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15 (2022) 200099

Contents lists available at ScienceDirect

Resources, Conservation & Recycling Advances

journal homepage: www.sciencedirect.com/journal/Resources-Conservation-and-Recycling-Advances

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ARTICLE INFO

Keyword:
Industrial symbiosis
Plausible promise
Rational myth
Discourse
Case studies

ABSTRACT

In an industrial symbiosis initiative (IS-I), an initiating actor faced with a situation aims to enroll other actors in a collective action, or response, to address the situation. The rational myth theory embeds this "situation-response" pair. This paper explores the relevance of rational myth, along with that of plausible promise, to understand the emergence and development of IS-Is. We adapt the definition of these two concepts to IS and illustrate how they take shape with real case studies, by conducting the qualitative analysis of 14 French IS-Is. We demonstrate the potential of this framework to shed new light on IS-Is, and address a new range of questions for the dynamic analysis of initiatives. This paves the way to study the role of plausible promises in the initiation and development of IS-Is, and the design of discourses that enhance initiatives in situations of high potential of synergy.

1. Introduction

The development of industrial symbiosis initiatives (IS-Is) has attracted considerable academic attention (Chertow, 2007, 2000; Ehrenfeld and Gertler, 1997) and dissemination worldwide in recent decades (for a review, see Neves et al., 2020). Beyond the local scope of such initiatives, such attention favors their contribution to global change (Brullot et al., 2017). However, initiating and supporting these initiatives remains laborious and uncertain (Abitbol, 2012), and sometimes results in their decline (Mannino et al., 2015). Industrial ecology studies have reported on the factors that limit or foster IS-Is (Henriques et al., 2021; Tudor et al., 2007) by focusing on organizational perspectives (Walls and Paquin, 2015) or enabling tools (Yeo et al., 2019), but little attention has been paid to the mechanisms behind enrollment in these actions (Spekkink and Boons, 2016). Consequently, little is known about why actors are willing to engage with the initiators of IS-Is and remain involved. This knowledge is critical in situations where the actors do not initially share an explicit concern (Berthet, 2013), which is frequently the case in facilitated IS (Abitbol, 2012). What is more, some situations have significant potential of synergies, but implementation strategies remain to be conceived (Bijon et al., 2022).

In this paper, we explore how the concept of plausible promise (PP) (Douthwaite et al., 2001) and more specifically the notion of rational myth (RM) (Queste, 2016) offer tools to analyze IS-Is and to improve the understanding of their initiation and development in France. We performed a qualitative analysis of 14 French IS-Is to explore the new theoretical and operational possibilities offered by these concepts. The knowledge we obtained should help practitioners and decision makers to facilitate the initiation of new IS-Is, or to maintain existing initiatives.

1.1. Industrial symbiosis

Implementation of IS worldwide brought about a wide range of different situations that are difficult to describe in an integrated framework (Boons et al., 2016). To understand these practices, it is necessary to go beyond the classical picture of co-located pipe--connected industries like the well-known case of Kalundborg (Ehrenfeld and Gertler, 1997). IS-Is can indeed refer to all types of initiatives that aim to fostering regional cooperation among actors to improve the environmental and economic efficiency of their activities. This

VSI: icRS2021

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https://doi.org/10.1016/j.rcradv.2022.200099

Available online 23 June 2022

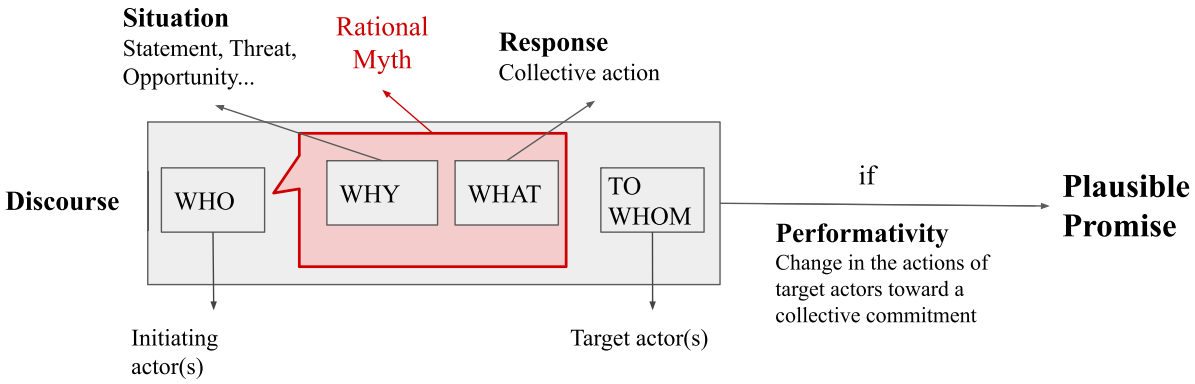

Fig. 1. Schematic representation of rational myth and plausible promise in the context of IS-I.

broadened definition stems from the incorporation of IS as a tool to achieve circular economy (CE) objectives (Kirchherr et al., 2017), for instance through the development of eco-industrial parks (Saha et al., 2021), in ore extraction (Vilaça et al., 2022), or in construction (Yu et al., 2021). While the general framework of CE is more aligned with political objectives than scientific advice (Korhonen et al., 2018) with little consideration for environmental efficiency (Harris et al., 2021), CE is now an important reference to understand the recent development of industrial ecology (Saavedra et al., 2018), specifically IS. Indeed, CE policies differ from one country to another (Feiferytė-Skirienė and Stasiškienė, 2021) and while some national strategies aim to create eco-industrial parks (Shi et al., 2012), others promote facilitated approaches, such as tools to increase mutual knowledge between actors (Paquin and Howard-Grenville, 2012). Some countries (including France) (Abitbol et al., 2014) recognize a wide range of practices, such as sharing and pooling, as an integral part of an IS-building process. In this paper, we apply this broadened definition of IS-I, even for initiatives that do not describe themselves as IS-Is. In France, this is the case for the management of residual organic matter, through "bioeconomic initiatives", listed in a recent publication by a public organization (Ademe, 2018), that we include in our set of case studies (see section 2.2.).

The emergence of IS is deeply rooted in local social, cultural or political conditions (Boons and Howard-Grenville, 2009),. An often-cited distinction exists between "self-organized" and "facilitated" IS (Chertow, 2007): the former describes IS-Is where there was no external intervention as actors spontaneously engaged in synergies, and the latter describes IS-Is that are accompanied by facilitating actors. Paquin and Howard-Grenville (2012) reported that the distinction remains of interest throughout the course of an IS-I. Abitbol (2012) analyzed the emergence of IS-Is in French contexts and concluded that in the absence of a shared initial concern, successful initiatives require that the actors formulate the issue jointly. Hewes and Lyons (2008) also highlighted the role of "champions" in the success of IS-I, champions being influential individuals who uphold the initiative and inspire other actors. These elements help understand how the concepts of plausible promise and rational myth relate to industrial symbiosis.

1.2. Plausible promises and rational myths

Doutwhaite et al. (2001) introduced the concept of plausible promise (PP) as an interface between scientific innovation and practical application in an agricultural context (Douthwaite and Gummert, 2010). As a response to the failure of the standard "technology transfer" pathway in which innovations are transferred at the end of the development process, leading to end-user inadequacy and rejection (Chambers and Jiggins, 1987), they propose an alternative "follow-the-technology" pathway in which innovations are co-constructed by researchers and end users. The authors argue that "*This partnership needs to be motivated by the belief amongst at least some of the key stakeholders that the prototype technology makes a plausible promise to benefit them*" (Douthwaite et al., 2002, p 126). The PP is thus an unfinished innovation, although sufficiently promising to interest the stakeholder for whom it is designed. Through the possibilities unlocked by this promise, stakeholders agree to contribute to the improvement of the technical solution in an adaptive learning cycle (Reed et al., 2006). This discourse plays a functional role in the innovation process, i.e. enrolling new actors in a collective action. This property can be described as *performativity* (Austin, 1962) since the utterance of the PP influences human action without requiring its components are true or become so. This pathway still has important individual implications for the innovator (Mokyr, 1992), and the role of "champion" in promoting the innovation is played by a member of the scientific community.

