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Local Entrepreneurs' Involvement in Strategy Building to Facilitate Agro-Food Waste Valorisation within an Agro-Food Technological District: A SWOT-SOR Approach

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Abstract: The paper focuses on Agro-food waste valorization conceived as a long-term, complex socio-technical process involving several different actors belonging to multiple levels. Although this process is typically affected by a series of uncertainties, the convergence of stakeholders' expectations proves to be a means to overcoming barriers, as it acts as the foundation of a shared agenda setting which formalizes the coordination efforts among the actors involved in an innovation process. Applying the strategic niche management (SNM) framework to the case of the Apulia Agro-Food Technology District (DARe), whose mission is to promote a bio-based industry for food-waste valorization, the paper proposes an operational tool capable of designing the strategy based on the entrepreneurs' knowledge. The DARe aims to promote the technological innovation of agro-food firms located in the South of Italy. The results of a SWOT-SOR analysis led to the establishment of a twofold strategy aimed at (a) promoting the innovation of more active and dynamic firms, and (b) reducing the gap between "pioneer" and "laggard" firms, with the result of promoting integrated innovation throughout the entire district.

Keywords: agro-food waste valorization; socio-technical transition; strategic niche management (SNM); socio-technical barriers; convergence of expectations; SWOT-SOr; agenda setting

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1. Introduction

The treatment and disposal of food waste represent some of the most important long-term challenges in the agro-food sector and are an emergent opportunity to pursue the so-called bio-based economy. In the last decade, the European Commission has focused on bio-based economy (BBE), defined as the industry which " ... encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bio energy" [1]. This may also represent new opportunities to revitalize rural areas, while pursuing the societal global challenges of climate change and fossil fuel replacement [2–5].

In this study, we focus our attention on the valorization of agro-food waste, which may be usefully employed as raw material in the bio-refinery industry to produce energy, fine chemicals and biomaterials. Specifically, bio-refinery is the sustainable processing of biological material derived from living or recently living organisms (biomass) into a spectrum of marketable products (food, feed, materials, chemicals) and energy (fuels, power, heat) [6].

In particular, this work is focused on a particular type of innovation characterized by a low technological readiness level [7], whose development implies a socio-technical transition, a process which is typically hindered by several kinds of uncertainties, such as technology, market dynamics, economic constraints and regulatory gap, which are often framed in the literature from a multi-level perspective (MLP) [8]. Within this approach, strategic niche management (SNM) [9] has been developed to manage the socio-technical transition process. SNM is a theoretical approach aimed at explaining and modelling the factors affecting the development and establishment of an innovation niche, which is defined as a temporary "protective space" for the configuration and development of this type of innovation [9,10]. More specifically, sustainability transitions research emphasises the role of niches as a source for path-breaking innovation. A defining characteristic of these niches is that they afford temporary 'protective space' for the configuration and development of such innovations [9,10]. Initial protection is deemed essential, because path-breaking innovations fail to successfully compete within selection environments embodied in incumbent socio-technical regimes. Hence, the protective space is needed to shield the innovation against (some of) the prevailing selection pressures. Within this protective space, niche actors can nurture the path-breaking innovation so it becomes more robust through performance improvements and expansions in supportive socio-technical networks" [11].

The approach is based on a long-term vision, as a frame to define objectives and develop strategies [12,13]. In this process, the involvement of local entrepreneurs is a key issue to achieve the needed level of convergence of expectations, as it reduces the uncertainties and the risks of failures related to the "ungovernability" of the transition process [14–16], due to the complex interplay of the actors involved and the pressure exerted by a multitude of exogenous selection forces.

In this paper we focus on agro-food waste valorization conceived as a long-term, complex socio-technical process involving many actors (e.g., entrepreneurs, researches, investors, extension services, public authorities) belonging to multiple levels (i.e., technological landscape, socio-technical regime and innovation niche). This process is typically affected by a series of uncertainties hindering actors' cooperation, which is crucial for achieving the transition [15]. This uncertainty stems both from the unavoidable risk of the investment into the novel technology, and from the indeterminacy of the interaction among involved actors moved by diverse interests. According to the literature [15,16], a success factor for overcoming these barriers is represented by the convergence of stakeholders' expectations, which occurs when they share a common vision towards the potentiality of the new technology in catching some promising opportunity. This creates the premises to the creation of the agenda setting, which represents the binding commitment of the local stakeholders to the realization of the long-term strategy to develop the technological niche. In other words, the agenda represents the formalization of the coordination efforts among the actors involved in the innovation process.

