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## Digital Platforms for Industrial Symbiosis: Business Models to Overcome Barriers

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**Abstract:** Industrial symbiosis is a collaborative circular economy paradigm that aims to close-the-loop by valuing waste and by-products. However, several barriers hinder its implementation. Digital platforms are widely recognized as relevant enablers to overcome those barriers. Still, literature on barriers and digital platforms developed separately. We merge these streams with an exploratory empirical analysis based on a multiple case-study methodology. We identify seven barriers and nine mechanisms for value creation, transfer and capture in digital platforms' business models. We develop a novel framework with thirty-three matches among barriers and mechanisms. We posit that mechanisms for value creation are paramount to overcome barriers. Digital platforms should be designed to create value that overcomes barriers to industrial symbiosis from the beginning, otherwise those barriers are less likely to be overcome through value transfer and capture mechanisms. We contribute to literature concerning industrial symbiosis and digital platforms and provide insights to scholars and practitioners.

**Keywords:** circular economy; industrial symbiosis; barriers; digital platforms; business models; value creation; value transfer; value capture.

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## 1. Introduction

Resource depletion is an environmental grand challenge that has attracted the attention of a broad audience (Meili & Stucki, 2023). Scholars (Kirchherr et al., 2023), practitioners (Ellen MacArthur Foundation, 2025), and policymakers (European Commission, 2026) are engaged in a joint commitment to cope with this grand challenge. Circular economy has become a hot topic in this debate, and it has been widely recognized as a promising alternative economy model to tackle resource depletion (Morseletto, 2020). Circular economy is a closed-loop economy model that aims to value resources and extend the lifecycle of products (Bocken et al., 2016). Circular economy can be implemented at three main levels: micro (company-level), meso (ecosystem-level), and macro (broader level encompassing a whole region or nation) (Aarikka-Stenroos et al., 2022). Circular economy goes beyond the boundaries of a single company to be fully achieved (Centobelli et al., 2020). Closing-the-loop requires a cross-level implementation to exploit synergies among diverse companies (Kaipainen et al., 2022). The need for a systemic transition towards circularity is gaining increasing attention and recognition in the academic discourse on circular economy (Sgamaro et al., 2025).

In this debate, the concept of industrial symbiosis has been closely linked to that of circular economy (Baldassarre et al., 2019). Industrial symbiosis stems from biology and the seminal contribution by Chertow (2000) defined it as “traditionally separate entities in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products” (p. 314). The understanding of industrial symbiosis has enriched over time. For instance, it evolved to question the role of geographical proximity, which is no longer considered a must-have feature to implement industrial symbiosis (Lombardi & Laybourn, 2012). Industrial symbiosis is grounded on two main elements: collaboration and symbiotic exchanges (Sgamaro et al., 2024). The former refers to the engagement of dissimilar actors. The latter refers to the exchange of tangible and intangible resources among those actors to achieve mutual benefits. Industrial symbiosis aims to extend the lifecycle of resources and to turn by-products and waste into valuable inputs (Neves et al., 2020). Industrial symbiosis represents a collaborative circular economy paradigm to close-the-loop of resource flows by leveraging the complementary needs of diverse actors (Bocken et al., 2016; Sgamaro et al., 2024).

The implementation of industrial symbiosis is rather challenging, and the widespread implementation of this paradigm in real-world settings remains limited (Neves et al., 2020; Sgamaro et al., 2024). Literature has focused on investigating the barriers that hinder the implementation of industrial symbiosis (Palagonia et al., 2025). Scholars highlight that trust-related and information sharing issues represent major barriers to the implementation of industrial symbiosis (Agudo et al., 2023; Velenturf & Jensen, 2016). At the same time, literature focused on identifying the enablers that can be leveraged to support the implementation of industrial symbiosis by overcoming its challenges (Patricio et al., 2018; Pizzi et al., 2022). Among them, scholars converge on the role of digital platforms as crucial enablers of industrial symbiosis (Fraccascia & Yazan, 2018). Their role in enabling industrial symbiosis is paramount in connecting formerly unrelated companies and uncovering synergies (Sgamaro et al., 2026). Digital platforms enable novel business models, which also open up opportunities in the context of industrial symbiosis (Fehrer & Wieland, 2021; Krom et al., 2022).

