of Prato* case, the EIP practices have been mostly developed through a bottom-up trend without a theoretical knowledge of the concept. As the EIP representative expressed in the interview, *“the area has evolved into a symbiotic industrial ecosystem without an academic approach”*. Initial visions and expectations were shaped mainly by the private character of the area, and the environmental commitment of the actors was led by top-down pressure through environmental regulations. The starting point towards a more conscious understanding of sustainability was the first environmental assessment, which was carried out in 1999 through a top-down intervention. Even though it did not lead to an immediate transition into an EIP, it shaped the industrial development processes by creating awareness among the actors and calling attention to the main sustainability-related problems of the industrial production.

Meanwhile, the management body has succeeded in revealing economic advantages of the EIP practices by introducing the sustainability concept as a competitive advantage in the market. This was also addressed in the interviews: *“... the area is mainly dedicated to the textile industry where the clients are from the fashion world, where the topics related to the sustainable production have been increasingly important. This means that for many companies, sustainability had to become a must and also turned into be an economic added value”*. Moreover, the economic advantage-oriented sustainable development visions of the actors have continued to evolve around the District EMAS and EEPA programme, although the area abandoned the EEPA before becoming certified.

In the case of *Ponte a Egola*, sustainability has been perceived as a continuous improvement process that cannot be decoupled from the industrial development. The interviewee from the representative consortium of the EIP stated that: *“since our production activities are quite polluting, finding sustainable solutions has always been our aim. Our search for environmental compatibility is on-going. We know that the technology continuously improves, and our industry, to survive, should always be technologically advanced and environmentally clean”*. Moreover, the long-standing participatory and collaborative culture among the institutional actors has fundamentally contributed to the evolving visions and expectations on the EIP practices.

Before getting involved in the EEPA programme in 2013, the EIP practices were structured around sharing the common infrastructure, and recovery and recycling of the materials among the involved industrial actors. The expectations of the actors have been broadened after the involvement in the EEPA programme towards urbanization aspects such as green areas, sound-absorbing asphalts, energy-efficient lighting systems, and waste management. Moreover, the importance of the management body as a trusted actor has been credited more among the regional actors. Meanwhile, the experience gained for the EMAS certification has also contributed to the actors' commitment towards the EIP practices and it facilitated the EEPA certification in 2016. The EIP experimentation journey of this case has been taken as a reference point by other interested industrial production systems in the implementation of the EIP practices, which have leveraged the motivations of the industrial actors from individual-profit-oriented level to a true environmental commitment at the area level.

Finally, the *Green Economy and Sustainable Development Project* started the EIP experimentation in a top-down manner and then followed a facilitation approach by spreading the knowledge and culture of the IE philosophy behind the EIP practices, aiming to involve traditionally separated industrial actors in a collective manner in a symbiotic collaboration with each other and also with other regional institutional actors. Since the beginning of the experimentation, the expectations were driven towards

realisation of an EIP model into practice, through a theory-based approach. This was because it was a top-down introduced project by the well-informed actors on the topic. Moreover, the experimentation took place at a period when the concepts related to IE had already gained momentum in the region. The expectations regarding the implementation of the EIP practices were linked to the potential economic advantage that can be achieved on the already matured responsive market that was available at the regional level.

## 6.2. Network building

*The First Macrolotto of Prato* case represents a broad network of actors and can be characterized by complex interactions among them. The network involves actors from *governmental institutions* like the Regional Government of Tuscany, Prato Municipality, the Ministry of Environment, the Ministry of Productive Activities, EMAS Italy Committee, and The Environmental Protection Agency of Tuscany Region (ARPAT); the Italian National Institute for Environmental Protection and Research (ISPRA); *intermediary organisations* like CONSER (the first management body), Confindustria Toscana Nord (the current management body), the Management of Prato District, the Industrial Association of Prato, and the Chamber of Commerce of Prato; *private companies* such as the water management company GIDA and located companies; *non-profit organisations* such as IDRA and Greenpeace; *research centres* like the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA); and *investment banks* like Fidi Toscana and Cassa di Risparmio.

