Industrial Parks in Italy: A Systematic Overview and Preliminary Analysis of the Fosso Imperatore Case Study

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Keywords: Industrial Parks, Eco-Industrial Parks, Industrial Consortiums, Italy, Systematic Literature Review.

Abstract: This paper presents a systematic overview of Italian Industrial Parks (IPs) and introduces a preliminary analysis of an understudied case in Southern Italy. PRISMA guidelines were employed, to identify eight relevant studies primarily focused solely on North-Centre Italy. The analysis uncovered a certain degree of diversity in park dimensions and industrial sectors, with specialized single-sector and multi-sector parks. This diversity enables integrated supply networks and optimized resource flow in multi-sector parks, while single-sector parks achieve operational efficiency through sector-specific shared services and infrastructure. This study has then examined the unstudied case of Fosso Imperatore Industrial Park (Campania). Based on publicly available information, the analysis evaluated key elements that characterize successful Eco-Industrial Parks (EIPs). The preliminary findings have suggested the potential presence of several EIP elements, particularly regarding networking capabilities and shared services. Further research is needed to validate these characteristics through primary data collection, focusing also on investigating additional cases of EIPs in Southern Italy. Additionally, supply chain management practices and operational strategies within EIPs should be further explored. This research provides an initial exploration of an understudied area in Italy, revealing its potential for industrial symbiosis (IS) and setting the stage for future comprehensive studies.

1 INTRODUCTION

Traditional industrial practices, deeply rooted in the linear economic model, are increasingly criticized for their unsustainable nature, making the transition to a circular economy (CE) crucial for mitigating environmental and social impacts (Susur et al., 2019).

In response to these challenges, the Agenda 2030 developed the Sustainable Development Goals (SDGs), which seek to stimulate sustainable and inclusive industrial development through the adoption of green practices, resource optimization, and implementation of sustainable processes and technologies (Bilyaminu et al., 2024).

In this regard, the CE offers a novel path to sustainability, seeking to minimize resource consumption, waste production, and pollution while fostering socio-economic growth (Dantas et al., 2021).

To shift from a linear to a circular production model, Industrial Ecology (IE), with its tools, and Industrial Symbiosis (IS) represent a promising approach (Saavedra et al., 2018; Demartini et al., 2022). IE and IS, introduced in 1989, have fundamentally reshaped industrial development globally (Bilyaminu et al., 2024).

Indeed, CE's foundation lies in IE and industrial ecosystems (D'amato & Korhonen 2021), with IE aiming to create more sustainable industrial systems that interact efficiently with both the industrial and natural worlds (Leigh & Li 2015).

Moreover, at the meso-level, IS represents a major application of the CE, characterized by close, cooperative relationships between businesses (Sgambaro et al., 2024). It aims to create a system where economic, environmental, and social benefits arise from shared resource flows and material exchanges (Wadström et al., 2021), as well as

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D'Alessandro, C., Ioppolo, G., Calabrò, G. and Caristi, G.
Industrial Parks in Italy: A Systematic Overview and Preliminary Analysis of the Fosso Imperatore Case Study.
DOI: 10.5220/0013404900003956

In *Proceedings of the 7th International Conference on Finance, Economics, Management and IT Business (FEMIB 2025)*, pages 61-67
ISBN: 978-989-758-748-1; ISSN: 2184-5891

infrastructure/utilities (Uusikartano et al., 2022), between and within industries.

In this context, Industrial Parks (IPs) have emerged as key regional hubs for concentrated industrial activity and resource consolidation, particularly given the accelerating pace of global economic change and growing emphasis on sustainability (Shao et al., 2024). Building on this foundation, Eco-Industrial Parks (EIPs), emerges as a key practical application of IS, representing a promising approach to achieving both environmental sustainability and economic prosperity (Galvan-Cara et al., 2022). Operating as a cluster-based supply chain management system, EIPs play a dual role: they act as a mechanism for optimizing resource allocation while serving as a vital platform through which firms can develop their CE competencies (Zeng et al., 2017; Gao et al., 2024). Indeed, collaboration among businesses and communities within EIPs, lead to the creation of symbiotic supply chains, operations and logistics networks (Turken & Geda 2020). Sharing resources - from materials to energy, infrastructure and knowledge - allows improved operational efficiency, creating sustainable supply chains where waste from one process becomes input for another, while shared facilities and services reduce operational costs and environmental impacts (Nessim et al., 2024). For these reasons, IS, emerging from EIPs, can have a significant impact in shaping the structure of supply chain (Turken & Geda 2020).