Wassenaar et al. (2014) suggested that such dynamics could occur in the regional management of organic waste flows, which can be considered as local resources. Such practices fall within the scope of IE since they enhance the sustainability of the "*metabolism of the Anthroposphere*" (Baccini and Brunner, 2012). By promoting collective learning, they actually share similarities with facilitated IS initiation and evolution, and resemble what Hoffecker (2021) suggested calling *inclusive innovations*. The main differences are the nature of the innovation, that in the case of IS, is organizational rather than technical, and the fact that the "champion", hereafter "initiating actor", is rarely a member of the scientific community. This may seem paradoxical as IS-Is is promoted by science as a way to change societal organization, thus increasing the need to understand the nature of PPs formulated in the context of IS.

Queste (2016) conducted studies of collective action in the context of waste recovery and established the importance of rational myths (RMs) that take their origin in the institutional change analysis provided by Holm (1999). A RM is defined as "*a discourse allowing actors to make sense of a given situation by providing a formulation of the problem and a presentation of the solutions able to solve it*" (Queste, 2016, p.66, authors' translation). A RM can be summarized as the statement of an issue and a collective response to this issue. It represents a shared understanding to which the actors refer while carrying out the responses related to the issue, as a collective justification to perform these actions.

1.3. Research gaps, definitions and objectives

Except for the references mentioned in the previous paragraph, the link between IS and collective innovations remains poorly developed in the literature. Most work on enablers and barriers to IS focus on external political, economic, technical, or social factors (Henriques et al., 2021), but do not describe the strategy used by practitioners to initiate or maintain IS-Is, namely, how they turn these external factors into efficient enrollment discourses to get other actors involved. The theoretical approach to PPs and RMs is a promising framework to improve this

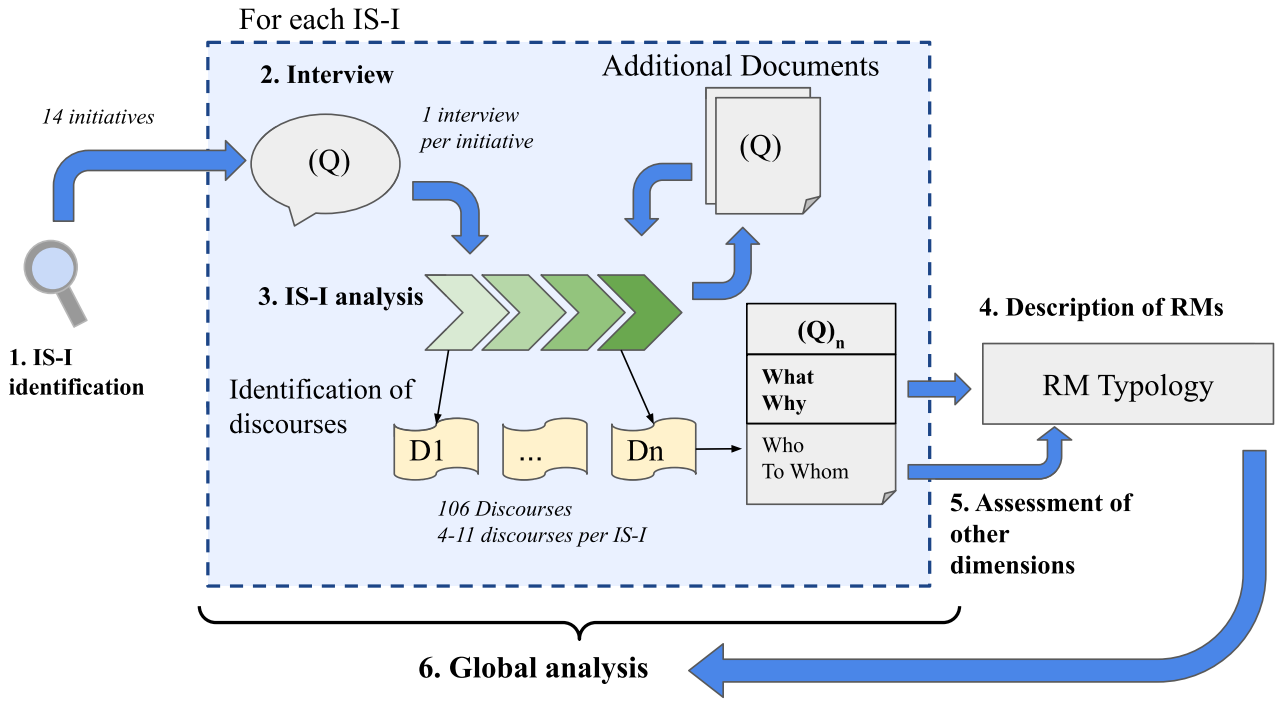

Fig. 2. General methodology of the study. (Q) refers to the question described in section 1.3.. IS-I Identification is explained in Section 2.2, Interview methodology is explained in Section 2.3. IS-I analysis is explained in Section 2.4., the RMs is described in Section 2.5, the other dimensions are assessed in section 2.6., and the global analysis is described in Section 2.7.

understanding and to identify implementation and development strategies for IS-Is. However, no theoretical adaptation of such an approach to IS has been proposed to date, and no empirical examples of PPs and RMs – or similar objects – in existing initiatives have yet been illustrated. Before stating our objectives, we propose to adapt the definitions of PPs and RMs to IS based on the above literature review.

In IS-Is, a plausible promise can be defined as the discourse of an initiating actor (or group of actors) confronted with a specific situation, formulated in a way designed to enroll a group of target actors in a collective process to address this situation. This definition reveals the twofold dimension, discursive and performative, of the PP. In this context, a PP corresponds to an enrollment discourse that involves a rational myth (Fig. 1) that the target actors help shape after becoming involved in the initiative.

Actions taken in the course of IS-Is can be translated into discourses that include a RM. These specific discourses can be identified through the elements that answer the following question:

(Q) *Who* proposes *What, To Whom* and *Why?*

In question (Q), "Who" describes the initiating actor, "To Whom" defines the target actors, "What" and "Why" are respectively the "situation" and the "response" dimensions of the RM. This makes it possible to tackle the embeddedness of events within their context, which is essential to understand how initiatives derive from local conditions (Boons and Howard-Grenville, 2009). It also makes it possible to differentiate PPs from other discourses. PPs have a *performative* dimension: they play a functional role in the development of innovation, i.e. to bring about a change in the system by convincing target actors to contribute to the collective response. Like the critical discourse analysis approach (Mogashoa, 2014), it recognizes that discourses not only represent the world but also help shape the world and help understand social configurations. These elements provide operational tools to identify how these discourses relate to and influence IS-Is, as summarized in Fig. 1. The question (Q) makes it possible to identify discourses that include RMs, among which performative discourses may be considered as PPs. In this paper, we focus on the characterization of RMs based on real examples that occurred in France, a national context in which IS-Is are numerous, diversified and available.

The specific objectives of this work are to (1) implement a methodology to study these objects among IS-Is as situations of collective innovation based on our definitions of PPs and RMs, (2) use this approach to improve the knowledge on the initiation and development of IS-Is through a description of RMs in the French context and (3) assess the consistency of this novel approach in the field of industrial ecology to study, understand, implement or consolidate IS-Is.

2. Material and methods

2.1. General methodology

This study involved the qualitative analysis of case studies (Yin, 2018) that have already been used to analyze IS-Is (Cerceau et al., 2014). Our methodological approach included six main steps (Fig. 2): (1) Selection of IS-Is in the study perimeter; (2) Design, implementation and transcription of interviews with key practitioners of these initiatives; (3) Analysis of each individual IS-I, including identification of discourses occurring within the IS-I using interview transcripts and documents; (4) Characterization of the RMs present in the discourses; (5) Description of other dimensions of the discourses; (6) Global analysis of discourses and their features. Detailed descriptions of the different steps are given in subsequent sections.