The role of the first management body, CONSER, has been crucial as a facilitator of interactions in the network and creator of visions linked to the environmental sustainability benefits. Even before the EIP concept was highlighted and specified by the EEPA programme, CONSER had played the role in the management of water, energy, security, and dissemination. Its outstanding management performance was recognised in 2004 at the national level and its management approach was selected among the 23 best practices in terms of environmental management systems targeted to fostering collaboration among small and medium-sized enterprises (SMEs). The current management body is Confindustria Toscana Nord, which was created in 2015 as an attempt to reinforce the territorial industrial representation and increase the efficiency of the industrial activities. Its networking facilitation strategy has been inclusive at broader levels compared to CONSER, so the interaction to communicate with regional, national and international actors has been stressed as well. As a specific networking strategy, CONSER has been organising periodic meetings that provide a space to the actors to share their voices and derive the potential synergies. This was also expressed in the interviews by the EIP representatives as “... *the meetings accumulate into a kind of state of the art and a platform to share updates. This helps to carry out the different initiatives in the best possible way incorporating different actors*”.

Another important aspect highlighted in the interviews concerned the good communication strategies regarding the associated economic gains of the EIP practices, which resulted in high number of private companies in the EIP network. This was also mediated by the fact that the area has been a concentrated and homogeneous one and has been composed of mainly textile companies, which allowed the Macrolotto to develop a series of EIP practices. Moreover, Chinese industrial immigration has been strong in Prato, and Chinese textile manufacturers have located in facilities vacated by the companies that left mainly because of the economic crisis. Chinese manufacturers have been adapting to the regional standards and now just a small group of polluting industrial actors remain in the area.

Regarding *Ponte a Egola*, there is also a broad network of actors collaborating with each other to advance the environmental sustainability following the EIP practices. These actors are from *governmental institutions* like the Regional Government of Tuscany, the Municipality of San Miniato, The

Environmental Protection Agency of Tuscany Region (ARPAT); *intermediary organisations* like Tannery Consortium (the cooperative society of the located companies), Cuoio Depur Consortium (entitled as the management body of the area), National Confederation of Craft Workers (CNA Area del Cuoio, the representative association of the regional craft workers), and Technological Pole of Navacchio (which brings together businesses, universities, researchers and investors to boost their ideas); located *companies*; and *universities and research centres* like Sant'Anna University, Tannery Technological Pole and Cerco Lab (the spin-off of the University of Florence).

Perhaps the most active actor during the EIP experimentation has been the Tannery Consortium, which was created in 1976 to manage the concerns of variety of actors. The creation of the consortium coincides with the beginning of the industrialization process of the area and has played an important role in the urbanization and relocation of the tannery activity. The contribution of the consortium to the emerging participatory and collaborative culture has been undeniable. It plays a central role in addressing the sustainability issues by leveraging the homogeneity of the area through facilitating the collaboration among SMEs and other institutional actors. Moreover, the consortium has been the representative entity for the EEPA and District EMAS programmes.

The EEPA programme, as an important seed during the EIP experimentation, started with the call of the Tuscany Region, to which the San Miniato Municipality, as the owner of the land, responded by volunteering itself as the entity in charge of the EEPA planning. A working group composed of the municipality, private actors, universities and other regional actors was then created to share the tasks and the new management body was chosen as Cuoio Depur through common deliberation. The management body, in close collaboration with the governmental institutions, aimed to add economic value to the located industrial actors and help them manage their environmental impact. Cuoio Depur has been in charge of the organisation, realisation, and maintenance of the EEPA-related activities. Furthermore, the continuity in the working group structure allowed for common decision-making grounds among the regional institutional actors and different points of views were integrated throughout the experimentation. Even since the EEPA certification, the working group remains in place and meets periodically.

Finally, for the ***Green Economy and Sustainable Development Project***, a broad network has emerged during the experimentation, including *governmental institutions* like the Emilia-Romagna Regional Government and the Regional Planning Office of Rimini; *intermediary organisations* like the Consortium for Innovation and Technology Transfer of Emilia-Romagna (Aster), the Environment Society Social Cooperative (Coop Formula Ambiente), the Italian Union of Chambers of Commerce, Industry, Handicraft and Agriculture (Unioncamere) and the Agricultural Cooperative Conserve Italia; *universities and research centres* such as the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Energy and Environment Laboratory Piacenza (LEAP) and MatER Research Centre of Politecnico di Milano, and the Emilia-Romagna High Technological Network, which brings together the centres for industrial agro-food research (Ciri Agrifood), renewable sources, environment, sea and energy research (CIRI Frame), advanced industrial material research (CIRI Mam), and the research centre for packaging (CIPACK); and *private industrial actors* like Agricoltori Riunti Piacentini (ARP), Barilla & R Fratelli, the cooperative multi-business industrial group CCPL, General Machine Company (CGM), Schmack Biogas, and Valfrutta-Conserve Italia.