Furthermore, an EIP can emerge from a bottom-up approach, often initiated by companies seeking to enhance performance through cost reduction, revenue growth, or business expansion via resource sharing. Alternatively, EIPs may be developed through a top-down approach, driven by institutions, local governments, research centres, or universities (Taddeo, 2016).

The Italian industrial context presents a unique opportunity for studying IS networks, characterized by its distinctive industrial districts model and the prevalence of small and medium-sized enterprises (SMEs) (Daddi et al., 2015).

Previous studies have documented various initiatives exploring the EIP approach across different regions, particularly in Northern and Central Italy (Tessitore et al., 2014; Tessitore et al., 2015). However, there is a gap in the literature regarding IPs in Southern Italy, limiting the understanding of the complete national landscape.

This research aims to address this gap through two complementary objectives: (1) provide an overview of IPs in Italy through a systematic literature review, analysing their key characteristics; and (2) illustrate the potential for expanding research into Southern Italian IPs through a preliminary analysis of the Fosso Imperatore Industrial Park in Campania as an exemplar case.

Understanding these regional differences and opportunities is essential for supporting Italy's transition toward more sustainable industrial development. Additionally, expanding studies to Southern Italy could enrich the understanding of IP in the Italian context. Such understanding is important for informing policy decisions as well.

Following this Introduction, Methodology section is provided along with Results and Discussion, and Conclusion.

2 METHODOLOGY

A systematic literature overview was conducted following the PRISMA guidelines (Page et al., 2021) to identify relevant studies describing IPs in Italy. The search was performed employing two major scientific databases: Scopus and Web of Science. The keywords used were: “industrial park*”, “Eco Industrial Park*”, “Eco-Industrial Park*”, “Industrial consort*”, and “Ital*”. Wildcard “*” was utilized to encompass plural and root word variations.

Without temporal restrictions, only English articles or reviews describing at least one Italian IP, were included.

The initial search yielded 73 records from Scopus and 37 from Web of Science, for a total of 110 documents. After importing all records into Mendeley reference management software (Mendeley 2024), 36 duplicates were removed, leaving 74 unique records. The screening process was conducted in three stages. First, documents were filtered by type, excluding book chapters (n=4) and conference papers (n=32), resulting in 38 journal articles. Second, titles, abstracts, and keywords were screened to remove out-of-topic records (n=21), leaving 17 potentially relevant articles that were included in the final sample for full-text reading. The full text reading allowed to exclude 8 out of topic articles and 1 was not accessible, leading to a final sample of 8 studies. A graphical summary of the PRISMA process is reported in Figure 1.

Following the approach of Daddi et al. (2015), this systematic overview focused on extracting specific characteristics of Italian IPs from the selected literature, including the name of the IP, industrial sectors represented, geographic region, number of companies, total area, and source reference.

All extracted data were systematically collected in an Excel spreadsheet for subsequent analysis. To address the gap in the literature regarding Southern Italian IPs, the research was enriched through a preliminary analysis of the Fosso Imperatore Industrial Park in Campania. The case study analysis employed the same analytical framework, examining both the fundamental characteristics and the potential presence of key elements identified by Daddi et al. (2015), based on publicly available information from the consortium's website.

In particular, the analysis examined the presence of operational key elements that characterize successful EIPs: by-products and energy exchange, shared services and technologies, landscape ecology, utility sharing, networking, and involvement of local stakeholders.

This preliminary assessment aims to lay the groundwork for future research, which will focus on validating these characteristics through primary data collection, quantifying their extent, and conducting more detailed analyses through field investigations and stakeholder engagement.