However, the literature streams concerning the barriers to industrial symbiosis and the enabling role of digital platforms developed rather separately. In addition, existing research on digital platforms is mainly focused on theoretical and quantitative approaches, such as agent-based modeling (Fraccascia & Yazan, 2018). There is a paucity of research that employs empirical methods based on real-world evidence, such as a single case study (Pizzi et al., 2022). Scholars advocate for more empirical research that investigates the full spectrum of mechanisms underlying digital platforms' business models, including value creation, transfer, and capture (Franzò & Urbinati, 2023). Such an investigation can uncover how these novel business models enable overcoming the barriers that hinder the implementation of industrial symbiosis.

The objective of this study is to explore how value creation, transfer, and capture mechanisms of business models based on digital platforms overcome the barriers to industrial symbiosis. Accordingly, our research question is as follows: "*How does the business model of digital platforms enable overcoming the barriers to industrial symbiosis?*"

To do so, we employ an exploratory empirical analysis based on a multiple-case study methodology (Eisenhardt & Graebner, 2007) to connect the mechanisms of digital platforms' business models with the barriers to industrial symbiosis. Our unit of analysis is represented by digital platforms that enable the implementation of industrial symbiosis initiatives in the European context. We develop a novel framework that links the three mechanisms for value creation, transfer, and capture to the barriers that they enable to overcome. We identify not only the linkages but also explain how each link works, namely, how each mechanism overcomes each barrier.

This study offers implications for scholars and practitioners alike. From an academic perspective, our study represents a one-of-a-kind study in the nexus between barriers to industrial symbiosis and the business model of digital platforms. We offer scholars a reference point that identifies seven barriers and nine mechanisms for value creation, transfer, and capture. We point out that the mechanisms for value capture are less effective at overcoming the barriers to industrial symbiosis, which may explain why digital platforms face challenges in scaling up and promoting its diffusion in real-world settings. From a practitioners' perspective, managers skeptical of approaching industrial symbiosis can leverage our results to understand the possibilities unlocked by digital platforms. We equip them with practical guidelines on how to leverage digital platforms to overcome the barriers to industrial symbiosis.

## **2. State-of-the-art: the barriers to be overcome in industrial symbiosis and the business model of digital platforms**

In this section, we identify two relevant dimensions of analysis to answer our research question. First, Section 2.1. identifies seven barriers to the implementation of industrial symbiosis stemming from prior studies on this matter. Second, Section 2.2. identifies nine mechanisms for value creation, transfer, and capture of digital platforms' business models grounded on existing literature.

### *2.1. Barriers to industrial symbiosis*

The debate concerning industrial symbiosis is rather old from an academic as well as a practitioners' audience. On the one hand, industrial symbiosis is a rather old concept in

scientific literature, as it originated at the end of the last century and was clearly conceptualized in the seminal contributions by Chertow (2000). On the other hand, the most well-known example of industrial symbiosis is Kalundborg Symbiosis. It self-describes as “the world's leading industrial symbiosis [...] located in Kalundborg [...] that] creates profits through a circular approach to production. Benefiting locally and inspiring the rest of the world” (Kalundborg Symbiosis, 2026). It started in 1972 and involves seventeen private and public actors that continuously share knowledge to foster symbiotic exchanges and that are physically connected to exchange energy, water, and resources.

These two audiences are strictly connected as the academic debate largely considers empirical evidence stemming from real-world evidence gathered in Kalundborg Symbiosis. Already the seminal contribution by Chertow (2000) considers this case, and the same do the seminal contributions by Bocken et al., (2016), which links industrial symbiosis to circular economy, and by Aarikka-Stenroos et al., (2021), which presents industrial symbiosis as a paradigm to implement circularity at the meso level and build circular industrial ecosystems.

Still, the implementation of industrial symbiosis is not widespread in real-world evidence (Neves et al., 2020; Sgambaro et al., 2024). Despite the efforts of scholars and practitioners in disseminating knowledge regarding the benefits and opportunities unfolded by industrial symbiosis, actors are still reluctant to approach and implement this circular collaborative paradigm.