The project was financed by Unioncamere and Aster was the lead in conducting the EIP experimentation. Aster played a key role in identifying the initial potential synergies leveraging on its familiarity with the industrial network in the region and collection of relevant data from the companies.

The regional network embedded in the industrial context presented the region as an ideal testbed for this pilot experimentation and boosted the competencies and resources to stimulate the sustainable industrial development.

The experimentation was started over the existing synergistic composition between the industrial actors producing industrial waste and the technology developer advancing the biomass treatment. It was then relatively simple to identify upstream and downstream elements for the development of further potential synergies. Moreover, the classification of economic activity codes (ATECO codes) of the companies particularly helped to determine whether there were other possible synergies that were not easily recognizable from the provided data. That was especially important because synergies between sectors outside the project were also recognized, which facilitated scaling up of the network at broader levels.

Apart from Aster, there were other synergy facilitators such as research laboratories of the High Technology Network and ENEA, which were acquired with relevant technological, scientific and research skills. Moreover, ENEA was responsible for disseminating the knowledge about the EIP practices to the industrial actors. The size of the companies also positively influenced the emerging EIP network. The project representative from ASTER in our interview stated that “... *big companies were more likely to be aware of the EIP practices in comparison to the smaller ones.*”

### **6.3. Learning**

During *the First Macrolotto of Prato* experimentation, the learning process has been iterative and the attitude of the management body towards raising awareness was essential. Initially, the difficulties of realising the EIP practices were apparent in terms of restricted regulations and missing interests from the industry due to economic concerns, but the management body treated those issues as potential sources of adaptation through learning. The dissemination of knowledge and environmental awareness has been promoted in the industrial production system through educational courses, special training sessions and meetings, planning of guidelines, and promotion of environmental certifications for the industrial actors, to increase regional awareness to engage with more actors. The idea that environmental and economic benefit can be coupled has been stressed during the learning activities. The management body representative expressed that “... *since too long we have been talking about the environment-related concerns, the need to save resources ... However, when talking to public and private entities it is important to show the practical results ... Because when things are perceived as investments and not just as costs, there are more positive responses in terms of involvement from different organisations*”. Moreover, the knowledge dissemination was not limited to the benefit of the regional actors. The management body has been acting as an EIP development influencer across Italy and Europe.

In the case of *Ponte a Egola*, learning has been mostly oriented towards the importance of extending the useful life of important resources. The actors’ understanding of the potential collective benefits through the EIP practices has been mediated by the existing participatory and collaborative culture of the industrial production system. That culture was reinforced by the fact that the management body was not an ex-novo figure, but rather had been running its activities with its strong technical and managerial capabilities long before the EIP experimentation journey. Therefore, the area was able to take advantage of trust and mutual interests. The representative of EIP commented that “*it could be difficult to create an instrument from scratch that could create high level of trust and interest in the EIP practices, because it would require very high managerial and training costs.*” Knowledge dissemination has also been supported by other regional actors, such as the Tannery Technological Pole and Cerco Lab, which provided the infrastructure and competencies for learning activities.

Considering the *Green Economy and Sustainable Development Project*, among the fundamental concerns of the organised learning activities were communicating to the regional actors and transferring them the potential economic and environmental benefits of the EIP practices. Since the beginning of the experimentation, actors had different standpoints regarding their expectations about the EIP development. For this reason, it was very important to create a common understanding and convince them of the importance of their involvement in synergistic relationships. When the industrial actors were able to understand the savings from waste disposal and purchase of raw materials, the reduction of carbon emissions and pollution, and the synergy opportunities that they could get advantage from, they became more engaged in the project. To facilitate the comprehension of the concept, knowledge on the best practice EIPs at the national and global level was provided to the actors. Furthermore, the existing know-how of Aster and ENEA has been an advantage as it accelerated the gathering and analysis of the data from the companies.