2.2. Case study selection

French IS-Is benefit from national recognition and promotion, along with a broad community of practitioners (Orée, 2020, 2016), i.e. a suitable context to identify initiatives with available documents and people to interview. We used three repositories of initiatives (Ademe, 2018; Elipse, 2020; Orée, 2016), in which we identified 195 IS-Is that could possibly be investigated. The references included short descriptions of initiatives that we used to select a smaller number of IS-Is

Table 1
Description of situations in rational myths.

	Immediate term	Prospective term
Explicit	Reaction (Specific actions)	Strategy (Strategic Actions)
Equivocal	Intricacy (Open actions)	Ideograph (Institutionalized Actions)

for time-intensive qualitative inquiries, while being sure we were covering the diversity of existing situations. As stated by Morse (2015), the case studies and people interviewed should not be selected using randomization methods, and are difficult to select definitively before initial inquiries have been made. In addition to cases in these repositories, some unreferenced cases were known by the co-authors, or suggested by interviewees.

Among all the referenced IS-Is, in all, we used three selection criteria (complexity, diversity and availability) to identify around 20 case studies to investigate. First, we used two criteria, complexity and diversity, to shortlist 30 case studies. Concerning complexity, we selected IS-Is that reportedly had a developed network of actors, or in which a large number of economic sectors were involved. Concerning the second criterion, we sought to maximize the diversity of initiatives with respect to their promoting actor, governance, method of facilitation, waste stream, type of synergies and lifespan. In addition, we made sure to include in the shortlist, five emblematic French IS-Is (Abitbol et al., 2014; Orée, 2016) with five more recent and contrasted "bioeconomic initiatives" (Ademe, 2018) (see section 1.1.). At this stage, IS-Is that were not described in sufficient detail in the repositories were discarded. We conducted additional research on the 30 shortlisted cases using the same two criteria. Some cases turned out to less complex than their short description suggested and were consequently also discarded. Finally, we applied a third criterion to the remaining cases: the availability of an appropriate interlocutor with real knowledge of the IS-I, plus sufficient additional documentation to insure the rigor of the qualitative analysis. We discarded IS-Is with no proven recent external activity (website, press articles, recent description) and for which we were unable to find an active interlocutor.

This selection process left us with 14 case studies that we considered suitable for the purpose of qualitative analysis since they presented an accurate picture of the diverse situations that exist in the French context. They covered six out of the 12 French administrative regions, with diversified perimeters and coordinating structures, consistent with the latest observations of French initiatives (Orée, 2020). The features concerned are listed in Appendix A.

2.3. Data collection: interviews and documents

We performed one semi-directive interview per selected case study to collect the discourses of the key actors concerning the development of IS-I. The guideline for each stage of the initiative was the question (Q).

Specific questions were not immediately asked in the interviews to avoid introducing a bias in the interlocutor's discourse and also to keep the conversation moving naturally. The first questions were general, such as "Can you explain how the initiative emerged and developed?" To obtain all the available information, we encouraged the interviewees to give more details on any dimensions of (Q) they did not mention spontaneously. The interview guide is given in Appendix B.

To improve the quality of the analysis, we searched for additional documents for each case study, including documents mentioned by the interviewees, activity reports, applications for subsidized projects, articles published in the specialized and general press (see Appendix A). Additional documents helped improve the accuracy of discourses identified in the interview, and sometimes led to the identification of new discourses that were not mentioned during the interview.

2.4. Identification of discourses through analysis of the case studies

Based on the interview transcript and additional documents, we identified a set of discourses in each IS-I. As defined in paragraph 1.3, a discourse corresponds to an action that takes place during the course of an IS-I in which we were able to identify the answers to question (Q) (Who, To Whom, What and Why). This method considers actions and the discourses that describe the actions to be equivalent. When the actors, situations or actions change within the same initiatives, so does the discourse. Starting from here, we constructed a chronological description of each IS-I as a succession of discourses. The four sub-questions we used to derive discourses are the dimensions that need to be described. Two of them correspond to the RM (see section 1.3): the questions *What?* and *Why?* correspond to responses and situations, respectively.

2.5. Characterization of RMs

We characterized RMs through a structured description of the "situation-response" pair. To build this description, we used references in the literature and selected elements we considered appropriate to interpret the discourses identified in the IS-Is. This is a hybrid approach that combines a deductive and inductive methodology (Paillé and Mucchielli, 2016). Only methodological elements are included in this section, while illustrations of the different categories from case studies are included in section 3.1 and in Appendix C.

2.5.1. Situations

The situation of the RM – The question *Why?* in (Q) – designates the collective justification for conducting an IS-I. An important dimension of a prospective analysis is the temporal perspective. The situation can either result from past actions and occur in the immediate term, or be the projection of a possible future state of a system, which corresponds to a prospective term. This distinction integrates a prospective strategy framework (Godet et al., 2004) that has already been used for IS analysis (Cerceau et al., 2014). Another important distinction can be made between explicit and equivocal situations. Some situations are clearly framed by a motivated actor with specific objectives stemming from an individual strategy (Mermet et al., 2005). In this case, the purpose of the collaboration is explicit, and enables a clear assessment of the success of the actions. However, in many cases, no clear shared objective existed prior to the collective action (Abitbol, 2012; Berthet, 2013) and the action may emerge from an equivocal objective (Bos et al., 2014), an abstract concept (Hatchuel, 1999) or an ill-defined problem (Ison, 2008). As a result, unlike in explicit situations, equivocal situations are not conclusively determined, and leave room for interpretation by the target actors. Incidentally, the interpretation of the problem may well depend on the actor involved. This leads to situations in which the problematic situation needs to be collectively assessed (Funtowicz and Ravetz, 1993) as the first step of a participatory initiative (Trébuil et al., 2018). McGee (1980) introduced the term *ideograph* to describe the fact that consensual collective objectives are embedded in ill-defined words, such as "progress" (Joly, 2010) or "sustainability" (Bos et al., 2014). Ideographs correspond to institutionalized actions since they embed a shared RM among the actors that can be referred to without being specified. This concept is particularly appropriate to describe prospective and equivocal situations (for more details, see section 4.1).

Situations of RMs can thus be distinguished by two dimensions, the time perspective, and the definition of the issue. Based on these two characteristics, we introduce four types of situations, listed in Table 1.

2.5.2. Collective response

Collective actions in IS-Is can be interpreted as facilitation actions within IS (Paquin and Howard-Grenville, 2012). We use the term *response* to emphasize that the course and result of the processes engaged remain uncertain.

The first important dimension of actions taken during the course of

Table 2
Description of collective responses in rational myths.

	Develop	Attract
Integrate	Co-construction	Reinforcement
Mobilize	Territorial service	Participant mobilization

IS-Is is the involvement of actors in the governance of the initiatives. Actions can be designed either to integrate new actors in the governance of the whole initiative, or to mobilize participants for a specific stage of the initiative without explicitly allowing these participants to contribute to the design of further steps. In the field of public participation, these two level of involvement can be related to the distinction between a closed and an open mode of response (Rowe and Frewer, 2005). They also directly refer to the learning selection process described by Douthwaite and Gummert (2010), in which the purpose is to have the actors shift from consultation ("mobilization") to collaboration ("integration") and lastly to "control" the initiative – which is the moment when actors shift from being the target of the RM to taking over the role of initiating actors. To link with the IS framework, it is necessary to consider the relation between the initiating actor and the target actor. This distinction can be summarized by "push" and "pull" strategies (Chauvet et al., 2013) that are also related to the theory of groups and collective action (Olson, 1965). The action can be dedicated to develop existing activities, or to attract new ones. Developing activities entails focusing on the interests or needs of an existing formal or informal group irrespective of whether these interests are clearly expressed by the actors or not. In turn, attracting new activities implies justifying the interests the actors have in contributing, thereby creating a new need.