Until now, this framework has been mainly used to understanding the process of technological development and to draw lessons from the past (i.e., positive approach). On the contrary, we believe that there is a great potential for possible adoption of the framework as a normative tool, which may play a determinant role in steering the innovation process in the desired direction. In this respect, the aim of this paper is to translate the SNM framework into practice by proposing an operational tool capable of designing the strategy based on the entrepreneurs' knowledge. The study case describes the case of the Apulia Agro-Food Technology District (DARe), which is a consortium aimed at promoting the technological innovation of SMEs in the agro-food sector in the Apulia region (Southern Italy), and which aims to promote a bio-based industry for food-waste valorization. The DARe district has been successful in promoting the innovation of associated SMEs to enhance their competitiveness, but it needs a methodology for defining a specific strategy based on a strong commitment of stakeholders to take advantage of the new opportunities related to the biorefinery development. We apply a combination of SWOT (strengths, weaknesses, opportunities, threats) analysis and a strategic orientation round (SOr) to stimulate the direct involvement of the stakeholders according to a science-based approach.

This study presents a concrete example of how to define the agenda for a technology district through a rational process enabling the sharing of knowledge (that is vague and verbal in nature) held by the entrepreneurs. This will overcome the bounded rationality which was addressed in [17] as one of the main factors determining the failure of the decision-making process characterized by multi-stakeholder interplay.

In Section 2, the theoretical framework of the socio-technical transition process is presented. In Section 3, agenda setting is performed by means of a SWOT–SOr analysis using a participatory approach. Section 4 focuses on the case study, while concluding remarks are provided in Section 5.

2. The Socio-Technical Transition Process in a Technology District

A socio-technical transition occurs when a new socio-technical configuration replaces the dominant regime. The suffix *socio-* highlights the profound change implied in this process, which goes beyond the mere technological dimension and includes changes in practices and institutional and cultural structures (e.g., regulatory frameworks, networks, practices, habits, social norms) [18]. Accordingly, along with the conceptualization of new products and services, new business models and organizations will also emerge to substitute the existing ones. Basically, these processes are heavily path-dependent, since the socio-technical configuration is formed from deeply rooted elements, limiting the probable evolution of the system [19].

The SNM approach implies a conscious and deliberate effort by the innovators to steer the change in the desired direction. Therefore, it also implies some degree of control and management in which entrepreneurs, as well as regulatory and authority institutions, are expected to play a major role. In other words, SNM has been defined as "the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation", to foster the future development of the novelty [9]. This protected space has been labelled as *innovation niche* and framed as the *micro-level* within the multi-level perspective (MLP), as defined in [8]. This analytical framework explains the occurrence of socio-technical transition as the interaction between the innovation niches and two other interrelated levels of the technological domain, namely the socio-technical regime and the technological landscape. The regime identifies the meso-level and represents the dominant socio-technical configuration, fulfilling a specific social function (e.g., education, electricity and water supply, food supply, health care). The technological landscape is the macro context, formed from deep structural trends (e.g., natural resources and the material and immaterial context of societies). The innovation niche operates according to three fundamental mechanisms: (i) convergence of expectations, (ii) networking, and (iii) learning. Briefly, the *convergence of expectations* refers to the process of formation of a guiding vision that defines, contextualizes the novelty and explicates the advantages (supposedly) brought to the involved entrepreneurs. Accordingly, this mechanism leads to the formation of a critical mass of innovators [20]. The *networking* mechanism refers to the formation of a coalition of innovation actors (i.e. firms, research centers, consumers, third sector organizations, institutions), which will play a crucial role in the collection and mobilization of strategic resources [21]. Finally, the *learning* mechanism includes learning-by-doing and learning-by-interacting, which occur when the network of innovators conducts experiments related to the novelty and shares the lessons learnt.

2.1. The Role of the Convergence of Expectations in the Agenda-Building Process

The basic assumption underlying this paper is that economic agents join the innovation niche according to their expectations [22] and the critical mass is reached when the convergence of their expectations occurs [23]. To break down the process of formation and convergence of actors' expectations, in this study, we adapt and stress the theoretical cycle proposed in [23] (Figure 1). According to our proposed model, elements which are external to the niche (i.e., developed and shaped at landscape and regime level) create the opportunities (*R1*) for developing a new technology. Some examples of these external elements are: cultural change, resource depletion, regulation change, R&D

breakdown. Subsequently, public and private actors, typically consultants and extension services, translate these opportunities into promises (e.g., sustainable development, profit, quality of life) (*R2*) deriving from the adoption of the new technology.