## **7. Discussion on the unfolding EIPs: Niche experimentation**

### **7.1. *Through interacting niche-building processes***

The results revealed that the analysed EIP experimentation within the three cases has been implemented under the brownfield model. We can conclude that niche processes of each have been in constant interaction and interdependent on one another, as also argued by Schot and Geels (2008). Each niche process has had an essential influence on others during the experimentation. That interdependence makes it difficult to understand their individual development dynamics separately, which reinforces the need to analyse the niche processes under their dynamic interactions, as also reasoned by Elmustapha et al. (2018).

Starting from the coupling of expectations and visions, the implementation of the EIP practices considering three cases can be interpreted as a continuous search for economic advantages, as Daddi et al. (2015) also claimed when referring to the Italian approach. Yet, during the experimentation, the economic development trend has been shifting from individual-performance-oriented focus considering only economic sustainability towards collective-benefit-oriented collaboration with other actors. This also implies that the building of networks among the actors has been a fundamental enzyme to the reaction of articulating visions and expectations, as Gibbs (2009) also explained for other EIP cases.

The evolution of the analysed EIP experimentation journeys can be understood as an adaptive and continuous process during which the visions and expectations of the regional community have been converging through learning processes, which at the same time have had an impact on the size of the EIP networks. For example, in the early stages of the First Macrolotto of Prato experiment, a relatively narrow network existed, mainly involving the located industries. However, during the experimentation, new actors like private saving banks (such as Cassa di Risparmio) and non-profit organisations (such as Greenpeace) were involved as well. Enlightened visions about the EIP development alerted local actors to the importance of looking beyond the local interests and being more open-minded to new interactions. Network adaptation not only implies the continuous entry of new actors to the EIP networks, but also that some others have been leaving, and existing interactions have been changing as well. Therefore, the EIP network, as a reflection of changes in visions and expectations, has been changing in terms of the actors involved and the relational dynamics among them.

In all three cases, broad networks have been observed where fundamental roles have been played by the management bodies, the governmental institutions, intermediary organisations, universities and



research centres, and the private companies. The intermediary organisations, especially the agency of the management body (see Tessitore, et al., 2015; Daddi, et al., 2015, for further reading on the management bodies in Italian approach) can be claimed to play the central role in the unfolding EIPs as they have been coordinating and/or providing shared services and infrastructure, facilitating interactions among the network members, identifying synergies, creating awareness, scaling up existent EIP practices and designing new ones. The governmental institutions' role has also been fundamental in enabling and boosting the EIP experimentation, especially through developing relevant regulatory and incentivising mechanisms. For example, the Italian Government recognises the EIP development as a strategic regional development model and reasons that EIPs shall not only serve for better environmental performances but also foster job creations and contribute to the regional economic development. This has also nurtured the involvement of the regional governments in the EIP experimentation for three cases.

Moreover, the universities and research centres have provided learning tools for the dissemination of knowledge and brought a theory-based vision for testing in the field. They have also substantially advanced the identification possible synergies among actors that contributed to the realisation of the EIP practices and, consequently, the involvement of more industrial actors to the EIP networks, as seen clearly in the Green Economy and Sustainable Development Project. The learning processes have built on existing knowledge and contributed to the new knowledge within the EIP networks. The accumulating knowledge has shaped expectations and visions by providing understanding of whether and how these EIP practices could add to the regional economies. The industrial actors have been integrating the EIP development vision to their expectations by changing their assumptions about the sustainability and becoming attached to the EIP networks that benefit economically and ecologically from emerging synergies.

