

FROM INDUSTRIAL DISTRICTS TO INDUSTRIAL SYMBIOSIS: AN OPPORTUNITY. THE CASE OF THE PONTE ROSSO INDUSTRIAL AREA, ITALY

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The industrial zone north of Spilimbergo – the fusion between the Consortium of Ponte Rosso and the Consortium of Spilimbergo.

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From industrial district to industrial symbiosis: An opportunity. The case of the Ponte Rosso industrial area, Italy

ABSTRACT: The article highlights the importance of industrial symbiosis in the industrial ecology literature, which refers to geographically close relationships between companies in which networks and geographic proximity play a vital role. Industrial symbiosis traditionally deals with different industries in a collective approach to economic and environmental management. The research was carried out in the northeast of Italy in the autonomous region of Friuli Venezia Giulia, close to the Slovenian border. The Ponte Rosso was used as a case study. The empirical analysis served to highlight some critical aspects of the environmental, geographic-economic, and social factors that could hinder the development of industrial symbiosis in this region.

KEY WORDS: industrial districts, industrial symbiosis, industrial symbiotic networks, economic geography, Friuli Venezia Giulia

Od industrijskega distrikta do industrijske simbioze: Priložnost. Primer industrijskega območja Ponte Rosso, Italija

POVZETEK: Članek prikazuje pomen bistvenega pojava v literaturi o industrijski ekologiji, ki označuje geografsko tesne odnose med podjetji, v katerih igrajo omrežja in geografska bližina ključno vlogo – industrijske simbioze. Ta se tradicionalno ukvarja z ločenimi panogami v skupnem pristopu poslovanja in ravnanja z okoljem. Raziskava je bila izvedena na severovzhodu Italije v Avtonomni deželi Furlaniji Julijski krajini, v neposredni bližini slovenske meje. Ponte Rosso je bil vzet kot primer, za katerega so značilne priznane okoljske, geografske, gospodarske in družbene koristi. Z empirično analizo izpostavljamo nekatere ključne vidike okoljskih, geografsko-ekonomskih in družbenih dejavnikov, ki so ovira razvoja industrijske simbioze v tej regiji.

KLJUČNE BESEDE: industrijski distrikti, industrijska simbioza, industrijska simbiotska omrežja, ekonomska geografija, Furlanija – Julijska krajina

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1 Introduction

The term industrial symbiosis was first used by Renner (1947) to describe the »organic relationship« between different industries, including the use of the waste products of one input for another, and later defined by Christensen (1992, cited in Chertow 2000) with the famous industrial symbiosis case Kalundborg, an eco-industrial park in Denmark. Later, Chertow (2000), Chertow and Lombardi (2005), and Mirata and Pearce (2006) provided definitions of industrial ecology and circular economy. Industrial symbiosis, a sub-field of industrial ecology, is concerned with the cyclical flow of resources through business networks. The main goal of industrial symbiosis is to support the industrial organisation by getting companies to think beyond the boundaries of the individual company at a broader systems level (Chertow 2000).

The first approach to this concept was eco-industrial parks and islands of sustainability. They grew out of the idea of creating »industrial biocenoses« around certain industries. So-called clusters would produce minimal emissions due to the exchange of materials between the sectors involved (Erkman 2002).

In 1989, a cluster of companies from different industries was established in Denmark that intensively distributed resources (Knight 1990, cited in Chertow 2007). As noted by Taddeo et al. (2017), clusters are one of the most effective models for local industrial growth and are considered a good starting point for industrial symbiosis projects.

At this point, we refer to the concept of circular economy, which aims to bring industrial systems closer to environmental and social protection. In the circular economy, waste from production and consumption circulates as a new input in the same or a different process (Ellen ... 2013).