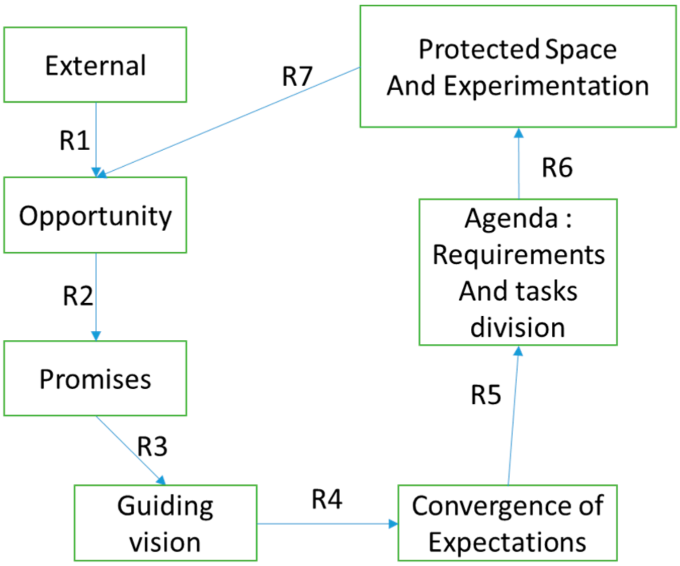

Figure 1. Expectation convergence cycle. Source: adapted from [23].

The term *promises* implies that the new technology lacks a clear market and functionality but presents interesting development potential. When the promises framed in the vision are widely shared among the key actors (i.e., investors, entrepreneurs, managers, opinion leaders), they become constructive forces capable of enrolling them and their resources for specific roles. The key actors develop and share a guiding vision (R3) which paves the way to the convergence of their expectations (R4). The convergence of expectations, in turn, is the basis on which the formation of a new business is carried out.

On this basis, stakeholders develop a "to-do list", i.e., the agenda formed of task division, requirements and specifications (R5) [24]. This agenda exerts a binding effect on the enrolled actors. Accordingly, investors and authorities define the protected space, i.e., the innovation niche, to carry out the activities and experiments needed to develop the novelty (R6) [13,21]. Finally, the experiments and the activities will dynamically and continuously change the expectations (R7), by confirming or reducing the opportunities, in a sort of a "closed" loop. The meaning of closing the loop relies on the fact that the experimentation conducted within the protected space will enable actors to clarify and achieve a better understanding of the initially identified opportunities. Accordingly, they may operate a sort of "fine-tuning" of their expectations and, therefore, a new cycle may arise. In this process, both the external factors and actors' characteristics, in the initial and subsequent phases, respectively, will affect the original vision.

In the next section, an in-depth description of the role of internal and external factors is contextualized within the technology district study case.

2.2. External Factors

According to the theory of socio-technical transition, niche development is initially promoted by external factors (e.g., breakthrough in R&D research), or external circumstances (e.g., change in regulation or in resource endowment), which may create opportunities for new technology development [25]. The literature identifies various dimensions of change, such as technological, material, institutional and political, economic and socio-cultural [18]. Within the technological dimension, some relevant elements are represented by technical norms, technological knowledge, technological complexity and appropriability [18,26]. The material dimension includes artefacts, hardware and infrastructures, and complementary infrastructures. Examples of institutional and political factors include regulations, standards, law enforcement, institutional efficiency and the command of legitimacy. The typical economic elements are consumers' willingness to pay for new products and/or services, pricing, competition, contracts, taxes and charges, and profitability. Finally, within the socio-cultural dimension, there are norms, conventions, changes in broad social habits and cultural attitudes [8], and other social factors commonly referred to in the literature as social capital [27].

The same categories are classified by [26] in two main groups of pressure that can foster socio-technical transition. On the one hand, there are the typical economic factors that affect tangible changes at the firm level, such as competition, profitability, pricing, taxes and charges, skills and knowledge, contracts, regulations. On the other hand, there are less economically tangible factors emanating from conventions, institutional structures, political economic "landscapes" and general sociocultural attitudes. Often these factors generate opposing stimuli to the transition process. Sometimes these stimuli can hinder the process of change, while on other occasions they exert coherent pressures, giving a clear orientation to the transition.

2.3. Actors' Characteristics

Various theoretical as well as empirical studies have investigated factors internal to a district and to its firms, and the role they play in shaping the innovation process [28,29].

In the context of the agro-food sector, innovation can be studied both as a process of development and change [30,31], and as a firm's ability to satisfy the needs and preferences of its potential customers by using its own resources, skills and capacities [30,32].

2.3.1. District's Own Characteristics

The institutional, technological and political environment of the area in which a district is based plays a role in determining whether a region is a potentially innovative milieu [33]. The dynamism of the area in which firms operate, activated by the presence of universities, public research centers, industry associations, technology support services, membership of other types of networks, industrial policy and food legislation, contributes to the innovative behavior of firms [33].

Chain and network relations can influence the decision of a firm to innovate and, in particular, to outsource innovation [34–36]. These relations include the linkages between the agro-food firm and other actors in the food chain and may reflect firms' attitude of entering into formal and/or relational networks (consortia, production-based associations, manufacturing joint-ventures, informal contracts). The positive influence of such "networking" attitudes on innovation capacities is activated by the sharing of information and "know-how", the reduction of uncertainty and the increase in economies of scale for the involved firms [31].