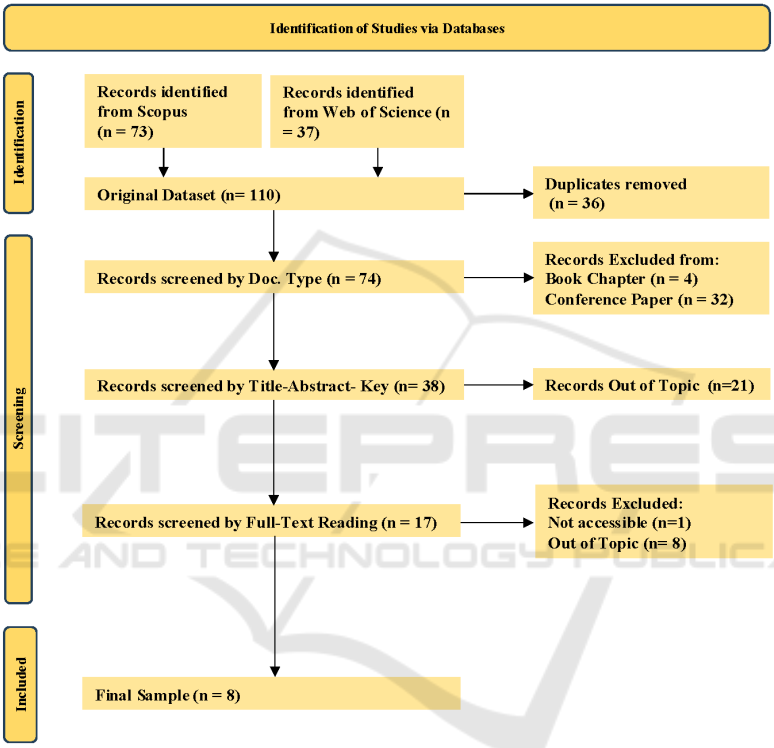

Figure 1. Prisma Flowchart.

3 RESULTS

The analysis revealed that most of the studied parks are situated in Emilia-Romagna, followed by Tuscany and Veneto (with only two studies each). Friuli-Venezia Giulia, Marche, Apulia, and Abruzzo are also represented. As indicated in Table 1, the exact surface area of the parks is often unavailable, except for a few specific cases such as the Bomporto Industrial Area (95 hectares, Aguinaldo et al., 2019), the Raibano Industrial Area (100 hectares, Conticelli and Tondelli, 2013), the Macrolotto Industrial Area (150 hectares, Daddi et al., 2015), and the Bussi Chemical Site Industrial Area (22 hectares, Taddeo et al., 2012).

While many of the observed Italian IPs are primarily focused on single activities (mostly manufacturing), some of them showcased encompass a diverse range of sectors, including logistics, software, financial services and others. Other than manufacturing, there were cases of other focuses.

Indeed, the Bussi Chemical Site Industrial Area remains dedicated to its core competency in chemistry (Taddeo et al., 2012), while, the Porto Marghera Industrial Area in Veneto has pivoted towards a service-oriented activities (Mannino et al., 2015).

Table 1. Overview of Italian IPs details. IA: Industrial Area.

Park's Name	Region	Surface (ha)	No. of companies	Major Activity	Reference
Bomporto IA	Emilia-Romagna	95	>70	Manufacturing	Aguinaldo et al., 2019
Rolo-Fabbrico IA	Emilia-Romagna	N/A	18	Manufacturing	Brunoro et al., 2019
Raibano IA	Emilia-Romagna	100	N/A	Manufacturing	Conticelli and Tondelli, 2013
Macrolotto IA	Tuscany	150	380	Manufacturing	Daddi et al., 2015
Ponterosso IA	Friuli-Venezia Giulia	N/A	142	Manufacturing	Daddi et al., 2015
Padova IA	Veneto	N/A	1500	Diversified	Daddi et al., 2015
Ancona ZIPA	Marche	N/A	90	Diversified	Daddi et al., 2015
Porto Marghera IA	Veneto	N/A	690	Services	Mannino et al., 2015
Taranto IA	Apulia	N/A	10	Manufacturing	Notarnicola et al., 2016
Ponte a Ecola IA	Tuscany	N/A	160	Manufacturing	Susur et al., 2019
The Green Economy Project	Emilia-Romagna	N/A	13	Not available	Susur et al., 2020
Bussi Chemical Site	Abruzzo	22	N/A	Chemistry	Taddeo et al., 2012

Moreover, the Industrial Area of Padova stands out with its 1,500 companies engaged in a variety of activities (Daddi et al., 2015). This broad spectrum of activities fosters innovation and collaboration, driving economic growth and development. Similarly, the ZIPA-Industrial Productive Zone of Ancona houses 90 companies that span diverse industries, creating a dynamic and multifaceted environment (Daddi et al., 2015).