## **7.2. *Within the spatial context***

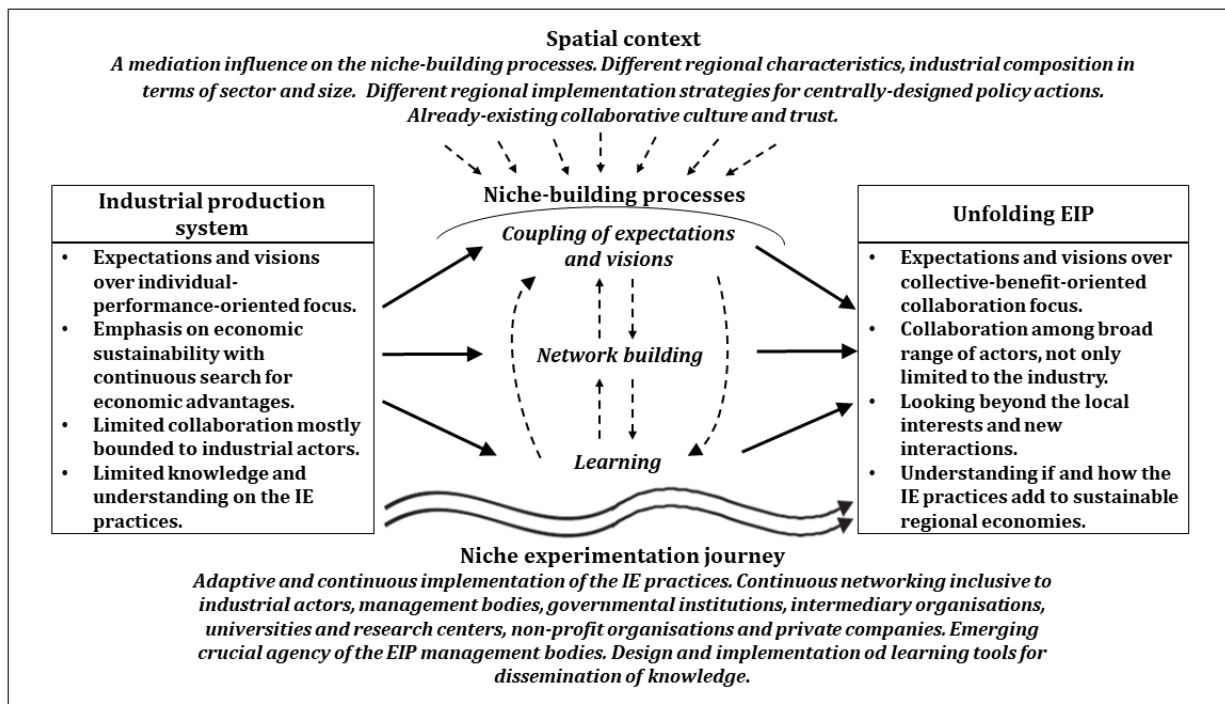
Our results have shown that the niche-building processes of the analysed EIP experimentation journeys within the three cases experimentation processes have been mediated by the spatial contexts. Although the brownfield EIP experimentation was common for three cases, we have not observed a rigid model on how the EIPs unfold. This can be explained by the argument that the niche-building processes are highly dependent on the realities of the different industrial production systems and the context in which they operate. Moreover, Italy has no national guidelines in terms of EIP requirements and different regions take specific approaches. Therefore, the EIP experimentation management and its contribution to the EIP emergence have been highly influenced by the specific regional characteristics. For example, regional governments' pressures, incentives or different regional implementation strategies on the programmes such as EEPA and EMAS have been shaping both the planning and implementation of the experimentation in different regions. This also reinforces the importance of considering spatial variants when studying sustainability transitions, as also argued by Coenen et al. (2012).

Moreover, the analyses of three cases have shown that relatively more homogenous industrial production systems composed of SMEs are more likely to develop the EIP practices. Similar size and sector industries may share similar concerns in terms of resilience strategies to changing socio-economic environment, which can also contribute to the (further) construction of participatory and collaborative culture in the regions. The unfolding EIPs in Tuscany represent good examples of this. Tuscany is one of the most advanced Italian regions in terms of the EIP development and the areas in that territory show the characteristics of homogeneity and companies of small dimension. However, it may be necessary to note that the lack of heterogeneity may restrict the type of potential symbiotic

exchanges and make the areas more focused on particular synergies, such as recycling and recovery consortiums, a common management body, or shared infrastructure, as also indicated by Daddi et al. (2015) while discussing the Italian approach.

### 7.3. Overall framework

Following our initial analytical framing and taking the EIP niche experimentation as central to our inquiry, we analysed three EIP cases to understand and explain how they unfold over the traditional industrial production systems, focusing on three niche-building processes under the mediating influence of the spatial context at regional and national scales. Building on the empirical insights from three Italian EIP experimentation journeys guided by our initial analytical approach, we have derived a framework to demonstrate the transition from industrial productions systems into the EIPs through an experimentation journey (see *Figure 4* below).



**Figure 4.** The framework of the EIP niche experimentation to understand how EIPs unfold over the traditional industrial production systems.