Proximity, not only geographical but also organizational, social, institutional and cognitive, has an important impact on learning, knowledge creation and innovation [34], since it reduces uncertainties and facilitates interactive learning and innovation through coordination. However, proximity may also have some negative impacts on innovation, creating a lock-in problem, which refers to a lack of openness and flexibility [37].

Finally, innovation processes in districts may also depend on macroeconomic factors, such as market size and demand growth, which may represent an incentive to innovate [38,39].

2.3.2. Firms' Own Characteristics

Generally analyzed in terms of number of employees or an economic dimension (mainly income or turnover indicators), firm size is often indicated as a key factor in explaining the role of organizational complexity, effort in R&D and market power. According to the literature [29,40–42], large firms are more likely to innovate than small firms are. However, empirical studies have reached apparently contradictory conclusions, mainly due to the different measurements of innovation and different sampling methods used.

Firm age (number of years since establishment) is also highlighted as a key factor, since it serves as a proxy for companies' experience, know-how, accumulative processes and dynamicity [43]. The role of firm age, however, has been controversial in the literature. Some studies show a higher inclination to innovate for old firms, while some others have considered young enterprises as more active in the direction of innovation [36].

Organizational features linked to the internal governance of firms also play an important role in promoting or hindering their innovative behavior [28]. The level of decentralization of decision-making inside the firm [44], for example, might explain its flexibility and adaptability to changing conditions in terms of internal governance. Undoubtedly, knowledge plays a crucial role in shaping the innovative behavior of a firm, as it is a crucial input that may stimulate the firm's innovation performance. For instance, human capital endowment (e.g., highly qualified employees, employees dedicated to R&D activities) is expected to influence the decision to innovate and how [44,45].

However, due to limitations of their scale and (financial) capital, many firms often cannot afford to develop and build up all the knowledge they need. In this case, they can benefit from knowledge spillover from other firms or external institutions. In this regard, absorptive capacity is defined in the literature as the ability to recognize the value of new, external information, to assimilate it and to apply it to commercial ends, and it represents a critical component of firms' innovative capabilities.

A firm's absorptive capacity does not simply depend on its direct interface with the external environment. It also depends on transfers of knowledge across and within subunits [46]. In this process, information and communication technologies (ICT) can be an asset for a firm as it decides (if, when and how) to innovate. Extensive internal and external communication networks increase the firm's absorptive capacity to facilitate the necessary scanning and integrating activities when firms acquire knowledge and technologies from outside their boundaries [45].

Another variable which is recognized as strategic is represented by the proprietary and ownership features. Small and medium-sized enterprises are mostly family-owned in many economies [47]; this is particularly true for agro-food firms. Similarly to other firms, in order to be competitive, family businesses have to be innovative. On the one hand, their relatively smaller size, greater (local) market knowledge and relative financial independence compared to large companies [48] play a positive role in enhancing their innovative behavior. On the other hand, family firms may be ill-equipped to build innovation capabilities; they may have limited financial resources, and/or their family members may be overly concerned with wealth preservation, thus limiting their investments [49]. The attitude of firms towards risk is another element that exerts an impact on their innovative behavior. Although little is known about the effect of uncertainty on entrepreneurial investment decisions, entrepreneurial households appear incapable of diversifying the risk of their business [50]. Studies demonstrate that the effect of uncertainty on entrepreneurial innovation is quantitatively significant. Risk-loving entrepreneurs are reported to invest in product innovation with larger potential impact on firms' revenues, whereas risk-averse individuals appear to select product innovations that affect firm growth less intensely [51].

The factors explained in this section and summarized in Table 1 were used as input to the analytical model, the SWOT-SOr matrix, whose application is reported in Section 3.

Table 1. The structure of the methodological framework.

External-to-District Factors	Internal-to-District Factors	
	District's Own Characteristics	*Firms' Own Characteristics*
• change in regulation or in resources stocks • technical norms • technological knowledge • technological complexity • appropriability • regulations, standards, law enforcement • institutional efficiency • consumers' willingness to pay for new products • pricing • competition • contracts • taxes and charges • profitability • norms, conventions • changes in broad social habits and cultural attitudes • social capital	• institutional, technological and political environment • presence of universities, public research centres • presence of industry associations, technology support services • industrial policy and food legislation • chain and network relations between the agro-food firm and other actors in the food chain • attitude towards entering formal and/or relational networks • proximity, not only geographical but also organizational, social, institutional and cognitive • market size • demand growth	• firm size • firm age • level of decentralization of decision-making • human capital endowment • financial capital • knowledge spillover • information and communication technologies (ICT) • internal and external • communication networks • ownership features • attitude of firms towards risk

Source: our elaboration.