Given these premises, a literature stream concerning industrial symbiosis focused on identifying the barriers that hinder the implementation of industrial symbiosis (Palagonia et al., 2025). Scholars highlight that industrial symbiosis is hampered by various barriers that include environmental, social, and economic factors (Golev et al., 2015). Considering the environmental side, managers should be committed to sustainability and circularity in order to successfully approach the paradigm of industrial symbiosis. Environmental benefits should be complemented by economic ones in order to make them implement symbiotic exchanges of resources. Lastly, information regarding by-products and waste is perceived as highly confidential, especially in manufacturing companies in competitive sectors like chemicals. Social aspects are also relevant as managers are reluctant to trust each other and share such confidential information, which is required to spot synergies and implement industrial symbiosis.

Prior studies converge on identifying seven barriers that consider all these aspects and hinder the implementation of industrial symbiosis. Table 1 presents these barriers that stem from prior studies on this matter (with reference to Golev et al., 2015; Palagonia et al., 2025; Soares et al., 2023; Tseng et al., 2021).

**Table 1** The barriers hindering the implementation of industrial symbiosis.

<i>Barrier</i>	<i>Brief description</i>
Data and information	Challenges related to information sharing for confidentiality reasons and to the collection and analysis of information regarding not valuable resources (e.g., by-products).
Collaboration and trust	Reluctance to collaborate with other actors and to trust each other to unearth potential synergies.
Technical	Insufficient technical skills to implement symbiotic exchanges, e.g., to adapt

knowledge	the production process to receive as an input by-products and waste.
Economic challenges	Economic unfeasibility and long-term uncertainty related to unclear profitability or potential relocation of key suppliers of secondary raw materials.
Regulation	Uncertain and unclear regulatory framework, limited regulatory support offered to the implementation of industrial symbiosis, and long administrative procedures.
Awareness	Lack of community awareness and dissemination concerning the benefits of the implementation of industrial symbiosis.
Managerial commitment	Limited engagement and commitment of managers towards long-term initiatives concerning sustainability, circularity, and industrial symbiosis.

Source: Authors' elaboration based on prior studies (Golev et al., 2015; Palagonia et al., 2025; Soares et al., 2023; Tseng et al., 2021).

## 2.2. Digital platforms: mechanisms for value creation, transfer, and capture

Digital platforms “bring together individuals and organizations [...] using modern software, hardware, and networking technology” (Cusumano et al., 2021, p. 1260). In a nutshell, digital platforms enable novel business models based on interactions across dissimilar market sides (Patrucco et al., 2024). The academic discourse on this matter is rather mature, with several contributions concerning the business models of digital platforms and the mechanisms for value creation, transfer, and capture (Fehrer et al., 2018; Rohn et al., 2021).

Digital platforms' business models are characterized by three dimensions: value creation, value transfer, and value capture (Tauscher & Laudien, 2018). First, value creation aims to define internal activities related to the design of the services to be offered to the platform's final users. Second, value transfer aims to connect internal and external activities; it focuses on communicating the benefits of using the digital platform to final users. Third and last, value capture takes an external perspective, defining how the value created and transferred to customers is captured back by the company that operates the digital platforms through revenue and pricing strategies.

In order to characterize how these three dimensions work, several mechanisms have been identified by existing literature to understand how to create, transfer, and capture value in digital platforms' business models. We leveraged the academic discourse on this matter to identify mechanisms stemming from prior studies (with reference to Hagiú & Wright, 2015; Muzellec et al., 2015; Rohn et al., 2021; Tauscher & Laudien, 2018; Trabucchi & Buganza, 2020). Table 2 presents the mechanisms for value creation, value transfer, and value capture in digital platforms' business models.