As the figure shows, the experimentation journey is steered by three niche-building processes: coupling of expectations and visions, social network building and learning processes. The spatial context has a mediating influence on the interaction and functioning of those processes. The main actors involved in the EIP experimentation involve industrial actors in the production system, management bodies, governmental institutions, intermediary organisations, universities and research centres, non-profit organisations and private companies. The broad network continuously built by this broad range of actors designs and implements different learning tools that contribute to changing expectations and visions diverging from individual-performance-oriented focus towards collective-benefit-oriented collaboration focus. The emerging EIP niche community implements the IE practices, not only prioritising the individual economic benefits but also considering the sustainable regional economies. The regional industrial composition related to the size and sector of the companies, as well as (existing) collaborative culture and trust, affects the effectiveness of the niche-building processes and may foster a relatively smoother transition into the EIP niches. Moreover, in the absence of a unique national

strategy policy for the EIP development, each region may develop specific implementation strategies for centrally designed policy actions.

## **8. Conclusion and implications**

This article has sought to understand and explain how EIPs unfold over traditional industrial production systems for extending the debate on whether and how the IE philosophy can bring a real paradigm shift in industrial production routines. We have taken the niche and experimentation concepts from the sustainability transitions field – which are central to our analytical framing – and mainly drawn upon the foundations of the SNM perspective as our method theory. Empirically, we have followed a qualitative multiple case study and bring three EIP cases from the Emilia-Romagna and Tuscany regions of Italy. We have analysed three EIP experimentation journeys by focusing on three internal niche processes under the mediating impact of regional and national context where they are embedded in. Our empirical inquiry, guided by our analytical framing, enabled us to derive an overall framework that illustrates the unfolding EIPs through an experimentation journey (see *Figure 4* in Section 7).

### ***The unfolding EIPs through niche experimentation***

The results of the multiple case study revealed that the way in which the EIPs unfold depends on the interacting and interdependent niche-building processes during the experimentation. The three Italian EIP experimentation journeys analysed here carry characteristics of a brownfield EIP development model. The niche processes have been under the mediating impact of the regional context in which the industrial production systems function. Considering the Italian context, each region has its own specific requirements for the EIP development and there is no unique EIP development guideline at the national level.

The emerging EIP networks have been composed of different institutional actors, including the governmental institutions, the intermediary organisations, non-profit organisations, universities and research centres and the industrial actors in the production systems. This suggests that the EIP networks should not only focus on the industry involved in the symbiotic exchanges, but also on other actors that contribute to the emerging community with converging visions on the continuous implementation of the IE practices.

The visions and expectations of the actors have been articulating through the learning processes towards a shared understanding of the EIP development. During the experimentation, not only the environmental gains of the EIP practices but also their economic benefits have been increasingly realised among the network actors. However, their initial motivations were established around the expectations about the economic benefits. Moreover, the niche processes of each EIP experimentation journey have been constantly interacting with and interdependent on each other; this calls for consideration of the divergent blurred lines in between them, which makes it complicated to analyse each niche process separately.

### ***Action- and policy-oriented implications***

In this article, we built on our analytical framing for ex-post analysis of the EIP experimentation in three cases and we came up with an overall framework that illustrates how EIPs unfold over the traditional industrial production systems. The learning offered through the results and discussion may serve for the regional policy-makers and practitioners for further EIP experimentation in the Emilia-

Romagna and Tuscany regions. Moreover, the overall framework we derived may be used as an ex-ante management tool for future EIP experimentation elsewhere. We suggest that the potential for an industrial production system to transform into an EIP calls for specific niche formation policies. Specific importance can be given to the network building process targeting various regional actors (not only focusing on the industry), which will couple their expectations and visions through learning mechanisms disseminating the knowledge on the EIP practices. Moreover, continuous experimentation of the EIP practices will not only lead to an increased number of EIPs in the regions but may also bring a shift in traditional industrial production routines through the IE philosophy on a wider scale.

### **Research implications**

The case study provided in this article can be extended to different EIP cases to understand their emergence and to further test the plausibility of our analytical framing for the analysis and explanation on how EIPs unfold over different industrial production systems at different spatial contexts. Moreover, further research could study in detail the interdependency of the niche processes and their impact on each other during the experimentation. Finally, future studies could test the plausibility of other analytical frameworks, such as technological innovation systems and multi-level perspective from sustainability transitions field, in order to understand and explain the IE-related transitions.

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