The circular economy approach is one of the fundamental concepts within industrial symbiosis. It envisions a recuperative system in which materials flow in a stable system that provides a balance between economic and industrial development and geographic and environmental resource protection (Džajić Uršič 2020). In the context of the circular economy, industrial symbiosis can be considered a strong archetype of a business model based on shared infrastructure and by-products to improve resource efficiency and create value from waste. Minor or broader collaborations within the industrial symbiosis reduce the need for raw materials and waste disposal, thus closing the material loop (González-Val and Pueyo 2019; Papetti et al. 2019).

Gibbs and Deutz (2005) note that it is unclear whether the exchange of by-products should be considered as a defining feature of an eco-industrial park or/and industrial symbiosis, leading to an ambiguous and inconsistent use of the terms, which is still controversial. Some authors consider eco-industrial parks as one of the ways to create industrial symbiosis, as Chertow (2007) states.

The literature on economic and industrial geography has significantly influenced industrial geographic analysis. For instance, geographic proximity has become a major factor in managing social synergies in industries in industrial symbiosis. It reduces transportation costs and energy depletion and indicates sufficient material supply from the surrounding companies to make industrial symbiosis more sustainable (Ehrenfeld and Gertler 1997). For an efficient industrial symbiosis structure, geographic proximity should be considered as a relevant variable for navigating through social ecosystems such as industrial districts (Howard-Grenville and Paquin 2008; Jensen et al. 2011). On the other hand, the dynamic evolution of industrial networks that develop in complex environments does not allow companies involved in the exchange of by-products to calculate their optimal geographic location for suppliers and consumers using traditional linear methods (Staber 2001; Morales and Diemer 2019).

The literature on geographic economics now offers opportunities to think about some critical factors from a geographic point of view: industrial location, land, spatiality, spatial diversity, undefined development, spatial embeddedness, path dependence, and scaling (Beaurain and Varlet 2015; Boutillier et al. 2015).

Let us start with the concept of clustering, proposed by an economist Alfred Marshall (2013). He tried to identify the reasons that make the agglomeration of specialised industries a territorial phenomenon worth studying (Jelen 1993; Storper 1997; Porter 1998; Becattini et al. 2003). Since 1990, the concepts of industrial district and cluster have been widely used, and the term industrial district is commonly used in the economic literature (Markusen 2003; Lazzeretti 2006; Ortega-Colomer, Molina-Morales and Fernández de Lucio 2016). In the 1980s, Marshall's concept of the industrial district was used as a new unit for analysis of industry-specific enterprises clustering based on a socio-economic approach to industrial organisation (Becattini 1987). Later, Porter (1989), starting from his interest in the combination of competitive forces which give impetus within the economic system to specific specialised clusters formed through inter-organisational

networks, proposed the territorial cluster. Becattini (1987) often cited territorial clusters as a typical example of industrial districts (Becattini et al. 2003). A cluster approach can be limiting if the geography is defined by a rigid boundary (Henriques et al. 2022). Often, the industrial area is interpreted as a cognitive system or »cognitive laboratory« where knowledge and information are elaborated in a complex way. Culture and social values are created, and the companies' effectiveness drives unspoken understanding, a social-productive system in which knowledge, social experiences, mental models and collective beliefs are accumulated over time in a given space. Geographic proximity favours the exchange of information and knowledge among co-located stakeholders (Neves et al. 2020). In this approach, the industrial area must be understood as a complex system of knowledge generation, absorption, and sharing, as well as a network of social interactions« (Becattini et al. 2003). From the above, the crucial role of trust emerges. The importance of this social dimension in industrial areas is often recognized in the literature (Ehrenfeld and Gertler 1997; Gibbs and Deutz 2005; Gibbs and Deutz 2007; Tudor et al. 2007).

In the Autonomous Region of Friuli Venezia Giulia, there are seven industrial districts that, despite their geographical location, use the concept of industrial symbiosis as a collective approach to competitive advantage. They achieve economic and environmental benefits while taking social aspects into account (Chertow 2007).