**Table 2** The mechanisms for value creation, value transfer and value capture in digital platforms' business models.

<i>Dimensions</i>	<i>Mechanisms</i>	<i>Brief description</i>
Value creation	Network dynamics	Identification of the user groups to be targeted by the digital platform.
	Matchmaking	Identification of the matchmaking logic to facilitate the interactions between the identified user groups included in the platform.
	Trustworthy	Definition of the role of the company that operates the

	environment	platform in building and maintaining trust among its user groups.
	Data collection and exploitation	Definition of the data that is required as an input to the digital platform from its user groups and of how this data is used to create value for its user groups.
Value transfer	Transaction efficiency	Communication concerning the time and cost benefits provided by the usage of digital platforms for users.
	Tailored services	Communication of tailored services offered to its users to adapt the benefits offered by the usage of the digital platform to specific users' needs and peculiarities.
Value capture	Revenue model	Definition of the revenue streams that sustain the economic sustainability of the digital platform.
	Pricing strategies	Identification of the diverse possibilities offered to the user groups to access and pay for the service provided by the digital platform.
	Value protection strategies	Definition of the additional services offered by the digital platform that lock in its users.

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Source: Authors' elaboration based on prior studies (Hagiu & Wright, 2015; Muzellec et al., 2015; Rohn et al., 2021; Tauscher & Laudien, 2018; Trabucchi & Buganza, 2020).

Recently, literature streams on industrial symbiosis and digital platforms collided (Krom et al., 2022; Pizzi et al., 2022). Overall, scholars converge on identifying digital platforms as a major enabler of industrial symbiosis (Fraccascia & Yazan, 2018). In the context of industrial symbiosis, platforms' business models enable connecting resource seekers with resource users and uncover several opportunities (Sgambaro et al., 2026). For instance, resource matching is enabled even among actors operating in distant geographic locations. Still, it is not clear yet how the mechanisms presented in Table 2 enable overcoming the barriers to industrial symbiosis described in Table 1. Therefore, the exploratory empirical analysis aimed to uncover the linkages among these two dimensions of analysis.

### 3. Methodology

We conducted an exploratory empirical analysis based on a multiple-case study analysis (Eisenhardt & Graebner, 2007). We adopted the exploratory approach given that our study represents a pioneering contribution in the nexus between the barriers to industrial symbiosis and the business models enabled by digital platforms. These topics have been investigated so far by two parallel literature streams. We selected the multiple case-study methodology as it enables conducting comparative analysis grounded on real-world evidence to achieve analytical generalizability of results (Baškarada, 2014; Yin, 2009).

We started by drawing on relevant databases of industrial symbiosis and circular economy cases, including the European Circular Economy Stakeholder Platform, (2026), and the MEASTRI database (2026). We applied the theoretical sampling approach (Eisenhardt, 1989; Eisenhardt & Graebner, 2007) in order to select case studies suitable to tackle our research question. Our unit of analysis refers to companies that operate a digital platform that connects companies to enable the implementation of industrial symbiosis. We included companies operating in diverse contexts across Europe, which is

recognized as a relevant context to be considered to investigate industrial symbiosis (Neves et al., 2020), to improve external validity and robustness of results (Baškarada, 2014). We selected four European digital platforms operating in the context of industrial symbiosis.

To investigate their business models and understand how they enable overcoming the barriers to industrial symbiosis, we gathered primary data. We conducted semi-structured interviews to collect empirical evidence as they align with the exploratory approach of our study and allow us to tailor the interview based on the expertise and the previous answers of the interviewees (in accordance with prior studies, see, e.g., Neri et al., 2023). We interviewed employees with managerial roles to ensure a proper knowledge of the topic under investigation, like Head of Business Development or Sustainability Manager (Weaver et al., 1999). Interviews lasted approximately 60 minutes. They were conducted online through MS Teams, and they were recorded and transcribed. We followed an interview protocol structured in three sections: i) general information regarding the digital platform and the interviewee, ii) the mechanisms for value creation, transfer, and capture applied in the business model of the digital platform, iii) how these mechanisms enable overcoming the barriers to the implementation of industrial symbiosis. We triangulated primary with secondary data to ensure the reliability of results (Yin, 2009). The gathered empirical evidence was analyzed with a deductive approach. We leveraged the barriers presented in Table 1 and the mechanisms presented in Table 2 to code the gathered evidence and understand how each mechanism enables overcoming each barrier. As an example, Case B stated that “our platform acts as an intermediary. Companies are encouraged to trust each other as they share only the needed information without confidential data. We share confidential information only when the matchmaking is approved by both parties”. This sentence was coded to connect the barriers “data and information” and “collaboration and trust” to the mechanism “Trustworthy environment” and to unveil that the platform enables overcoming those barriers as it is designed as an intermediary that offers a secure environment fostering trust.