3. Methodology

In this section, we present a methodology to effectively manage the process of formation of a desired agenda and to guide stakeholders towards the setting of one. With respect to the development of shared visions, SNM has been used mainly to represent the "past within the present" in order to learn lessons on success or failure of innovation diffusion. The novelty element of this study relies on the representation of the "future in the present", that is, the adoption of SNM as a normative tool, to shape the convergence of actors' expectations in a desirable way. This implies the analysis of the elements framed in Figure 1 (Section 2.1.) In agreement with the socio-technical transition theory, the method is based on the following assumptions:

(a) The convergence of expectations occurs at a local level; the method does not consider the expectations of the whole community, but only those of a specific group of actors capable of analyzing the possible future in a context of strategic planning;
(b) Local actors possess knowledge on the best strategies to foster the local economy, which cannot be captured by third parties (analysts or policymakers);
(c) The stakes are multiple: the resources endowment needed to promote the transition is fragmented; a pool of innovation actors is needed, and each of them wants to represent his or her categorical stake;
(d) External factors affect the development of the new technology;
(e) The opportunities represented by the novelty are the prime mover of the agenda-building process;
(f) The actors involved are able to translate the opportunities deriving from the novelty into a well-defined promise, by means of their interaction;
(g) The actors involved are capable to identifying the actions and measures (the strategy) needed for the transition, according to their shared vision.

In order to interact with the real agents, we conducted an in-depth interview and applied a semi-quantitative method of analysis, the SWOT-SOr, to generate strategies of possible future paths. The SWOT-SOr consists of two complementary tools for conducting strategic analysis: the SWOT (strengths, weaknesses, opportunities, threats, which is qualitative) and the strategic orientation round (SOr, which is semi-quantitative).

The idea to focus on the interaction between S/W and O/T was firstly proposed by [52], who developed the TOWS matrix (Table 2). It encompasses a logical framework for identifying four strategies derived from the combinations of the S/W and O/T. Afterwards, the TOWS matrix was improved by Igor Ansoff and the French consulting firm Société Eurequip [53] by introducing a scoring method (SOr) to evaluate the four resulting strategies. SWOT-SOr has also been applied in the analysis of the relevance of food firms' participation in regional networks in explaining innovation [54]. Ref. [55] applied this methodology to define a local strategy in the Apulia region, aimed at fostering tomato crop production while pursuing sustainable use of water resources.

Table 2. Strategy generation in the TOWS matrix.

	Opportunities (Os)	**Threats (Ts)**
Strengths (Ss)	*maxi-maxi* *Do Ss help us to grasp Os?*	*maxi-mini* *Do Ss help us to defeat Ts?*
Weaknesses (Ws)	*mini-maxi* *Do Ws prevent us from grasping Os?*	*mini-mini* *Do Ws prevent us from defeating Ts?*

Source: adapted from [52,56].

With respect to other multicriteria methodologies, the SWOT-SOr provides a clear strategic frame, easing the discussion about the novelty which may easily be understood and communicated to the entrepreneurs involved, and, therefore, facilitates the convergence of expectations. Though it might be difficult to involve a large number of experts in order to get a statistically significant result using a quantitative analysis, the methodology may be considered a semi-quantitative technique that helps participants to compare their opinions, to reconsider their evaluation and to attain a shared vision.

In our study, we followed three basic stages:

(i) SWOT analysis, which relies on the identification of the strengths and weaknesses of the agro-food technology district, and the opportunities and threats represented by the external conditions. The internal strengths and weaknesses and the external opportunities and threats have already been shown in Table 1.

(ii) Strategy generation through TOWS matrix and SOr analysis for strategy selection, which refers to the selection of the most relevant actions to have emerged from the combination of the main interaction between the S/W and O/T variables. From an operational point of view, each interaction is weighted by means of semi-structured interviews with opinion leaders and experts of the bio-refinery sector, who were asked the questions reported in the quadrants of Table 2.

The weight values range between 0 (no interaction) and 3 (maximum strength of the interaction) for each combination of the S/W with O/T, resulting in 100 possibilities (i.e., 5 strengths and 5 weaknesses, combined with 5 opportunities and 5 threats).

In order to standardize the magnitude of weights among respondents, we limited the sum of weights in each row to a maximum of 12. In most of cases, this forced respondents to reconsider their initial evaluation and to reformulate the weights of each combination. The sum of rows and columns provides a first overview of the relevance of the strengths or weaknesses and opportunities or threats, respectively, affecting the strategy development. In addition, the sum of weights of each quadrant indicates the strategic orientation. Specifically, the dominant quadrant (i.e., the one with the higher sum) represents the core strategy according to the interpretation provided in Table 3.

Table 3. Identification of the strategic orientation.

	Opportunities	Threats
Strengths	*If we have good Ss to grasp Os: Attack!*	*If our Ss enable us to fight Ts: Defend!*
Weaknesses	*If we have too many Ws to grasp Os: Change!*	*If we have too many Ws to grasp Os: Clean Ws to face the Ts; Face the crisis!*

Source: [56].