The article aims to present the crucial positive and negative highlights in the current geographical, organisational and economic areas. They show the importance of companies belonging to foreign multinationals present in industrial districts; the awareness of smaller, younger and expert companies for the sustainable development of the area; the relationships between different types of companies within production systems; social aspects of synergies and mechanisms between companies and their formation; strong and mutual dependencies between industrial districts, disregarding some characteristics, such as size, organisational structure, economic income and age.

To achieve this goal, a comprehensive assessment methodology was developed and carried out. This study is divided into two sequential phases: first, the industrial districts in the Autonomous Region of Friuli Venezia Giulia were analysed, and in the second phase, primary data were collected in the field. A comprehensive analysis is proposed to interpret the role of factors influencing the development of industrial symbiosis. As driving forces, networks were considered as 'institutions' (laws, central concerns for direction, the formal mechanism for policy rule-making and enforcement), 'social networks' (social structure consisting of a set of social actors such as individuals), and 'cognitive frames' (norms, values) (Beckert 2010; Džajić Uršič 2020; Jelen et al. 2020).

2 Friuli Venezia Giulia and the case of Ponte Rosso

It is undeniable the Italian regional governments are actively incorporating concepts such as the eco-industrial park into their local policies, beginning with a 1998 national law (Italian Legislative Decree 112/98) designed to promote industrial development. This proposed a model for environmentally sustainable local industrial development or a system based on shared utilities, infrastructure, and services called »ecologically equipped industrial areas« (Daddi et al. 2016; Taddeo 2016; Taddeo et al. 2017). As Daddi et al. (2016) noted, this model has been a national challenge to outline a new organisational standard of production activity inspired by the principles of industrial ecology.

Few studies describe industrial symbiosis cases in the Autonomous Region Friuli Venezia Giulia (Ponte Rosso). However, in other regions of Italy, there is great interest in eco-industrial parks, and many policymakers encourage their creation (Tessitore et al. 2014). The case study of Ponte Rosso was chosen as a starting point for the study because of its good inter-company connectivity and contribution to the local economy and society in the region.

Regardless of the industrial symbiosis in the Friuli Venezia Giulia Autonomous Region, Article 58 of the FVG Regional Law of 2015 on the reform of industrial policies provides critical guidelines for the financing of supply chain projects through (1) the establishment of industrial networks; (2) the organisation and integration of phases of the production cycle and supply actions; (3) the distribution of resources, knowledge and activities; (4) the exchange of the work cycle and the use of renewable energy sources together with industrial symbiosis projects and projects aimed at sustainable flexibility of goods, and (5) the development of combined eco-innovations related to the prevention of waste production.

The »Consortium for the Economic Development of Local Enterprises and Industries – Ponte Rosso, Tagliamento«, based in San Vito al Tagliamento, whose current name is Consortium, was established on October 2nd, 2017, by merging the »Consortium for the Industrial Development Zone of Ponte Rosso« and the »Consortium for the Industrial, Economic and Social Development« of the Spilimbergo area. The new entity, the result of the restructuring operations referred to in LR 3/15 »Rilancimpresa FVG«, manages the industrial areas of Ponte Rosso, the northern industrial area of Spilimbergo and the San Vito al Tagliamento craft area (Daddi, Tessitore and Testa 2015).

An eco-industrial park Ponte Rosso manages part of the technical, administrative, and maintenance services in the Tabina craft area in the Valvasone Arzene municipality (Tessitore et al. 2015). It was launched in 2015 through an agreement with the city and includes 224 companies covering an area of almost 570 ha and employing about 5,300 people. The reference area of the companies extends from Castelnovo to Pravidomini, with 65,000 inhabitants (Daddi, Tessitore and Testa 2015).