Table 3 provides contextual information on the selected case studies and their primary and secondary data sources.

**Table 3** The selected case studies: contextual information and data sources.

<i>Case</i>	<i>Geographical context</i>	<i>Company size</i>	<i>Establishment year</i>	<i>Primary data sources (# interviews)</i>	<i>Considered secondary data sources</i>
A	Northern Europe	SME <sup>1</sup>	2020	3	Press releases,
B	Southern Europe	SME <sup>1</sup>	2018	2	company reports,
C	Southern Europe	SME <sup>1</sup>	2017	1	company website,
D	Northern Europe	SME <sup>1</sup>	2012	2	sectorial reports, third-entity reports

Source: Authors' own elaboration.

<sup>1</sup> Small and medium enterprise (SME): a company that employs less than 250 people and has an annual turnover under 50 million euros (European Commission, 2003)

## 4. Findings

In this section, we present the results of our study. Figure 1 depicts our novel research framework that unveils the linkages between the mechanisms for value creation, transfer, and capture and the barriers to industrial symbiosis. The three subsections below describe how each mechanism for value creation (subsection 4.1), transfer (subsection 4.2), and capture (subsection 4.3) enables overcoming each barrier to industrial symbiosis.

		Barriers to industrial symbiosis							
		Data information	Collaboration and trust	Technical knowledge	Economic challenges	Regulation	Awareness	Managerial commitment	
Digital platforms' business model	Value creation	Network dynamics	✗	✓	✗	✓	✗	✗	✓
	Value transfer	Matchmaking	✗	✓	✓	✓	✓	✗	✓
		Trustworthy environment	✓	✓	✗	✗	✗	✓	✓
		Data collection and exploitation	✓	✗	✓	✓	✓	✗	✗
	Value capture	Transaction efficiency	✓	✓	✓	✓	✓	✗	✓
		Tailored services	✗	✗	✓	✓	✓	✗	✗
		Revenue model	✗	✗	✓	✓	✓	✗	✗
		Pricing strategies	✗	✓	✗	✓	✗	✗	✓
		Value protection strategies	✗	✓	✗	✗	✗	✓	✗

**Key:** ✓ The selected mechanism for value creation, transfer, capture enables to overcome the selected barrier    ✗ The selected mechanism for value creation, transfer, capture does not enable to overcome the selected barrier

**Figure 1** The linkages among the mechanisms for value creation, transfer, capture and the barriers to industrial symbiosis.

### 4.1. Mechanisms for value creation to overcome barriers

The mechanisms for value creation are the most effective for overcoming barriers to industrial symbiosis. The majority of the matches among mechanisms and barriers refer to this dimension, namely, sixteen out of thirty-three. We describe the enabling role of each *mechanism* for value creation below through in-text headings highlighted in italics, and we highlight in italics as well each *barrier* that is overcome.

*Network dynamics.* The identification of the user groups and the creation of network effects, which positively influence the growth of the digital platform, enable an increase in the number of users of the platform. This virtuous mechanism enables overcoming the barrier related to *collaboration and trust* through the expansion of the geographic reach of the actors involved in industrial symbiosis, expanding the collaboration network even to distant actors. The numerous users of the platform decrease also the *economic challenges* related to industrial symbiosis by increasing the likelihood of identifying suitable actors with which to collaborate and implement industrial symbiosis. Lastly, as the number of users increases, more users are attracted to join the platform, encouraging *managerial commitment*. As stated by Case C, “Our platform has a huge user base. This encourages managers as they can access a broader network of potential collaborators.”

*Matchmaking.* Digital platforms for industrial symbiosis offer an easy matchmaking process to their users. Resource providers and seekers are matched based on their characteristics. This offering eases the initial contact between actors who may implement

industrial symbiosis, overcoming *collaboration and trust* issues. In addition, the matchmaking is conducted with an initial economic, technical, and regulatory assessment, based on the information provided, overcoming technical, economic, and *regulatory challenges*. Case A reports that “the platform suggests potential alternative matchmaking options to its users, based on economic, technical, and regulatory criteria. Once the managers have chosen the most suitable matchmaking, we put them in contact and initiate collaboration among them.” Lastly, digital platforms that provide a matchmaking centered on their users with smart features increase *managerial commitment* to approach the transition towards sustainability and the benefits unlocked by industrial symbiosis by improving efficiency, data quality, and decision-making.