(iii) Identification of strategic actions to be undertaken within the core strategy. We performed a ranking of each combination of the S/W with O/T. Firstly, O/T are ordered according to their total score. Secondly, the highest score within the cells of the column of each O/T within the selected quadrant is considered; it will identify the combination of S/W_O/T, which corresponds to a specific action.

4. Case Study

4.1. The Apulia Agro-Food Technology District (DARe)

The Apulia Agro-Food Technology District (DARe) was formally constituted in 2006, as a public-private institution whose mission was aimed at fostering the technological innovation of agro-food SMEs. It stems from the Italian government's innovation policy, aiming at the promotion of local aggregations of activities with high technological content and the synergistic integration of science, research and business. Through this initiative, national and regional authorities sought to promote innovation within the agro-food industry, a system that plays a crucial role in the economy of the Apulia region (Table 4).

Table 4. Contribution of agriculture and food industry to the regional and national economy.

	Apulia	Italy
Agriculture contribution to GDP	4.40%	2.31
Food industry contribution to GDP	1.81%	1.90%
Food industry contribution to manufacturing sector	14.75%	10.50%
Food industry contribution to total industry	11.66%	9.18

The most relevant actors of the agro-business sector that were able to boost the Apulian innovation system became members the DARe district. DARe supports the diffusion and adoption of innovation through the continuous growth of its organization and promoting the sustainable economic development of the Apulia region. The main activities rely on the generation, sharing and transfer of innovation through networking between public and private actors in the research and business domains. The strategy focuses on obtaining funding opportunities at the EU, national and regional levels to support technology transfer projects shared among public and private stakeholders. The large stockholder basis, the skills and competences gained in more than 12 years of experience and 14 highly trained professionals are strong points of the Cluster. Accordingly, the expected outcome relies on the promotion of scientific excellence, the improvement of the production system competitiveness, the attraction of new investments and support policy choices.

To secure solid governance, the initial financial own capital, provided by the shareholders, was about 500,000 Eur, which was equally distributed between public and private members. Forty-nine percent of DARe's equity is held by five regional universities, eight public research institutes and six local authorities. Among private actors, the district counts 7 associated firms and 102 food and food-related private companies, whose main features are shown in Table 5.

Table 5. Main features of private companies in the Apulian food district.

	Equity	Turnover	Employees
Average (Euro)	3.553.564	25.186.991	79
Min (Euro)	7.747	1.250	1
Max (Euro)	157.938.746	794.038.580	2.000
Distribution of firms	<50 KEur: 27% 50-100 KEur: 25% 100-500 KEur: 15% 500-1.000 KEur: 13% 1.000-3.000 KEur: 13% > 3.000 KEur: 7%	<1Meuro: 19% 1-2Meuro: 11% 2-5Meuro: 24% 5-10Meuro: 13% 10-50Meuro: 23% >50Meuro: 19%	1-9: 20% 10-24: 31% 25-49: 20% 50-99: 11% 100-249: 13% >249: 9%

Source: our elaboration on DARe data.

Since its formation, the district has managed 69 R&D and technology transfer projects (funded by 60 million Eur) and promoted and supported the creation of three spin-offs and two innovative firms.

At the same time, DARe has registered an average turnover of 583,420 Eur, with a permanent staff of 14 employees and many others temporary collaborators.

4.2. The SWOT-SOr Analysis

We conducted semi-structured interviews with three representatives (firms), two staff members of DARe and four experts selected for their knowledge of food waste management within the domain of the agro-industry sector.

The interviews allowed the identification of the following five most relevant strengths (S): S1. Size of business: expressed in terms of annual turnover; S2. Availability of scientific knowledge within the members of the technological district; S3. Readiness of firms to catch opportunities deriving from innovation policies; S4. Ease of obtaining support from technological transfer-supporting services; S5. Reliability of the DARe district as an innovation broker.

Subsequently, the five most relevant weaknesses (W) were identified: W1. Poor flexibility and adaptability of firms' governance (capacity to change and adapt); W2. Family-based character, limiting governance capacity, and affecting the manager recruitment mainly based on family relationships rather than real skills and capacities; W3. Poor absorptive capacity (firm's ability to recognize the value of new information, assimilate it, and apply it to commercial ends); W4. Scarce interactions and relationships among the food enterprises; W5. High risk aversion.

In order to identify external forces, we conducted semi-structured interviews with a different set of experts and local entrepreneurs (N = 14) selected in the domain of agro-food waste management and bio-based economy. Among the most relevant opportunities (O), the following 5 aspects were identified: O1. Growth of the potential demand for biomaterials (e.g. fertilizers, surfactants and polymers) originating from bio-organic substances; O2. An abundance of organic wastes and residues, which are concentrated in industrial sites; O3. Enforcement of environmental legislation (i.e., monitoring and sanction of irregular or illegal food waste management); O4. Availability of public financial support for the development of bio-refinery schemes; O5. Availability of a large mass of technical knowledge on food waste management and processing, and on green chemistry.