Ponte Rosso also has combined production facilities, self-generated electricity and heat distribution facilities, and a railway connecting it to the national grid. In addition, the consortium also monitors several key local environmental performance indicators (Daddi et al. 2015). The eco-industrial park also includes a wastewater treatment plant that complies with emission limits. One of Ponte Rosso's main activities is the acquisition of non-infrastructure land for conversion into large-scale industrial settlements. Consulting services provided under contracts with third parties include services that can lead to greater environmental sustainability, such as quality, environmental and safety consulting. Ponte Rosso is divided into five industrial areas, as shown in Table 1.

In 2018–2020, Ponte Rosso's commitment to infrastructures amounted to 8.444 million EUR, of which 5.251 million EUR was the regional contribution (Conzorzio ... 2020). In the 2020–2021 period, the main activities of the Ponte Rosso were to promote employment, and economic growth and to increase the attractiveness of new industrial and artisanal productions. The analysis of companies in the areas of expertise shows that the number of companies with less than ten employees will increase up to 51% of the total in 2020 (compared to 48.9% in 2019) (Conzorzio ... 2022).

Table 1: Available detailed data on the infrastructures of Ponte Rosso from 2021 and 2022.

DIMENSIONS	ZIPR	ZA	TABINA	ZIN	ZAPR	TOTAL
SURFACE in 2022 (ha)	372	11	60	112	11.5	566.5
FIRMS in 2022 (no.)	112	19	21	37	13	202
EMPLOYEES in 2022 including employees from rental businesses, companies, kindergartens and canteens (no.)	3,459	104	669	517	167	4,916
PRODUCT SECTORS in 2021	Mechanics, glass, construction, plastic, food, wood					
SEWERS in 2021						
• black network (m)	16,880			5,660		22,540
• white network (m)	19,560			6,400		25,960
RAILWAY CONNECTION in 2021 (m)	12,365					12,365
METHANIZATION in 2021 (m)						
• pipelines	15,170			3,300		18,470
• derivations	1,880					1,880
OPTICAL FIBRE in 2021 (m)	14,530			5,330		19,860
PUBLIC LIGHTING in 2021 (m)	9,730	750		5,400		15,880
INTERNAL ROADS in 2021 (m)	21,000	1,000		5,408		27,408
PARKING LOTS in 2021						
• parking spaces (no.)	250			173		423
• heavy vehicle seats (no.)	50			2		52

Ponte Rosso has equipped the industrial area of San Vito al Tagliamento with environmental protection devices and cameras that monitor the site and collect information on environmental conditions, especially water issues. However, Ponte Rosso urges for a complete cognitive system of ecological matrices, following a unified framework that will guide further project development. In response to this protection system, an experimental project was created; the Ecologically Equipped Production Area project, which has been carrying out studies and projects for public and private clients since 2007 (Brunelli and Buoncompagni 2012), providing expert support throughout the process of implementation and qualification of production areas.

It is evident that Ponte Rosso is following the corporate guidelines for the future regarding environmental issues: Strengthen the image in the region through the needs of the companies; improve and disseminate the management systems; more efficient documentation and implementation of appropriate measures to prevent possible contamination or pollution in the region; Compliance with the regulations and laws applicable to the activities of Ponte Rosso; guarantee environmental standards of the companies for the services provided; raise awareness and involvement of the members of Ponte Rosso to promote and increase respect for the environment, in order to strengthen the environmental culture throughout the territory of the Autonomous Region of Friuli Venezia Giulia (Conzorzio ... 2020).

3 Methods

The research goes from the theoretical concept to its implementation with qualitative research, using primary data from interviews and other accessible databases. In the first phase, we also collected all available data from the authors' databases and publicly available sources through literature, online research and reports, using keywords Autonomous Region Friuli Venezia Giulia, sustainable development, eco-industrial park, industrial symbiosis, industrial districts, social geography, networks/collaborations. We then established the protocol for conducting semi-structured interviews with representative stakeholders, consultants, experts, and policymakers (Table 2) in the Autonomous Region of Friuli Venezia Giulia. The qualitative interviews were conducted between June and September 2021. The interviews were conducted with stakeholders from different sectors and organisations (managers, policymakers, artisans, and workers in companies) in the industrial districts. As shown in Table 2, different selected stakeholders were interviewed according to the area/sector in which they operate. This allowed us to get a more comprehensive picture of how to build our dimensional model.