*Trustworthy environment*. Digital platforms can be designed to limit the sharing of confidential *data and information* or to share data and information in an anonymous manner to encourage actors to use the platform and implement industrial symbiosis initiatives. The company that operates the digital platform acts as an intermediary that favors collaboration and trust among its users, providing a virtual safe environment in which interactions take place. As highlighted by Case B, “we act as intermediaries between resource seekers and providers. Our platform is a safe environment, even if virtual, in which users are encouraged to trust each other and collaborate” Such a trustworthy environment favors the creation of a sense of community among its users, enhancing knowledge sharing and *awareness* regarding the benefits hidden behind industrial symbiosis. Lastly, the possibility to collaborate in an environment in which sensitive data are shared only when necessary and with a trustworthy intermediary increases *managerial commitment*.

*Data collection and exploitation*. Digital platforms clearly state the input data required to use the platform itself and encourage their users to collect *data and information* regarding by-products and waste, which can be turned into a valuable resource. Data analysis mechanisms need to be defined and are useful in order to provide an initial *economic, technical, and regulatory* assessment of the potential flow of resources that can be exchanged by the actors involved. Case D reports that “often companies do not perceive data concerning by-products and waste as valuable, and they do not even collect data on this matter. We aim to flip their perspective and show them the value hidden in waste.”

#### 4.2. Mechanisms for value transfer to overcome barriers

The mechanisms for value transfer include solely two mechanisms with nine matches. The enabling role of these mechanisms is described as stated in subsection 4.1.

*Transaction efficiency*. Digital platforms represent a relevant tool for their users to optimize the development and implementation of industrial symbiosis initiatives. Digital platforms enable the quick sharing of data and information in a secure manner and even in real-time, and to reduce searching costs in identifying *collaboration* opportunities. In addition, the integration of smart features to identify matchmaking possibilities based on *technical, economic, and regulatory* assessment decreases the administrative and managerial burden for the users while increasing *managerial commitment* to approach industrial symbiosis. Case A reports that “we put a great effort in communicating that our platform is useful for managers to save time and costs in navigating the possibilities to implement industrial symbiosis. Our platform is a powerful tool to support them in decision-making and pushes them towards industrial symbiosis.”

*Tailored services.* Digital platforms offer the possibility to activate tailored services that deepen the needs and peculiarities of a particular user to support it throughout the whole development and implementation of the industrial symbiosis initiative. The support offered by platforms overcomes *technical, economic, and regulatory challenges* that are analyzed in depth for the specific user in order to make the industrial symbiosis initiative feasible from a technical standpoint, profitable from an economic standpoint, and compliant from a regulatory standpoint. As stated by Case B, “we promote tailored services as the key to translate initial matchmaking suggestions offered by the platform into actionable strategic and implementation plans co-developed with the involved parties to tailor the initial suggestions to their needs.”

#### 4.3. Mechanisms for value capture to overcome barriers

The mechanisms for value creation are the most effective ones in overcoming the barriers to industrial symbiosis. The minority of the matches among mechanisms and barriers refer to this dimension, namely, eight out of thirty-three. The enabling role of these mechanisms is described as in previous subsections.

*Revenue model.* The companies that operate digital platforms for industrial symbiosis separate the revenue streams coming from matchmaking services from those from tailored services. The possibility of accessing tailored support services as add-on services lowers concerns related to *technical, economic, and regulatory challenges* for managers. Managers can activate these services only if they need them to specifically assess the technical, economic, and regulatory feasibility of the matchmaking identified through the basic functions offered by the digital platform. The possibility to separate these services, and revenue streams, is beneficial for the users of the digital platforms as it enables the platform to adapt to the needs of its users. As stated by Case C, “we leverage two separate revenue streams, one comes from the basic features of the platform, the other from our tailored services. Managers activate tailored services to solve issues related to economic, technical, or regulatory aspects only if needed.”

