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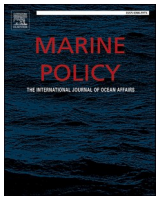

Technological innovation in fisheries and aquaculture: What are the "discourses" of the Italian policy network?

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ABSTRACT

This paper aims to explore the point of view of experts of the Italian policy network of the fisheries and aquaculture sectors on technological innovation. This type of research is still very recent and unexplored, and it is important to stress that most studies have been conducted to primarily analyze the point of view of producers. Over the past decades, there has been a growing recognition that the adoption of new technological innovation in the fisheries and aquaculture sectors should consider the perspective of all the stakeholders acting on the captured or farmed resource. The perspective of the experts involved in the political processes, or, in other words, the view of the "policy network" remains a largely unexplored field of analysis which deserves much more attention. With this purpose, the Q methodology is highlighted as an effective strategy for examining the policy network's perception toward technological innovation. The findings pointed out four macro discourses summarised in two main approaches to innovation: conservative, for which technological innovation is merely seen as a tool, the potential of which can be found in the perspective of improving a company's management; and progressive, which recognizes a wider effectiveness of innovation, even outside the functional unit of the company. The results could provide new insights to understand the people-policy gap in blue sectors, prompting European policymakers to rethink existing policies to stimulate the diffusion of innovative technologies.

1. Introduction

Policymakers in Europe are increasingly endorsing the blue economy (BE), inspired by the Commissioner for the Environment, Fisheries and Maritime Affairs Virginijus Sinkevičius, who posits that "to be truly green, we must also think blue".[1] Aquaculture, fisheries, port and shipbuilding activities, tourism and maritime transport are all BE sectors that should contribute to a successful green transition. Therefore, core aspects of policies related to BE strategy are located in different and partially contrasting policy areas, with a predominant focus on marine/coastal environments [1,2].

The effectiveness of these "blue policies" relies on a diversified set of dimensions and actors, which represent the architecture of what we identify as the policy network (PN). A PN refers to *"a set of informal and formal interactions between a variety of usually collective public and private actors, who have different, but interdependent interests, engaged in horizontal, relatively non-hierarchical discussions and negotiations to define policy alternatives, or formulate policies, or implement them"* [3], p. 11608). According to the definition of Coleman [3], we point out that policy network is a puzzle composed of people operating between the private and public sectors in a context that is essentially institutionalised to be pieced together. Three layers makes up the puzzle:

- the first, represented by components that actively influence policy formation, such as policy makers or directors of agency/authorities in agrifood systems;
- the second, made up of the so-called intermediate bodies, such as trade associations;
- the third, which includes all those actors of civil society, who participate directly or indirectly in the process of policy creation itself, such as academics or citizens, whose relevance has gained ground in recent years.

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Like the pieces of a puzzle, they all become integral parts for the clear formation of the overall image, thus rebalancing the importance of the layers, placing them on the same level and not hierarchically.

Indeed, as pointed out by Leifeld and Schneider [4], the idea behind a PN is that policy making can be influenced by interdependencies between organized governmental and non-governmental actors, who maintain relations grounded on the exchange of resources or information, influence attribution, or common group membership. Consequently, the analysis of PNs is framed within the context of collective decision-making [5].

A policy network can be said to be effective when, by involving the views of all private and public actors, it performs the strategic task of stimulating knowledge transfer and innovation adoption [6,7]. Effectiveness depends on a multiplicity of aspects: the inclusion of stakeholders in the policy discussion [7], the "openness" of the network [8] and the individuals' perception of the potential results of the political process, such as intervention, cooperation, pressure and concertation [9].

Failure to consider the perspectives of all parties involved can prevent the resolution of the "people-policy gap" when discussing the blue revolution, technological progress, or market innovation. This can result in the implementation of ineffective or harmful policies for the fisheries and aquaculture industries [10,11,67]. Green et al. [11] particularly recognized this gap in their study of Oregon shellfish farmers, emphasizing how the networking and participation of all stakeholders in building regulations, licensing, and policies can support the advancement of the sector.

Stakeholders' opinions to address fisheries and aquaculture management and policies is not a new topic. For instance, by applying the Q-methodology (QM), Cavanagh et al. [12] analyze perceptions of three stakeholder sectors in the case of the Antarctic krill fishery. Bacher at al. [13] apply the same methodology to excavate stakeholders' perceptions of marine fish farming in Spain. Yu et al. [14] focus on the policy network, actors and their interaction in the policy-making process concerning China's Ocean ranching policy, by highlighting a "vertically managed" network.

Although these studies shed light on the complexity of the view of the fisheries and aquaculture policy network (FAPN), their perspective remains unexplored on many relevant issues. These certainly include the transfer of innovation [15,16]. The study of innovation has mostly focused on the adoption process from the standpoint of producers actively engaged in the primary operations of fisheries and aquaculture (e.g., [17]. The policy network's view on the potential of innovation to tackle future challenges has received insufficient attention.

This paper tries to fill that gap with the aim of understanding the perspectives of the Italian FAPN on the uptake of technological innovations.