The population of the qualitative analysis consisted of five representatives of local authorities, one representative from the chamber of commerce, two experts from the ICT cluster, four managers from the Ponte Rosso Eco-Industrial Park and three project developers from manufacturing companies in the furniture district, all from the Friuli Venezia Giulia Autonomous Region. We did not focus on one industrial district area but on the entire region. In this way, we tried to avoid informal allies of companies or institutions among the respondents. All interviewees were assured of anonymity. Depending on their proximity, the interviewees selected were personal contacts and connections within the craft companies, the more prominent industries in the industrial districts and the local government. After the initial contact, we snowballed to obtain additional references. The eligible stakeholders were considered so that we could build trust with each of them. We decided to conduct one-on-one interviews. The semi-structural in-depth interviews consisted of 16 questions:

Table 2: Target groups in the Autonomous Region Friuli Venezia Giulia interviewed in 2021.

Number	Economic area	Geographical area	Social area	Environmental area
15 interviews with 16 questions	5 representatives of local authorities (governments, planning and economic development), 1 representative of the Chamber of Commerce from Trieste	2 experts of companies of the Digital Technology Cluster	4 managers of companies of the Industrial Area of Ponte Rosso	3 project developers of companies of the Furniture District

- Operational questions (4) as general questions for an overview of the potential for industrial symbiosis and networking in the Region Friuli Venezia Giulia: organisational structure; sustainable perspectives, goals, regulations, and collaboration; current and future sustainable plans for the area (location); benefits of their existing location.
- From an institutional perspective (3 questions), the survey asked about the legislative approach to waste recycling, factors influencing the successful implementation of sustainable projects, and opinions about regional efforts to reduce waste products.
- From the cognitive framework perspective (3 questions), we asked about the attitudes toward the relationships they currently have with other businesses (if any) that incorporate sustainability measures and networks; whether these relationships involve the exchange of reclaimed products; the potential of human capital in the region.
- From the perspective of the networks, we asked them about cooperation between existing industries in the area/site, general attitudes toward formal and informal cooperation, the importance of trust, the degree of trust among stakeholders, suggestions for improving the process of industrial symbiosis within industrial districts, and their critical thoughts about the improvements achieved (6 questions).

Upon completion of the interviews, we selected and hand-transcribed the primary data and presented them as the final interpretation of the research.

Our preliminary research questions were: »why and how do companies not develop the industrial symbiosis approach within industrial districts despite geographic proximity and organisational and environmental impacts?« And »why is there only one case of industrial symbiosis, although the synergies between stakeholders in this region seem to be very high?«

Following the empirical research (interviews), our preliminary analysis can be presented as a model based on the perception of the current situation in the Friuli Venezia Giulia region. This model refers (as a help) to (1) the geographical-organizational area of businesses, (2) the geographic area, and (3) the social area, as shown in Figure 1. The model could foster, improve or (re)build old/new collaborations within industrial districts in the region.