Nonetheless, the systematic overview confirmed a geographical bias in the literature, with most case studies concentrated in Northern and Central Italy. This geographical distribution highlights a potential lack of attention regarding IPs in Southern Italy.

The Fosso Imperatore IP case thus serves as a practical illustration of both the opportunities and challenges identified in this literature review: it exemplifies the potential for diverse industrial composition to support IS development, while also highlighting the need for more detailed documentation and analysis of Southern Italian IPs - a gap consistently revealed in our systematic review.

The Fosso Imperatore IP, located in the Agro Nocerino Sarnese area of Campania, represents a significant industrial hub in Southern Italy. The park, managed by the Co.I.F.IM. consortium (Co.I.F.IM., 2024), covers an area of 144,846 square meters and hosts approximately thirty companies employing around 1,000 workers, with a combined annual turnover exceeding 300 million euros. The IP benefits from strategic positioning, with direct access to infrastructure networks and proximity to the Caserta-Roma highway, ensuring optimal accessibility for industrial traffic.

The park is characterized by a diverse industrial composition, encompassing various sectors including food processing, precision mechanics, construction scaffolding, high-quality knitwear, tire recovery, dairy production equipment, software development, packaging, logistics and transportation, modular kitchens, construction resins and industrial flooring, graphics and printing, metalwork, windows and frames, and mining machinery. This industrial diversity has established the park as a significant economic driver in the Agro Nocerino Sarnese region (Co.I.F.IM., 2024).

When analysing the park through Daddi et al.'s (2015) framework, several key elements can be identified. The consortium's mission statement (Co.I.F.IM., 2024) suggests potential for by-products and energy exchange through its focus on raw materials and product exchange databases. Shared services and technologies are potentially present through the consortium's commitment to knowledge and technology exchange, as well as shared IT services and market information systems.

Networking is often promoted through various initiatives aimed at fostering integration and collaboration among member companies, including temporary exhibition spaces and the promotion of innovative products.

The involvement of local stakeholders is indicated by the consortium's openness to joining other business aggregations and its role in regional economic development. However, elements such as landscape ecology and utility sharing are not explicitly mentioned in the available information.

These aspects would require further investigation through primary data collection and stakeholder engagement to determine their presence and extent within the park.

4 DISCUSSIONS

The findings from both the systematic overview and the case study analysis revealed certain patterns and implications for the development of Italian IPs.

First, the geographical distribution of studied IPs highlights a significant North-South divide in the literature, which may reflect broader regional economic disparities in Italy. This bias in research focus potentially limits the understanding of industrial development opportunities in Southern regions.

The Fosso Imperatore Industrial Park, with its approximately 14.48 hectares, appears relatively compact compared to the other documented cases. However, its high employment density (about 1,000 workers) and substantial turnover might suggest efficient land use and significant economic impact despite its smaller size.

In terms of industrial composition, the overview has revealed two distinct development patterns: specialized single-sector parks (like the Bussi Chemical Site) and multi-sector complexes (such as the Industrial Area of Padova and ZIPA Ancona). The Fosso Imperatore IP aligns with the latter model, featuring a diverse mix of industries. This diversity could be particularly advantageous for developing IS relationships, as different sectors often have complementary resource needs and waste outputs, which can be integrated into different production processes, reducing logistics costs and environmental impacts.

While the park shows promising potential for networking and shared services, the absence of explicit information about landscape ecology and utility sharing suggests areas for development. The consortium's mission statement indicates awareness of IS principles, particularly in terms of resource exchange and knowledge sharing, though the actual implementation level remains to be verified.