*Pricing strategies.* Digital platforms offer diverse pricing schemes to their users depending on the features of the digital platform that they want to access. The possibility of accessing basic features for free lowers *economic challenges* and increases *managerial commitment* for managers skeptical towards industrial symbiosis. In addition, it also enables access to a broader network of potential actors with which to *collaborate*. Case B states that “Our platform has a very high number of users. Companies can enter our platform for free and gain access to a wide collaboration network. Thereafter, they can unlock further features through differentiated pricing schemes.”

*Value protection strategies.* Digital platforms have conceptualized various services to lock-in their users, such as workshops or webinars to disseminate knowledge or best practices regarding industrial symbiosis, which result in an increased *awareness*. Case A reports that “we organize webinars to favor cross-fertilization and dissemination of the benefits that can be unlocked through industrial symbiosis.” Such activities also enhance *collaboration and trust* by showcasing, e.g., successful examples of industrial symbiosis developed through the platform itself.

## 5. Conclusions

This study represents a pioneer contribution that collides two research streams on the barriers to industrial symbiosis and digital platforms' business model. We conduct an exploratory empirical analysis to shed light on this nexus employing a multiple-case study methodology. The findings of this study are depicted in Figure 1, and they refer to a novel framework that links each barrier to each mechanism for value creation, transfer, and capture.

This study comes with limitations that can represent promising avenues for future research. On the one hand, we focus on the European context, as it is one of the most important for industrial symbiosis. At the same time, we encourage scholars to consider diverse or broader geographical contexts to conduct comparative analysis or investigate the influence of contextual factors, such as support schemes for digital platforms. On the other hand, we focused solely on the barriers to industrial symbiosis. Scholars can also investigate the drivers of industrial symbiosis enhanced by the usage of digital platforms for industrial symbiosis.

We contribute to literature in the nexus between industrial symbiosis and digital platforms with two main pieces of evidence. First, we strengthen the role of digital platforms as industrial symbiosis enablers (in accordance with prior studies, see, e.g., Fraccascia & Yazan, 2018). Our findings unveil that digital platforms have a role in enabling novel business models that overcome the barriers to industrial symbiosis. Second, we characterize the enabling role of digital platforms by considering the mechanisms for value creation, transfer, and capture (as advocated by, e.g., Alcayaga & Hansen, 2024; Franzò & Urbinati, 2023). We unveil that these mechanisms have a diverse role in overcoming the barriers to industrial symbiosis. Mechanisms for value creation are crucial in overcoming barriers. On the contrary, mechanisms for value capture seem to be less relevant in this matter. Given these premises, we posit that value creation mechanisms, defined in the design phase of digital platforms, are crucial to enabling industrial symbiosis. Digital platforms should be designed to overcome the barriers to industrial symbiosis. If they fail to do so, the barriers cannot be overcome through value capture mechanisms once the platform is designed, with a lower effectiveness of the platform in enabling industrial symbiosis, potentially hindering the development and scalability of the platform. Therefore, we posit that the design of a digital platform is paramount to implement value creation mechanisms that enable overcoming barriers and implementing industrial symbiosis.

Our results are also relevant for practitioners. Managers striving to implement industrial symbiosis can leverage our framework in order to understand the benefits offered by the usage of digital platforms. Managers can couple our findings with their peculiar needs and specificities to understand the mechanisms offered by digital platforms that are relevant for them. As an example, managers reluctant to share data, which they consider highly confidential, can grasp from our results that digital platforms often require anonymous data as an input and preserve confidential information sharing for later stages of matchmaking. Also, managers skeptical towards the economic sustainability of industrial symbiosis can use digital platforms to get an initial economic assessment of a possible matchmaking identified by the platform, fastening and enhancing the decision-making process. Lastly, policymakers can also leverage our findings. In particular, we strengthen the debate concerning the relevance of the regulatory framework in the context of industrial symbiosis. Regulation represents a

barrier to implementing industrial symbiosis, due to, e.g., its uncertainty. We urge policymakers to modify the regulatory framework to promote the development of industrial symbiosis, turning regulation from a barrier into a driver for industrial symbiosis.

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