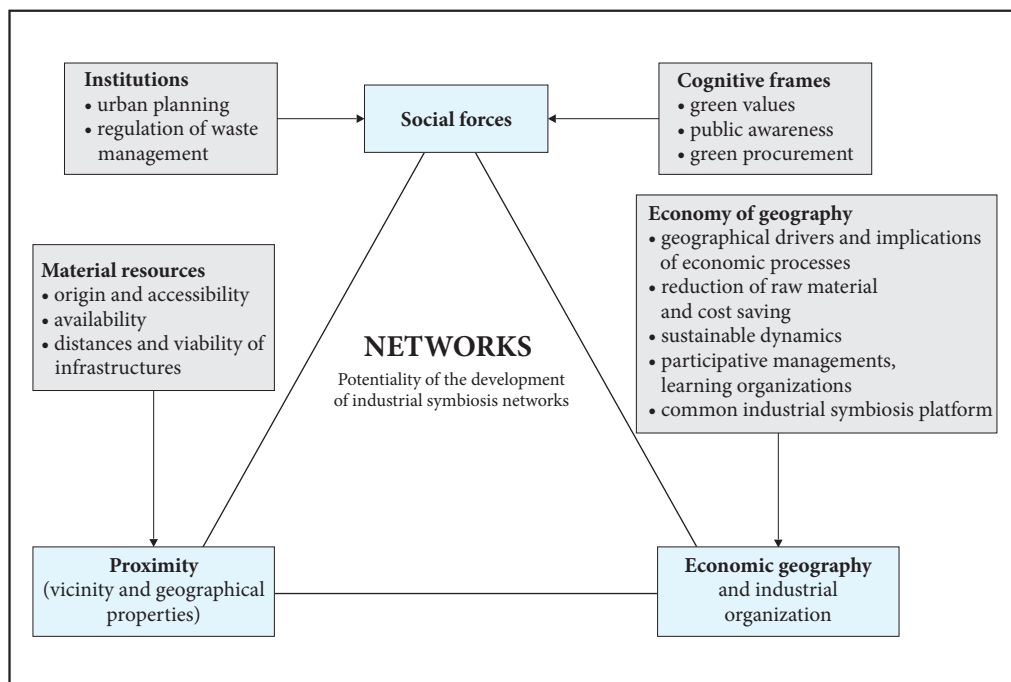


Figure 1: The proposed model of critical drivers, enablers, and barriers for realising potential industrial symbiosis within industrial districts.

4 Results and discussion

The number of small and medium enterprises and a large number of craft businesses increased enormously in recent years, despite the Covid-19 pandemic (as shared a common opinion by different interviewees). These new entrepreneurs are mainly young people under the age of 30, who developed their idea in a start-up and established their businesses with an awareness of the sustainable market and the Triple-R (Reduce, Reuse and Recycle) waste hierarchy. Among them, there are strong social, cultural and organisational links, but not so much with the larger and older industrial companies in the industrial districts. In any case, these young entrepreneurs are engaged in the tertiary sector and in research. One of the local authorities interviewed stated that this problem is worrying for the demographic and socio-economic dynamics. The Friuli Venezia Giulia region is a crossroads of the most developed environmental and business systems for the development of a sustainable industry. On the other hand, there is a risk that the already strong globalisation forces could hinder the model of industrial symbiosis in the industrial districts.

As the interviewee from a smaller company in the furniture industrial district stated: »Efforts to reduce CO₂ emissions, water consumption and waste products in the Friuli Venezia Giulia region are not prevalent in the industry itself, but the issue is more acknowledged than in the past, especially among the larger companies in the industrial districts, that show interest in sustainable technology with their resources«. As we learned from the personal meetings, the attitude of included stakeholders in the research (especially managers and policymakers) is currently not so much focused on sustainability measures. There is still not enough sharing of information and knowledge about the positive effects of the industrial symbiosis approach. Especially in the relationships among industrial districts.

The interviewees agree that a lot of human capital inclined to the industrial symbiosis approach is already present in the Friuli Venezia Giulia region. Key technologies and intermediaries for industrial symbiosis ideation and implementation are already at a reasonable level, and the necessary financial resources are available (thanks to the recent decisions of the European Commission). As for the cooperation of the existing industrial districts, the knowledge of the importance of sustainability is the basis for further development. Unfortunately, environmental improvements are expensive, so that smaller craft companies, for example, cannot afford them.

Some industrial districts are willing to collaborate to strengthen ties and adopt emissions reduction technologies, but only if other companies within the industrial community do the same. »The only and surest way to create a shared sustainable network for companies inside industrial districts is to set the stage for such upward alignment,« said one public official.