Although Italian IPs show varying degrees of progress toward eco-industrial development, there may be untapped potential, particularly in Southern regions. It is important to note that the heterogeneity in reported data across the analysed studies reflects the current state of published research on Italian IPs. While some parks provided detailed information about their surface area, number of companies, and industrial composition, others offered only partial data. This variation in reporting detail stems from the different focus areas and objectives of the original studies, rather than from limitations of this study. The presented data represents all available information from peer-reviewed literature, obtained through this systematic review following PRISMA guidelines.

The Fosso Imperatore case demonstrates that Southern Italian IPs can achieve significant economic impact while incorporating elements conducive to IS, though further development of environmental and resource-sharing initiatives may be needed.

5 CONCLUSIONS

This study analysed IPs in Italy through a literature review and introducing a preliminary analysis of an understudied case in Southern Italy. The systematic overview has revealed a geographical concentration of studied IPs in Northern and Central Italy, particularly in regions such as Emilia-Romagna, Tuscany, and Veneto. The analysed IPs have shown variety in terms of size, ranging from 22 to 150 hectares, and industrial composition. From an operations and supply chain management perspective, this variety in size and industrial composition presents both opportunities and challenges. Multi-sector parks offer greater potential for creating integrated supply networks and optimizing resource flows, while specialized parks may achieve higher operational efficiency through sector-specific shared services and infrastructure.

The Fosso Imperatore Industrial Park case study has helped to preliminarily address the identified geographical gap in the literature by providing a description about one important IP in Southern Italy. The preliminary analysis through Daddi et al. (2015) framework has suggested the potential presence of key elements, characteristic of successful EIPs, particularly in terms of networking capabilities and shared services. The park's diverse industrial composition and strategic location have indicated its significance as an economic driver in the Agro Nocerino Sarnese region. Indeed, strong networking capabilities and shared resources offers significant potential for sustainable supply chain and operational

management through CE practices, shared infrastructure, and coordinated logistics.

Nonetheless, it is important to acknowledge the limitations that pertain to this study. The data offered by the current literature on Italian IPs constrains the study by the varying depth and focus of existing studies, leading to inconsistent reporting of park characteristics across cases. The preliminary nature of the Fosso Imperatore case study, based primarily on publicly available information, limits comparability with other parks or drawing definitive conclusions about its IS potential. Finally, the geographical bias in existing literature toward Northern and Central Italy may mean that successful examples of IS in Southern regions remain undocumented.

However, this research has also highlighted important areas for future investigation. First, there is an urgent need for standardized data collection and reporting frameworks for Italian IPs to enable meaningful comparative analyses. Such frameworks should encompass quantitative metrics for resource flows, environmental impact, economic performance, and social benefits. Second, future studies should employ mixed-method approaches, combining quantitative analysis of material and energy flows with qualitative investigation of organizational relationships and barriers to IS implementation. Third, research should examine the role of policy frameworks and incentive structures in promoting IS development, particularly in Southern Italy where such initiatives appear less documented.

Specific to the Fosso Imperatore case, further studies should focus on gathering primary data to validate and quantify the identified characteristics, particularly regarding the actual implementation of by-product exchanges, shared services, and utility sharing systems. The potential for IS should be further explored through detailed material and energy flow analyses. Future research should also investigate how supply chain management practices and operational strategies can be better integrated within IPs to optimize resource flows, enhance IS relationships and create CE networks within the park.

Moreover, additional research is needed to examine other IPs in Southern Italy to develop a more comprehensive understanding of the national IP landscape. This would contribute to a more balanced geographical representation in the literature and potentially guide policy decisions aimed at promoting sustainable industrial development and IS across all Italian regions. Longitudinal studies tracking the evolution of IS relationships and their impacts over time would be particularly interesting in understanding the development patterns and success factors of Italian IPs.

Overall, this study helps laying the groundwork for more comprehensive research on IS development of the Italian landscape.

ACKNOWLEDGEMENTS

The authors would like to thank Project “CE_IPsa: A development model for Circular Economy between Industrial Parks and surroundings areas” CUP J53D23016630001 - codice identificativo P20227NFA4, Department of Economics, University of Study of Messina (Italy), for funding this work.

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