Combining these two aspects yields four types of collective actions (Table 2), which we named to match the context of IS. The actions are described in detail in the results section, Appendix D provides a graphical illustration of this categories.

2.6. Assessment of other dimensions of the discourses

To be consistent with qualitative approaches, we used an inductive method to describe the other dimensions of discourse (Morse and Mitcham, 2002; Paillé and Mucchielli, 2016): *Who*, and *To Whom*. We used the same categories for the two dimensions as they both inform on actors' quality.

Answers to the question *Who?* refer to the actor initiating a collective action translated into a discourse during an IS-I. It can correspond to a group of actors irrespective of whether the group is structured officially (for instance in an association) or not. We include the quality of all actors involved in such structures, which means that the quality of the actors is not exclusive. Answers to the question *To Whom?* refer to the actor or group of actors expected to contribute to the action or to benefit from it (target actors). The target actors is possibly partly or entirely similar to the initiating actor. Based on inductive analysis, the following typology of actors was used: (1) public sector actors, including different levels of territorial administrative divisions such as municipalities or local waste management service providers, with, in addition, technical, economic, or legal state-driven structures; (2) private sector actors, including all type of enterprises, as well as individual economic actors, such as farmers; (3) Associative actors, including structures recognized as associations by French legislation but excluding business associations like cooperatives; (4) Academic actors, considered as a separate category from that of public actors; (5) Citizens, regardless of their commercial or associative activities; (6) Trade unions.

2.7. Analysis of discourses

The analysis of discourses was divided into two stages: the first describes and illustrates all the dimensions separately to identify the diversity and richness of the elements within these dimensions; the second stage goes beyond a description of dimensions, by identifying most frequent RMs (combination of a situation and response) and describing their general features. The number and representativeness of our case studies and the qualitative approach do not correspond to a statistically-robust description. Indeed, no RM would probably fit perfectly to the descriptions given in section 3.3. However, these two stages enable identification the of the most frequent tendencies in the discourses of RMs and the actions that they relate to.

2.8. Main assumptions and limitations

This work assumes that each IS-I can be analyzed as a succession of actions described through discourses, which is consistent with qualitative analysis in social sciences (Paillé and Mucchielli, 2016), namely critical discourse analysis (Mogashoa, 2014).

Table 3
The different RMs in the industrial symbiosis initiatives and associated examples found in the case studies. The sample discourses have been reformulated to highlight the rational myth. Roman numerals refer to the case studies with which they are associated in Appendix A; * most frequent features, present in all case studies; ** most frequent combination.

	Reaction (Immediate / Explicit)	Intricacy (Immediate / Equivocal)	Strategy (Prospective / Explicit)	*Ideograph (Prospective / Equivocal)
*Co-construction (Develop / Integrate)	Specific Co-construction	Open Co-construction	**Strategic Co-construction	**Institutionalized co-construction
	Inquiry among members to understand why the initiative slowed down (III)	Emergence of synergies due to a shared culture of cooperation (VII)	Collective feasibility study for a multi-flow recycling platform (V)	Applied to a subsidized program to make use of local biomass (II)
Territorial service (develop / mobilize)	Specific service	Open service	Strategic service	**Institutionalized service
	Creation of a water plant to cope with water pollution and water scarcity (I)	Territorial diagnosis to face the lack of mutual knowledge (VIII)	Develop tools to foster the emergence of new IS-Is (XIII)	Accompany private actors to help increase their contribution to sustainable development (XI)
Reinforcement (attract / integrate)	Specific reinforcement	Open reinforcement	Strategic reinforcement	Institutionalized reinforcement
	Creation of a river contract involving different stakeholders to reduce water pollution (IV)	No example found.	Creation of a circular economy cluster to support local waste management actors (X)	Attract innovating projects to become an experimental territory in the environmental transition (XIV)
Mobilization of participants (Attract / Mobilize)	Specific mobilization	Open mobilization	Strategic Mobilization	**Institutionalized Mobilization
	Voluntary collection of waste oyster shells for local valuation (XII)	Change in leadership strategy to keep up the interest of actors (VI)	Consolidation of a green waste management channel to reduce costs and obtain agronomic benefits (IX)	Flow studies and analysis of potential symbioses to achieve sustainable development (I)

Table 4
Panel of facilitation actions in IS-Is based on several categories of collective action. Action order refers to the level of change developed by (Watzlawick et al., 2011). X means no example was found in the selected case studies although examples may exist in other IS.

Type of action	Actionorder	Co-construction	Territory service	Reinforcement	Participant mobilization
Workshop / Meeting	1	Workshop organized by and for the initiating actors	Workshop organized for interested members within the IS-I boundaries	Workshop organized to get new members involved in IS-I governance	Workshop organized for interested actors beyond actual IS-I boundaries
Study	1	Study performed on and by the initiating actors	Study performed to answer a need felt by members within the IS-I boundaries	X	Study performed with external members not further involved in synergies
Technical synergy	1	Co-construction of synergies by and for the initiating actors	Initiating actors help other members of the IS-I build synergies	Initiating actors look for outside actors who have the technical capacity to build synergies	X
Creation of a structure	2	Meeting of actors interested in forming a governance structure	Creation of a brand	X	X
IS support	2	Joint involvement in a call for projects	Creation of tools to support IS, action programs, support of? provided by? for? local actors	Involvement of key political actors	X

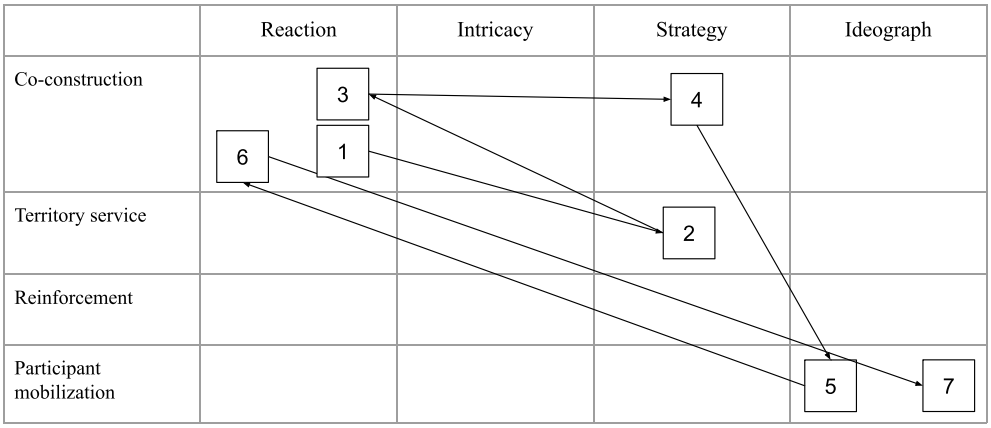

Fig. 3. Example of changes of RMs in one case study. Numbers indicate the chronological order of discourses. The squares correspond to the discourses and the numbers in the squares refers to their chronological order. The definition of the situations (columns) and of the collective actions (rows) are given in Section 2.5

The main limitation of this work is biased selection of the case studies, i.e. limited to the French national context. Other unreferenced initiatives may have been overlooked, for example, if self-organized initiatives exist outside the institutional framework. Finally, initiatives that did not last long enough to be available at the time of the study could not be included (see section 2.2.2). For these reasons, this article does not claim to assess the distribution of RMs in IS-Is in general. However, despite limited to this specific context, the resulting RM typology provides a sound theoretical basis, at least for preliminary studies of RMs in other contexts.