All respondents agreed on this: »When it comes to building new cooperation, trust is key« – but as we can see from responses, in the business world everyone tends to think formally about their own business. Therefore, the problem of cooperation and trust is solved through cooperation agreements.

Two of the respondents indicated that they have informal business collaborations on a personal level. Still, they stated that most companies prefer formal relationships to avoid brain drain and uncontrolled exchanges. The final statements from the interviews show that the »fiduciary« collaborations within the industrial districts in the Friuli Venezia Giulia region are not at the highest level. Regardless the reduction, reuse, and recycling of waste and environmental resources in industrial communities are still governed by formal contracts within industrial symbiosis in the region. Many stakeholders/interviewees agree that »right now there is no willingness to collaborate in different ways as they have for decades (as an industrial district). We also see this as a barrier to the development of greater synergies in the environment and geography, which is perhaps the best case for excellent industrial symbiosis in the region.

Based on the Friuli Venezia Giulia region case study, this article identifies some key issues to be considered for future industrial symbiosis linkages in terms of the policies and methods needed to achieve the objectives of attention to the entire chain of stakeholders involved in industrial districts. We have not thinned out any company described in the methods section, but we have presented and interpreted the main coded findings.

From the qualitative research, we can highlight some points. These include, for example, (1) inadequately prepared project proposals for funding industrial symbiosis initiatives (regional, national, international) and (2) a lack of regulations that hinder industrial symbiosis initiatives in the region. It could also be (3) the dilemma of the individual company within the industrial district as to what is »waste or non-waste« and (4) »by-products or not«; (5) a lack of communication and understanding by local authorities, (6)

end-of-waste regulations that conflict with other regulations (e.g., registrations, evaluations, authorisation and restrictions of chemicals (REACH) regulations in the region), (7) the market and labour situation, and (8) the behaviour of the management of an individual company.

In our preliminary analysis through the interviews, we encountered a contradiction. On the one hand, companies tend to open up to the public and cooperate with other stakeholders, which includes symbiotic links. They are willing to be part of a network with the principles of industrial symbiosis and sharing inputs and outputs with other neighbouring industries. On the other hand, the difficulties in creating this network from the company's point of view are persistent problems with human resources. The »rules of the game« are strict and rather old. Some modern technologies can provide exciting solutions but cannot be used freely without certification. For example, in one company, the residues from steel refining are processed to recover precious materials, and these »residues« are considered industrial waste. They must comply with precise and strict environmental regulations.

The proposed model (Figure 1) captures the geographic, social and economic impacts (triple bottom line), focusing on the social aspects. At the same time, the relevant literature for the Friuli Venezia Giulia region does not sufficiently address this gap and does not recognise the role of the social domain in industrial districts. There is little understanding of how social applications function and how they influence development and processes within industrial communities. Recommendations and lessons were drawn from the operational case of the Ponte Rosso industrial area, which can serve as a model for the Friuli Venezia Giulia region. Primary data were also collected through face-to-face interviews with the concept indicators presented in Figure 1 and with municipal, provincial and regional authorities (Table 2) that support our analysis in order to triangulate the material obtained and validate our findings.

Proximity and geographic properties in the model (Figure 1) refer to the geographic accessibility of material resources and the proximity of properties: origin and accessibility of material resources, availability of material resources and distances and carrying capacity of infrastructures. Assets are determined by the diversity of industries, location, core businesses, and the presence of water. As distances between industries increase, operating costs increase, making short physical spaces extremely important for minimising transmission costs.

In the economic geography and its industrial organisations in the Friuli Venezia Giulia, industrial districts themselves, following the rediscovery of Marshall's theories (see the Introduction chapter), emphasise the economy and the revision of the territory as a territorial society (and unit of analysis). In this context, we consider the geographic drivers and impacts of economic processes, cost savings, sustainable dynamics, and participatory management or learning organisations. Common platforms (e.g., shared online bases, centres) can help different companies/industries come together and share common ideas to build networks between companies. It is essential to involve institutions or external agencies (e.g., research institutes and universities) in linking the social platform of the industrial district. This enables serious relationships, trust, easier information sharing, and symbiotic development. In addition, the participatory dialogue between industries promotes organisation and facilitates collaborations.