Finally, the five most relevant threats (T) were identified: T1. Low quality and efficiency of public administration; T2. Low endowment in terms of social capital (i.e., trust between firms, public institutions, and social groups); T3. Difficulty with the patentability of inventions in the field of food waste management; T4. High specificity and complexity of technical knowledge related to green chemistry; T5. Scarce profitability of investments in food waste management compared to other food technologies.

Afterwards, we interviewed some opinion makers (N=9) with knowledge of the DARe district and competence in the bio-economy domain. The aim was to evaluate the effectiveness of strengths and weaknesses in, respectively, capturing the opportunities and preventing or mitigating the threats. The results are summarized in the SWOT-SOr matrix presented in Table 6, which reports the mean values of all individual scores.

Table 6. SWOT-SOr matrix.

	Opportunities (O)						Threats (T)						
	O1	**O2**	**O3**	**O4**	**O5**	***Subtotal S, W***	**T1**	**T2**	**T3**	**T4**	**T5**	***Subtotal S, W***	***Total Score S, W***
Strengths (S)													
S1	**1.42**	**1.71**	1.11	1.27	1.20	6.70	0.38	0.90	1.22	1.22	0.90	4.63	11.33
S2	1.05	0.65	0.60	1.56	1.34	5.21	1.01	0.83	1.65	2.14	0.38	6.01	11.22
S3	1.25	0.71	0.90	1.00	**1.91**	5.77	0.92	1.08	0.66	1.75	0.93	5.34	11.11
S4	1.14	0.92	0.79	**1.63**	1.58	6.06	0.94	0.95	1.00	1.69	1.01	5.60	11.67
S5	1.33	0.69	**1.20**	1.44	1.52	6.17	1.11	0.95	1.22	1.43	0.97	5.67	11.85
Subtotal O,T	6.19	4.68	4.60	6.90	7.54	**29.92**	4.35	4.71	5.76	8.24	4.20	**27.26**	57.18
Weaknesses (W)													
W1	0.99	0.59	0.92	1.47	1.41	5.38	**1.54**	1.03	0.95	1.25	1.66	6.44	11.82
W2	0.99	0.81	0.81	1.40	1.26	5.27	1.32	0.81	0.66	**1.47**	1.80	6.06	11.33
W3	0.66	0.37	0.81	1.29	1.26	4.38	1.25	1.14	**1.06**	**1.47**	1.25	6.18	10.56
W4	1.30	1.00	0.70	1.07	1.59	5.67	1.44	**1.67**	0.74	1.26	1.11	6.22	11.89
W5	1.03	0.71	0.71	1.72	0.94	5.11	0.74	1.08	0.71	1.05	**1.96**	5.55	10.67
Subtotal O, T	4.97	3.48	3.96	6.95	6.45	**25.81**	6.31	5.72	4.13	6.51	7.79	**30.45**	56.27
Tot.score O, T	11.16	8.16	8.56	13.86	13.99	55.73	10.66	10.43	9.89	14.75	11.99	57.71	113.45

Source: own elaborations.

By observing the subtotal values of all 4 quadrants, it emerges that the highest scores are reached by the upper-left (score=29.92) and lower-right (score=30.45), whose score value is not significantly different. This means that the best strategy is twofold. On the one hand, the strategy should be based on tailored actions for "pioneers", firms whose strengths are capable of capturing the opportunities (*Attack!*). On the other hand, it should include actions for "laggards", that is, firms whose weaknesses worsen the effect of threats (*Face the crisis!*).

In order to identify the priority list of actions forming the core strategy for "pioneers" (upper-left quadrant), we ordered the Os according to their total score: O5 (7.54), O4 (6.90), O1 (6.19), O2 (4.68), O3 (4.60).

Secondly, we ranked the cells of the upper-left quadrant (marked in bold face, Table 6), in decreasing order:

S3_O5 (score=1.91): Promotion of RST initiatives on key technologies.

S4_O4 (score=1.63): Targeted and specific public communication initiatives.

S1_O1 (score=1.42): Market trend analysis and competitive position analysis.

S1_O2 (score=1.71): Information initiative and technical training to promote the use of bio-based products in agro-food firms.

In practice, they indicate the priority list of actions which must be included in the agenda building, in order to boost the initiative of "pioneers", and enable them to capture the main opportunities.

Similarly, with respect to the strategy for "laggards" (lower-right quadrant), the identification of the strategy depends on the ranking of Ts: T5 (7.79), T4 (6.51), T1 (6.31), T2 (5.72), T3 (4.13).

Secondly, the rank of the cells belonging to the lower-right quadrant (marked in bold face, Table 6), in decreasing order are:

W5_T5 (score=1.96): Promotion of dissemination events and organization of training initiatives.

W2_T4 (score=1.47): Collaboration with universities and consulting companies to support SMEs.