3. Results

3.1. Description of the core dimensions of rational myths - situations and responses

Coupling situations and collective responses yielded 16 different possible RMs (Table 3), arising from 106 identified discourses (4-11 discourses per case study). We observed multiple situation-response pairs across the different discourses in the IS-Is. “Ideograph” was the most frequently encountered type of situation (N=55) and was present in at least one discourse in each IS-I. Symmetrically, “co-construction” was the most frequent type of collective action (N=45), and was also present in all the initiatives. Some “situation-response” pairs appeared more frequently than others, (for further details see section 3.3). The absolute and relative frequencies of situation, responses and RMs are given in Appendix E. In the following sections, the different characteristics of RMs are illustrated with examples taken from the case studies, which are associated with the Roman numerals used in Appendix A.

3.1.1. Why - description of situations

“Reaction” situations entail sudden awareness of a pressing threat or the reverse, i.e. of an opportunity. In the case of a threat, the trigger could be linked to environmental pollution (I, IV), slowing down of an existing initiative (III), high waste management costs (IX) or economic difficulties (XIV). In “reaction” to opportunities, the response may be positive, for instance, to a subsidized project (I, V), or to a local potential synergy (XII).

“Intricacy” situations include discourses formulated in a context where several opposing interests are at stake, for instance in the case of local political inaction (V), or the willingness to preserve industrial activity in an urban context (XI). It can also refer to a general but elusive state of mind, such as rural common sense (VII), the lack of mutual knowledge (VIII), or the willingness of members (IX).

“Strategy” is a very diverse class. Some can be explicitly linked with an IS project, such as identifying and expanding synergies (I, VI), or implementing an IS-I (XIII, X). Strategy is also linked to organizational changes that may be directly linked to the IS-I to maintain the action (III, IX) or reinforcing coordination with members (XIII, IX). Some cases include strategies that are not explicitly designed to develop an IS-I, for instance in the early stages of an IS-I. Waste treatment syndicates may apply a variety of strategies related to waste, such as reducing the

Table 5
Panel of case studies selected and outstanding characteristics

Name	Attributed number	French Region	Coordinating structure	Perimeter of the initiative	Initiation year	Type of actors	IS feature(not exhaustive)	Function and seniority of interviewee	Ref.	Additional documents
Caux Seine Developpement	I	Normandy	Economic Development Agency	Municipality	1972	Industrial	Water sharing	Facilitator (recently arrived)	1,3	5,6
Organic'Vallée	II	Occitanie	Collaborative Enterprise	Industrial platform	2010	Rural	Territorial organic waste recycling	Director (present from the beginning)	2	7, 8, 9
Club d'Ecologie Industrielle de l'Aube	III	Great East	Association	Administrative department	2003	Industrial, rural and urban	Energy and material substitution	Director (present from the beginning)	1,3	10, 11
Biovallée	IV	Auvergne-Rhone-Alps	Association	Group of municipalities	1990	Industrial and rural	Mutual knowledge	General Secretary (recently arrived)	3	12, 13, 14, 15, 16, 17
3.EVA	V	Occitanie	Association	Group of municipalities	2014	Rural	Organic waste recycling	Facilitator (present from the beginning)	2	18, 19, 20, 21, 22, 23, 24
Sarrebourg Moselle Sud	VI	Great East	Collectivity	Municipality	2016	Rural	Mutual knowledge	Facilitator (recently arrived)	4	25, 26, 27, 28, 29
Bazancourt-Pomacle	VII	Great East	None	Industrial platform	1990	Industrial and rural	Energy and material substitution	Other (present from the beginning)	1,3	30, 31, 32, 33
CBE Sud Luberon	VIII	Provence-Alps-Côte d'Azur	Association	Associative perimeter	2013	Industrial, rural and urban	Mutual knowledge	Director (present from the beginning)	/	34, 35, 36, 37, 38, 39
Syded	IX	New Aquitaine	Waste management Syndicate	Municipalities belonging to the syndicate.	2010	Rural and urban	Organic waste recycling	Director (present from the beginning)	2	40, 41, 42
ValOrizon	X	New Aquitaine	Waste management Syndicate	Municipalities belonging to the syndicate.	2015	Industrial and rural	Eco-industrial park	Facilitator (present from the beginning)	2	43, 44, 45, 46
Initiatives Durables	XI	Great East	Association	Administrative region	2012	Industrial, rural and urban	Energy and material substitution	Director (present from the beginning)	3,4	47, 48, 49, 50, 51, 52, 53, 54
Cyclad	XII	New Aquitaine	Waste management Syndicate	Municipalities belonging to the syndicate.	2017	Rural	Waste recycling	Facilitator (present from the beginning)	/	55, 56, 57, 58, 59, 60, 61, 62, 63, 64
SOLTENA	XIII	New Aquitaine	Association	Administrative region	2009	Industrial, rural and urban	Support to initiatives	Facilitator (present from the beginning)	1,3	65, 66, 67, 68, 69
PIICTO	XIV	Provence-Alps-Côte d'Azur	Association	Industrial platform	2014	Industrial	Energy and material substitution	General Secretary (present from the beginning)	1,3	70

production of waste (X), reducing the cost of waste management (IX), or changing the inhabitants' perception of waste (XII). The strategies used by actors of the private sector are also an important driving force, for instance, a multi-flow treatment platform project (X), sharing research and innovation practices (VII), replying to farmers' need for compost (VIII), or increasing local production (XI).

"Ideographs" is the most frequent type of situation (present in 51% of all discourses), and all the IS-Is we analyzed used at least one ideograph during its lifespan. Some ideographs can be interpreted as "ill-defined strategies". This category includes the following examples: willingness to become an experimentation territory (III, XI, XIV), to promote industrial ecology (III, I), to increase cooperation (II, X), to create local value (VII, XII), to turn waste into a resource (X, XI). Like strategies, these situations target a specific goal, but exactly what is expected by achieving the goal remains vague. More closely linked with the original meaning of ideograph, many initiatives refer at some point to ill-defined overarching goals such as local attractiveness and development (I, IV, V, XIV), sustainable development (IV, XI), the ecological transition (IV, VIII), the bioeconomy (IV, VII), innovation (VII), the circular economy (VIII, IX, XII), environmental exemplarity (IV, XI, XIII), green growth (XIII) or economic development (VIII, XI, XIV). This is illustrated in the following citation, where the mention of "industrial ecology" as a topic is sufficient to engage actions:

"(…) should we not also promote territorial innovation, through the topic industrial ecology?"

Interview with an IS-I facilitator, September 2020

3.1.2. What – description of collective responses

"Co-construction" is a mode of collective response used in all the IS-Is we analyzed. The first set of actions aims to obtain administrative and economic support for the initiative and often requires the active involvement of the stakeholders. For instance, initiatives frequently involve the creation of a structure (I, III, IV, V, VII, XI, XIII, XIV), and receive subsidies through calls for projects that require the involvement of local stakeholders (II, VI, VIII). The second set of actions corresponds to the core practice of IS, e.g. the organization of collective meetings aimed at increasing knowledge and building mutual trust among the stakeholders, and allowing them to participate in the IS-I governance (IV, VI, VIII, XIII, XIV). This category may include other collective technical actions such as the organization of participatory studies (V, VIII, X), or the implementation of concrete multi-stakeholder technical projects (VII, X, XII, XIV).