In this case, the conventional view of economic geography focuses on the idyllic establishment of economic activities, such as significant transportation costs (Sforzi 2002). The approach focuses on industrial structures and regional revenue intensity (e.g. merging with other companies to form a single production process or joining an established local society; Sforzi 2002). It should be remembered that the typical north-eastern Italian industrial districts are of spontaneous (historical-local) origin. At the same time, the Ponte Rosso Eco-Industrial Park is a planned industrial area that either attracts companies from other places or initiates new sustainable initiatives.

The social forces we consider from Beckert's (2010) theory are:

- institutions (local urban planning, waste management regulations, laws, the central concern for law, the formal mechanism for policy rule-making and enforcement),
- cognitive frames (green values, public awareness and green procurement, social interaction, meaning-making technologies, and selective strategic opportunities for reflection and learning), and
- networks (such as individuals or organisations and a set of dyadic ties between these actors), which are not the only means of solving coordination problems in market domains but play an essential role in defining the networks of the industrial district (Džajić Uršič 2020).

Local urban planning is a design of the conditions for issuing, building, permits and defining the general land use, protection and use of the environment, public welfare and design of the urban environment.

This includes air, water, the infrastructure of urban areas, transport, communication and distribution networks (Džajić Uršič 2020).

From a scientific point of view, the added value of the article is to increase the possible realisation of industrial symbiosis within the existing industrial districts specialised in »Made in Italy«; nevertheless, the benefits of this research could: (1) increase the number of existing synergies in the Region Friuli Venezia Giulia, which is the closest Italian region to the Upper Adriatic–Central European border area and geographically crucial for Slovenia. (2) The proximity to this region affects the mutual economic, cultural and social benefits for both countries (Slovenia-Italy). (3) The next advantage we can see is raising awareness of the possible development of industrial symbiosis within industrial districts or cross-border companies.

However, as mentioned above, the reader should interpret the study with caution, as it is an exploratory, qualitative study that may prevent the generalisation of interpretation. Future research could improve this study by increasing the sample size, comparing it to other Italian regions, or using other approaches. A more in-depth analysis of the industrial ecology, industrial symbiosis, and industrial synergies is particularly important in the Friuli Venezia Giulia region because of the support provided by the EU and the Italian Government.

5 Conclusion

In the course of the research, it was found that industrial symbiosis is related to the companies of the industrial district in both formal and informal relationships. Answering the research questions proved to be quite tricky. The answer to the first question, »Why and how do companies not develop sufficient industrial symbiosis within industrial districts despite geographic proximity, organisational and environmental effects?« was that despite geographic proximity, organisational and environmental effects within industrial districts, companies do not develop sufficiently solid trust to be defined as an industrial symbiosis network. The answer may lie in the fact that companies have some extra-professional activities and relatively moderate social connections, that limit the space for developing deeper collaborations/ industrial symbiosis networks and mutual trust. As mentioned above, trust is the biggest obstacle to the development of industrial areas into industrial symbioses in the Friuli Venezia Giulia region. It is also a consequence of the lack of strategies, corporate values and awareness for sustainable development. Ascani (2020) mentioned that the application of the principles of industrial symbiosis supports and develops the local environment and economy, with inevitable barriers such as: finding the right company, technological gap, quantities and innovations not available in the immediate geographical proximity of the companies, and with the obvious exception of waste heat.

Regarding the second research question, »Why is there only (we summarise it in a single case, even if many stakeholders are involved) a case of industrial symbiosis, although it seems that the synergies between the stakeholders in this region are high?« As indicated by the research results, the authors agreed that the role of industrial synergies in waste treatment tends to be underestimated.

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