W3_T4 (score=1.47): Selection of targeted consulting and training activities to specific needs of firms.

W1_T1 (score=1.54): Reinforcement of extension services.

W4_T2 (score=1.67): Specific extension services.

W3_T3 (score=1.06): Collaboration with universities and other private and public research bodies.

The agenda that emerged from this analysis is complex and diversified, and therefore would require a strong commitment from the district in order to promote the sharing of information and knowledge among stakeholders. Needless to say, stakeholders must change their reluctance to cooperate and collaborate towards the common goal. In fact, this is coherent with the mission of the District, which already provides a set of services to the firms, and is also able to play a relevant role in the promotion of an active dialogue with policymakers.

5. Conclusions

In this paper we stressed the relevance of the management for the transition towards a desired technological configuration to outline a long-term vision. This issue is particularly relevant for the development of the bio-refinery industry, since the setting of an agenda will mitigate the uncertainty related to the formation of a new business. In order to achieve this aim, we used the case study of an agro-food technological district facing the opportunity of food waste valorization by creating a new biorefinery industry. We proposed a rational and science-based methodology to identify actions to be included into an agenda, to favour the coordination of all actors involved in the innovation niche.

According to the results of the study, some conclusions can be drawn. Actors were not initially concerned about the production and disposal of food waste, as they are used to dealing with it by means of technical equipment and consolidated partnerships with downstream firms specialized in food waste disposal. They will be keen to change their organization only in case an innovative system would bring a relevant reduction of costs or a remarkable opportunity to expand and diversify their business.

The paper contributes to overcoming the novelty and uncertainty related to the development of a technological niche in a protected space, up to a market and self-sustainable scale. In order to achieve the desired technological change, strong cohesion of all stakeholders is needed. Specifically, stakeholder participation and the aggregation of relevant agents operating in the agro-food sector (i.e., public institutions, private firms, consultants, etc.) into a technological district represents a favourable condition and guarantees a better understanding of the learning theoretical prerequisites for promoting new technology [57].

However, the identification of a common strategy among actors who are heterogeneous and pursuing different goals requires a complex process of participation and methodologies which are able to disentangle this complexity in a rigorous and transparent manner. Therefore, stakeholder engagement and public participation are considered as central to effective strategy building [58,59]. The stakeholder's heterogeneity in perspectives and knowledge seems to have positively contributed to designing a strategy that is better suited to serve public needs. The basic rationale for stakeholder and public participation is reflected in better decisions and plans, improved implementation and compliance, more beneficial social outcomes, greater legitimacy of planning processes as compared to top-down, administrative decision-making [58]. All these considerations suggest the opportunity to organise periodic meeting with stakeholders to encourage them to participate in these kinds of activities, thus enriching their mutual trust. This consideration is particularly relevant when managing particularly sensitive issues as the valorization of agro-food waste, for the severe consequences that improper waste management systems can pose to the environment and society. Indeed, uncontrolled food waste decomposition may cause serious contamination of the environment and significant soil and water pollution, as well as aggravation of climate change by increasing greenhouse gas emissions. In this way, a further positive effect is the opportunity to shed light on the "grey zone" of illegal activities characterizing the current waste domain [60].

The scoring method of the SWOT-SOr, applied on data collected from stakeholders, experts and opinion makers, provides a rational and logical basis for the selection of the most robust and promising strategy. Notwithstanding the potential difficulties related to the engagement of relevant stakeholders and entrepreneurs who are not familiar with the novelties proposed, the SWOT-SOr might be used as a tool to assist a bottom-up approach leading to the convergence of expectations of the involved actors, a preliminary step towards the development of a technological niche.

The knowledge generated in this process may contribute to drawing the hidden embedded knowledge held by local actors, with a positive effect on the reduction of the bounded rationality problem. In addition, a positive effect is expected towards the mitigation of frictions and stickiness associated with knowledge transfer, which are among the failures in the decision-making context [17].

This approach is suitable for framing an original strategy tailored to the specific context. In fact, while in previous experiences [53,55], the SWOT-SOr method typically led to a univocal strategy, in this work we found an unexpected (though possible) twofold strategy targeted to both innovator and laggard firms. The added value of the approach is related to its capacity to collect and merge pieces of knowledge in a rational way, leading to the establishment of an influential agenda as a main tool for guiding efforts.

The policy implication lies in the need to address public funding schemes towards more intensive dissemination and demonstration activities (including extension) in order to exploit scientific knowledge and to encourage entrepreneurs towards the bio-refinery sector. Further development of this study will include the validation of the outlined strategy by the entrepreneurs of the technological district.

What we learnt from this case study represents a valuable outcome that can support practitioners, policymakers and researchers who are generally reluctant to consider long-term strategies, by encouraging them to accept a common framework to set an innovation agenda and to become engaged in innovation niche development.

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