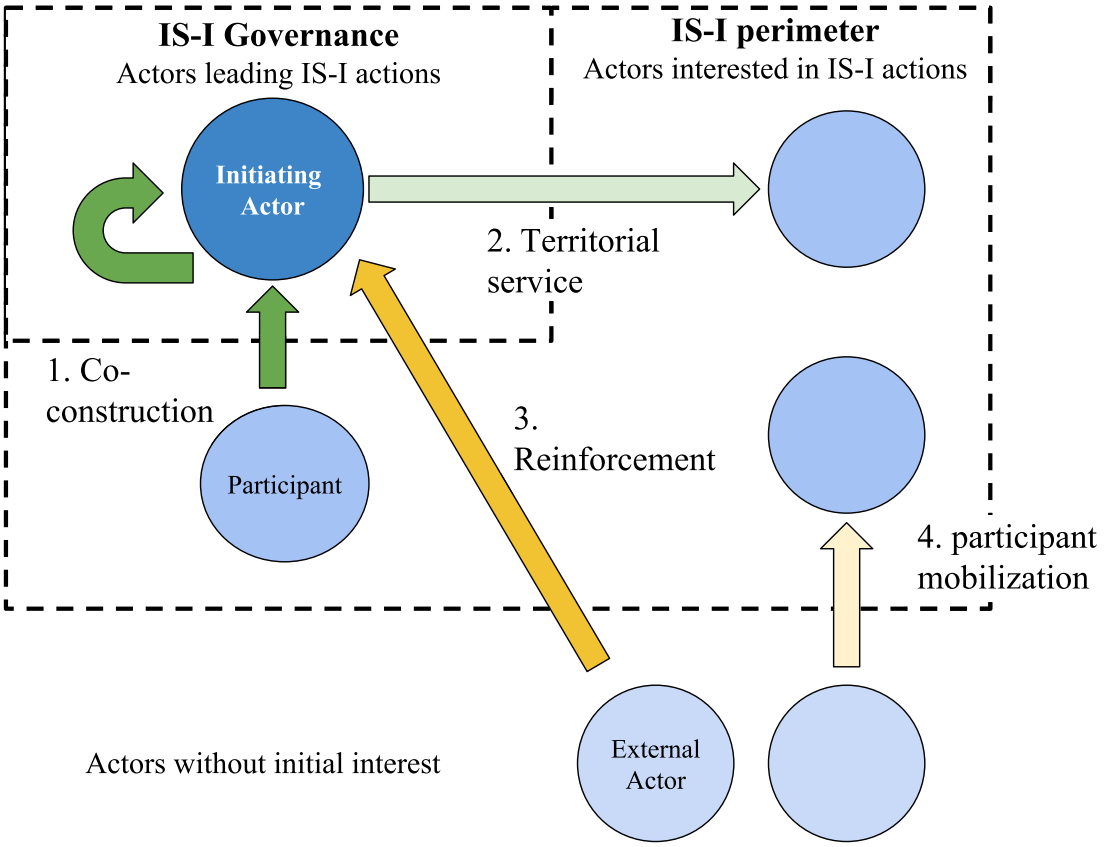

Fig. 4. Schematic representation of different types of collective actions in an IS-I. Circles represent actors. The deeper the color, the closer the proximity of governance.

Table 6
Proportion of RMs found in the discourses we analyzed. P-IS: percentage of IS-Is (n=14) including the RM or RM component; N-D = number of discourses. Percentage in the column N-D corresponds to the percentage of total discourses (n=106); Green cells indicate dimensions that were systematically present at least once in all the case studies, and yellow cells Indicate the most frequent "situation-response" pairs of RMs (see section 3.3 for more details).

		Reaction		Intricacy		Strategy		Ideograph	
		P-IS	N-D	P-IS	N-D	P-IS	N-D	P-IS	N-D
		64%	14	50%	7	86%	30	100%	55
P-IS	N-D		13%		7%		28%		52%
Co-construction	Specific co-construction	Open co-construction	Strategic co-construction		Institutionalized co-construction				
100%	45	29%	6	14%	2	71%	14	86%	22
	42%		6%		2%		13%		21%
Territory Service	Specific service	Open service	Strategic service		Institutionalized service				
71%	31	21%	3	21%	3	36%	8	57%	18
	29%		3%		3%		8%		17%
Reinforcement	Specific reinforcement	Open reinforcement	Strategic reinforcement		Institutionalized reinforcement				
50%	9	14%	2	0%	0	21%	3	21%	3
	8%		2%		0%		3%		3%
Participant mobilization	Specific mobilization	Open mobilization	Strategic mobilization		Institutionalized mobilization				
71%	21	21%	3	14%	2	29%	5	50%	9
	20%		3%		2%		5%		8%

"Territorial service" is another common action. The term "territorial" implies the potential beneficiaries are usually identified as belonging to the same geographic area. Incidentally, some actors use the term territorial to describe their actions. In its most obvious form, territorial service refers to a new service introduced by the initiating actor that targets other local actors who are not expected to be involved in the governance of the initiative. The service may be technical, e.g. the creation of an industrial water plant (I) or the diffusion of tools designed to help the IS-I (XIII) or the service may be institutional, e.g. a branding service (IV, XI), a subsidy for local initiatives through calls for projects (IV, IX) or action programs (III, VIII, X, XIII), studies (III, VIII), or more general support services to encourage and help actors achieve specific goals (IX, XI, XII XIII). Such services may also be explicitly dedicated to traditional IS actions, such as the organization of synergy identification workshops (X, VI) and territorial activities (VIII, XIII).

"Reinforcement", which was less frequently represented in the case

Table 7
Principal RMs and their attributes in the discourses analyzed. Categories of actors used to inform the dimensions "Who?" and "To Whom?" are described in section 3.2, categories of events ("When?") and mobilization strategies ("How?") are described in section F. * mean presence of all RMs in IS-I.

	Institutionalized co-construction (n=22)	Institutionalized service (n=18)	Strategic co-construction (n=14)	Institutionalized mobilization (n=12)	Base value (All discourses) (n=106)
IS including RM	86%	57%	71%	50%	32%*
Initiating actors	Public (77%) Private (64%) Associative (18%) Citizen (5%) Trade Union (5%)	Public (78%) Private (61%) Associative (22%) Academic (22%) Trade Unions (22%)	Public (79%) Private (57%) Academic (14%) Associative (7%) Trade Union (7%)	Public (83%) Private (50%) Academic (17%) Associative (8%) Trade Union (8%)	Public (83%) Private (58%) Academic (13%) Associative (12%) Trade Unions (8%) Citizen (3%)
Target actors	Private (95%) Public (64%) Associative (23%) Citizens (14%) Academic (5%)	Private (83%) Public (61%) Academic (22%) Associative (22%) Citizens (22%) Trade Unions (6%)	Private (79%) Public (36%) Academic (7%) Associative (7%)	Private (83%) Public (8%) Associative (8%) Citizens (8%)	Private (88%) Public (42%) Associative (17%) Citizens (15%) Academic (8%) Trade Unions (1%)
Temporal context	Public policy (5) IS-I continuation (5) Evolving ideas (2) Political support (2) Contingency (1)	IS-I continuation (9) Public Policy (4)	IS-I continuation (5) Strategic Choice (3) Evolving ideas (2) Public policy (1)	Public Policy (4) IS-I Continuation (2) Evolving ideas (1)	IS-I continuation (31) Public Policy (20) Strategic Choice (9) Evolving ideas (8) Contingenxy (4) Political support (3)
Collective mobilization strategy	Conviviality (5) Personal levers (5) Legitimacy (2) Communication (1)	Communication (1) Conviviality (1) Personal levers (1) Legitimacy (1)	Communication (3) Conviviality (1) Legitimacy (1)	Personal levers (2) Legitimacy (1)	Personal levers (13) Conviviality (12) Communication (11) Legitimacy (11)

studies we analyzed, consists in the initiating actor building synergies with other actors. There are two main types of reinforcement: organizational reinforcement and technical reinforcement. Organizational reinforcement refers to actions taken to reinforce the legitimacy of the initiative by including key political actors in the governance (IV). Technical reinforcement aims to use the technical facilities and skills considered necessary for a synergy project, e.g. the capacity to process or give added value to waste biomass (II).

"Participant mobilization" includes the organization of workshops, meetings or studies targeting actors who were not previously involved in the IS-I, but who are nevertheless not included in the governance of subsequent actions. This type of action is common in initiatives that aim to extend their perimeters (I, III, VI, X, XI). These actions may also be information initiatives aimed at increasing the legitimacy of the IS-I among external actors (XII, XIV). Mobilization can also take the form of a tool designed to attract new actors within the range of actions taken by the initiating actor (I, II).

3.2. Analysis of initiating and targeted actors - Who and To Whom

As could be expected in a national context where IS is mainly facilitated and promoted by public policies, initiating actors are mostly public actors (83% of discourses), and the most frequent target actors are private actors (88% of discourses). However, public-private partnerships are also common, as shown by the fact private actors are initiating actors in 58% of discourses. Symmetrically, public actors are also often the actors targeted by the discourse (in 42% of the cases), meaning they are not always the leading actors in IS-Is. Other types of actors are much less frequently present as initiating or target actors. One interesting observation was that initiating actors and targeted actors often vary from one discourse to another in the lifespan of the same IS-I due to changes in the actions undertaken within the IS-I concerned.

3.3. Description of the most frequently encountered rational myths

In this section, we illustrate the features observed in the most frequent RMs: institutionalized co-construction (N=22), institutionalized service (N=18), strategic co-construction (N=14) and institutionalized mobilization (N=9). We first observed that these four out of a total of 16 RMs accounted for 61% of all discourses, and that each RM was present in at least 50% of the initiatives. Details on the features of these RMs discourses are given in Appendix G.

Institutionalized co-construction corresponds to the organization of concrete and participatory actions to achieve an abstract and ill-defined overarching goal. They largely target private actors. A typical example of this type of RM was found in an IS-I, in which the initiator created a partnership with local actors to implement an "eco-industrial park" with the goal of testing IS principles:

"Last spring, we were prizewinner to define an industrial symbiosis initiative at a much smaller scale. (…) To this end, we will create a partnership with the municipality in charge of this business park, with the aim of testing IS in a rural area."

Interview with an IS-I facilitator, August 2020

Institutionalized services are actions taken by proactive actors that target local actors who are passive but need the service. In the following example, this RM is illustrated by a local business association, which had already been identified as a potential support structure before actions were taken to start an IS-I:

"The structure has existed for more than 15 years, it was created in 2004 by company directors, who intuited that sustainable development would be an important topic for businesses."

Interview with an IS-I facilitator, September 2020

Although strategic co-construction could be considered as a slight variation on institutionalized co-construction, its logic appears to be quite different. Strategic co-construction actions target private rather than public actors. In the following example, the initiating actors organized concerted actions to answer a local need for compost.

"We wanted to work on the management of green waste, which was a very important regional issue, since nothing was organized, and municipalities said "that is our business". So, that's it… We started a big initiative linked to composting, actually, to find a way to produce compost for farmers".

Interview with an IS-I facilitator, July 2020

Institutional mobilization was slightly less frequently present in discourses than the three other RMs, but also contrasts with them,

namely in the "Who/To Whom" pair. While the involvement of stakeholders in both the public and private sectors appears to be important in the main RMs, institutional mobilization is more unidirectional, starting from public actors with a moderate contribution of private sector actors, directed toward other private sector actors.

4. Discussion

4.1. The importance and paradox of ideographs

The analysis of IS-Is through discourses creates an interesting bridge to the field of rhetoric through the notion of ideographs. While ideographs are usually described as *words*, we extend the use of the term ideograph to include a *situation* involving justification of a collective action. Beyond umbrella words such as *progress* (Joly, 2010) or *sustainability* (Bos et al., 2014), we interpret ideographs as consensual objectives, broadly acknowledged by society, that are claimed to contribute to the common "good" while the demonstration of their contribution to this "good" is not deemed necessary. The absence of causal links leaves a lot of room for interpretation, while strategic objectives constantly need to be demonstrated and reevaluated. We do not consider that the possibility to formulate an ideograph in a simple word, - aside from the fact it would clearly reinforce its rhetoric - is a prerequisite to qualify a situation. Moreover, some ideographs can actually be interpreted as combinations of several ideographs. The best example is the *sustainable development* ideograph, which combines *environmental preservation, economic development*, and *social wellbeing*, which can also be considered as separate ideographs. However, despite the liberty we take in our interpretation of the term "ideograph'', section 0 illustrates how many IS-Is refer to keywords that correspond to one or more dimensions of *sustainable development*.

This study underlines the importance of ideographs in justifying collective action, as all the IS-Is cases we analyzed included at least one ideograph, and shows that ideographs were used to represent the situation in 55 out 106 discourses (see Appendix E). This suggests that the ill-definition of situations may not hinder the development of collective actions, on the contrary, we hypothesize that it could actually promote them. We indeed argue that an ill-definition carries a consensual message that all actors can endorse with their own viewpoint (Star and Griesemer, 1989). Moreover, ideographs are often relative notions: prospective goals for progress or sustainability implies the existence of a current situation that is unsatisfactory or unsustainable. This raises the question of the representation of this referential state by the actors that can vary considerably from one standpoint to another. Based on their own experience, not all actors will necessarily consider that the objectives of ideographs are equivocal.

However, the fact that, in the case studies we selected, such ambiguous objectives appear to be the norm rather than the exception questions the relevance of IS-Is as a normative tool to increase the sustainability of our societies. This involves answering the following questions: (1) How can ill-defined objectives guarantee an efficient change toward a reduction in resources consumption? (2) Would a more precise definition of the objectives reduce stakeholders' willingness to participate? (3) As sustainability requirements are formulated by advances in different scientific fields, do scientists have a more important role in the formulation of ideographs, or in the translation of such ideographs into strategies to achieve sustainability in field initiatives? The present study remains limited in space and scope (see section 2.8). However, if the same predominance of ideographs is confirmed in other contexts, it raises important questions concerning the role of expert knowledge in accompanying collective action.

4.2. Beyond facilitation of IS

4.2.1. Different levels of action

The collective responses illustrated in section 3.1.2 can be linked with the two levels of actions described in problem solving (Watzlawick et al., 2011) or institutional change (Holm, 1999) literature. The first level is the action within the IS-I ("first-order action"), and can be considered as facilitation actions to develop IS in a specific area. The second level of action represents actions supporting existing initiatives, and allowing them to emerge and then develop ("second-order action"). Interestingly, our analysis framework easily incorporates both types of actions. Table 4 summarizes our observations of typical facilitation actions in IS-Is, e.g. workshops or meetings, studies, technical synergies, creation of structures, and IS support. The table shows that based on our description similar actions may actually take different forms of collective response. This suggests that the features of collective action are more important than the name given to a specific action, since these features entail different consequences for the future development of the IS-I.

4.2.2. A wide range of collective actions

According to previous classification frameworks (Chertow, 2007) most of the selected case studies would correspond to "facilitated" IS as opposed to "self-organized" IS where there is no external influence. However, Table 4 shows the wide range of existing facilitation processes we encountered, and that are illustrated in section 3.1.2. Moreover, as the IS-Is we studied took place in one geographical area and in a specific social-political context, the global diversity of IS-Is facilitation processes may well be even larger and remains largely unexplored.

We also observed that the initiating actor often varies from one discourse to another over the lifespan of one initiative, and that the target of one action can become the initiator of further actions (as described by the theoretical framework of Douthwaite and Gummert, 2010). Thus the adjective "facilitated" is not necessarily appropriate to qualify an IS-I as a whole, but may more appropriately qualify certain stages of the initiatives.

The framework resulting from our work provides clues that will be useful to analyze the different facilitation options in IS. We suggest two important facilitation dimensions: the willingness to enroll actors in governance, and the relative position of the target actors within the actual range of the IS. As a general observation, our analysis reveals the value of linking IS with collective and institutionalized action concepts, a link that to the best of our knowledge, has not been previously established.

4.3. Toward a dynamic analysis of IS-Is. Evolution of rational myths and plausible promises

We observed that RMs vary considerably within IS-Is, as illustrated with one initiative on Fig. 3. This example involves in three different situations (columns in Fig. 3), three different collective responses (rows in Fig. 3), through four different RMs. Similar and sometimes even more complex variations were observed in all the case studies. This observation raises new questions and paves the way to study the changing dynamics of discourses in IS-Is. Possible questions are: (1) Are there general patterns that explain the transition from one RM to another? (2) Do these RMs have functional roles in IS-Is, or are they rather explained by local contingencies? (3) Are there similarities across IS-Is?

5. Conclusion & perspectives

This work shows the value of adapting the theoretical framework of collective innovation, including plausible promises and rational myths, to industrial symbiosis initiatives. This novel approach revealed precious information concerning the collective processes that occur in a whole range of industrial symbiosis initiatives. Considering these initiatives as a succession of discourses, we show that rational myths can be associated with concrete examples in case studies and propose a description of the typical features of the most frequent rational myths we observed in the French context. Through the diversity of collective

responses observed, our description offers a glimpse of the different practices applied under the umbrella of "facilitated" industrial symbiosis. It is not surprising that co-construction, which can be considered as the core practice of industrial symbiosis, was found in all case studies and in many discourses. However surprisingly, we observed that the collective justification for these actions was often ambiguous and prospective, features that are well captured by the ideograph concept. These first results in France suggest that similar studies in different contexts would be useful to assess the range of validity of these observations. We also noted a succession of different rational myths in a dynamic pattern visible in the initiatives. Such patterns could also be further investigated to adapt the framework of the plausible promise to industrial symbioses thereby improving our understanding of engagement in collective processes.

These results also open operational perspectives to design discourses in contexts where the potential for synergy is high but in practice, few actions are taken. The next step in our study will be to test and improve the findings presented in this paper to build discourses based on the different features of rational myths (situation and responses) and to assess them experimentally on synergies between agriculture and organic waste.

CRediT authorship contribution statement

Nicolas Bijon: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Juliette Cerceau:** Conceptualization, Methodology, Validation, Resources, Writing – review & editing. **Magali Dechesne:** Writing – review & editing, Supervision, Project administration. **Guillaume Junqua:** Validation, Resources, Writing – review & editing, Supervision, Project administration. **Tom Wassenaar:** Writing – review & editing, Supervision, Project administration.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Veolia Research and Innovation (Employment as Industrial Ph.D. Student).

Acknowledgements

We are very grateful to all the respondents to our interviews. We also thank Dr. Jerome Queste for his precious help during the early stages of this study and rich feedbacks on the results.

This research is supported by Veolia Recherche et Innovation (VERI) and the French National Association for Research & Technology (ANRT).

Appendices

Characteristics and references of case studies

Table. 5

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Interview Guide

Usual opening question: Can you describe your role and the history of the initiative?

Dimensions to be investigated during the interview:

	Who	What	To Whom	Why	How	When	Governance
Beginning of the initiative How did the initiative emerge in the first place?	Who was the initiating actor?	What were the first actions taken? What were the actors told?	Who was included in the initiative?	What was the original project?	What were the circumstances surrounding the emergence?	Did the project emerge at a particular time?	/
Development of the initiative How did the action evolve?	Who carried the initiative?	What actions were taken?	Did the participating actor change? If so, how?	Did the purpose of the initiative change?	If yes, what led to these changes?	What was the influence of external events?	What is the role of each actor?

Illustration of situations and responses from the case studies

a. Situations - Why

Name	Features	Example from a case study	Source
Reaction	Short Term Explicit	The following situation clearly illustrates a threat linked to pressure on water resource: *"Industry had a great need for water (…) They pumped so much water it led to rising salinity"*	Interview with an IS-I facilitator, July 2020
Intricacy	Short Term Equivocal	In the following statement, the interviewee explains how a local cooperative state of mind could initiate actions: *"The interactions between actors occurred naturally (…) That's to say it's countryside common sense, meaning that, well, two co-located businesses try to talk to each other to see if there are things they can manage together."*	Interview with an IS-I facilitator, July 2020
Strategy	Prospective Explicit	The following sentence shows the objective was a strategic reduction of costs: *"We reduced the costs, they realized that it was a resource for them, and that they wouldn't have to buy as many inputs."*	Interview with an IS-I facilitator, July 2020
Ideograph	Prospective Equivocal	In the following, "Industrial Ecology" is mentioned as a topic that is sufficient to engage actions: *"(…) should we not also promote territorial innovation, through the topic of industrial ecology?"*	Interview with an IS-I facilitator, September 2020

b. Responses - What

Name	Features	Example from a case study	Source
Co-construction	Integrate Develop	This statement illustrates a very simple form of this action: *"(…)organizing the stakeholders' commitment within the scope of an agreement and creating thematic working groups."*	Interview with an IS-I facilitator, July 2020
Territorial Service	Mobilize Develop	In this example, the coordinating structure can provide support for other actors related to specific topics: *"We try to structure our actions in the framework of an initiative we call 'eco-exemplariness'."*	Interview with an IS-I facilitator, July 2020
Reinforcement	Integrate Attract	In the following example, the initiative specifically seeks to attract innovative projects beyond the existing initiative: *"Today, we receive around 60 million euros worth of innovative projects on the platform"*	Interview with an IS-I facilitator, September 2020
Participant Mobilization	Mobilize Attract	An example of mobilization dedicated to local citizens: *"In fact, the idea was born there, and we started a very simple action, collecting oyster shells. The inhabitants could bring oyster shells to the different waste platforms in our region"*	Interview with an IS-I facilitator, September 2020

Graphical representation of possible responses

Fig. 4 illustrates the modes of response (sections 2.5.2. and 3.1.2) by representing the relative position of target actors within the existing IS-I perimeter, and the openness to governance through this action. The IS-I perimeter represented in this figure may not be geographical, but rather correspond to actors already involved in the IS-I actions (depending on? whether or not the action is institutionalized).

Observed frequencies of situations, responses, and rational myths

Table. 6

Additional question Q'

Other dimensions that are not discussed in the main text for reasons of brevity, have been added here to facilitate the understanding of the driving force behind the evolution of IS. These dimensions are in *italics* in the following question (Q')

(Q') *When* does this action take place, and *How* are the actors involved in the collective process ?

Information on dimensions related to the question (Q') – *When* and *How* – was not always available, and is consequently not systematically reported. We have included the dimensions in all the discourses in which enough evidence was found in the interview or in additional documents. The two dimensions were described with an inductive method. Answers to the question *When?* indicate events that take place before the action is taken and that are cited as driving forces or as background to explain the action. Answers to the question *How?* indicate the means by which the initiating actors got other actors to cooperate in the action. The following sections detail our observations.

a *When* - Temporal context

We found hints of important anterior events – in answers to the question *When?* - in 75 out of the 106 discourses. In many of the discourses, this indication referred to the continuation of the IS-I (n=31), in agreement with preceding actions. Another important temporal marker is the influence of public policies (n=20). These policies are external to the IS-I and represent either opportunities (action programs, subsidies, favorable regulations) or constraints (constraining regulations, budget cuts, administrative changes) to which IS-I actors adapt. Other temporal events are more linked to individual dynamics, such as strategic choices (n=9) or awareness raising (n=8) leading to a move towards cooperative development. Lastly, we should mention that some actions take place in the context of positive or negative contingencies (n=4), sometimes taking the form of public political support (n=3).

a *How* - Factors of success in rallying target actors

We were able to identify the methods used to collectively rally target actors – in response to the question *How?* - in 48 out of the 106 discourses. We identified success factors that are already well-known in IS. For instance, the influence of personal levers – political carriage, charisma, activation of networks – (n=13) known as the role of "champions" (Hewes and Lyons, 2008) in IS. Conviviality and mutual knowledge (n=12) were also mentioned and are known to enhance IS-Is (Abitbol, 2012). Communication and awareness raising (n=11) are other features used to familiarize actors with IS culture. When this culture of symbioses stabilizes and the first exemplary actions are taken, we observed that legitimacy was a sufficient legitimacy lever to get actors involved (n=11).

Observed Characteristics of most frequent rational myths

Table 7

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