Gathering the views of several actors of the Italian FAPN, so as to acquire the thinking of an "open" network [8], this study attempts to understand if there is a people-policy gap in perceiving the role of innovation for the blue transition. The "people view" will be investigated through the analysis of the literature on the adoption of technological innovation, analyzing the factors that drive or inhibit diffusion.

The present work is structured in three parts. The first part defines the concept of stakeholders' perception and its role in the process of innovation adoption in fisheries and aquaculture by identifying the "people" view. The second part describes the methodology proposed for the study of the policy network's view, the QM. The final part will be devoted to the results produced and the concluding reflections of the study.

2. Theoretical background

The aquaculture and fisheries sectors are required to make a great effort in order to understand actions to reduce the impact on the environment, on the one hand to reverse the intensification processes expressed by the linear approach, and on the other hand to protect biodiversity [10]. The "Blue Economy Model" – BEM (Gunter [18] aims to boost sustainability and is drawn on the functioning of natural ecosystems where cascade processes transform waste from one cycle into raw materials for another production cycle. The pursuit of this model fits in perfectly with the strategic actions taken by the EU to achieve the goals of the UN 2030 Agenda for Sustainable Development and the priorities announced by the European Green Deal, the EU Biodiversity Strategy and the EU Farm to Fork Strategy. The European legislator allocated 6.6 billion euros for the Operational Programme of the European Maritime, Fisheries and Aquaculture Fund 2021–2027 (EMFAF) and set out all the priorities according to the BEM, as called for in the European Commission's communication of 17 May 2021 [19]. How to better pursue the BEM purposes is under question and calls for innovative solutions.

Innovation has the potential to solve the conflict present in the BEM between growth and development and the protection of resources that make the identification of the scope and boundaries of the model and policies more complicated [20]. Wave and tidal energy, algae production, the development of innovative fishing gear or the restoration of marine ecosystems will contribute to the creation of new green business and job opportunities in the blue economy. In fact, the need to foster the deployment of innovative tools has become a key issue in priority setting. For example, priority 3 of the EMFAF ("*Enabling the growth of a sustainable blue economy and promoting the prosperity of coastal communities*") pays particular attention to the dissemination of technological innovations to pursue sustainable fishing and the renewed interest in economic and social development models inspired by the principles of the Blue Economy [19]. On the other hand, the fisheries and aquaculture sectors suffer from the low propensity of operators to change and introduce innovation due to numerous factors, which have been widely explored in literature (among others, [15]. The analysis of constraints of innovation adoption in fisheries and aquaculture is of paramount importance and has been mostly carried out through the lens of producers' perception of complexity. Perception is a concept belonging to the sphere of the "Self", which brings together a set of behavioural aspects such as motivation, relationships, emotion, and cognition [21]. Perception is often portrayed as how the farmer interprets reality and experiences, but it conceals much more multifaceted mechanisms. As Given [71] points out, "*Perceptions are influenced by the embeddedness of the context in which they reside*". Studies have revealed the complexity of the adoption process which has led many authors to explore the interactions between fish farmers, the institutional context and innovation [16].

As a matter of fact, the concept of "*perceived complexity*" is a context-related dimension, and it has already been applied to both the agricultural [22-24,68] and the fisheries and aquaculture sectors [17]. Drawn on Welter's [22] definition of context, we identify two main elements: the "who" and the "where" context.

As far as the "who" context is concerned, age, education and company size represent the main variables to be considered. As clearly shown in literature, young people are generally more likely to adopt innovations. In most cases, young entrepreneurs are also characterized by a higher educational background, which is well combined with a positive attitude towards innovation [26]. However, where older people are recognized as adopters, they experience much higher levels of adoption than younger people, who frequently stop at purchasing the tool without implementing it [26]. Regarding the company's size, large businesses usually show a higher propensity to adopt, as they tend to diversify and have greater financial availability. Whereas small companies, for which there is greater difficulty in accessing economic resources, are more likely to adopt where fishing is the predominant activity [27,28].

As far as the "where" context is concerned, it involves not only the territorial context, such as urban or rural areas, but it also includes the institutional context (both formal and informal) in which the innovation

is embedded. The socio-cultural dynamics explored by Blythe et al. [29] and Joffre et al. [16] reveal the strong influence exerted by the information sources (e.g., neighbours, fellow farmers, cluster farmers, friends, extension services) from the phase of awareness of the existence of the innovation to the final decision to purchase. For example, belonging to an aquaculture cluster increases the possibility of adoption [16]. Moreover, as emphasized by original institutionalists, culture, conventions, and habits exert an influence in this process [30]. The difficulty in accessing equipment, training and raw materials (feed, fries) is another factor impeding the innovation uptake. Finally, the support of local institutions can certainly create a fertile ground for anchoring innovation in a given context [15,27]. Therefore, within the "where" sphere, formal institutions play a key role: the regulatory environment as well as the typology of fisheries and aquaculture activity have an impact on the acceptance and intensity of innovation [15].

Briefly, all these interactions are used by scholars to understand farmers' views on the issue. Individuals develop an attitude towards adopting or not adopting a new practice or tool, as it expresses the way they perceive reality or an experience [31]. In addition, a greater likelihood of adopting a fisheries or aquaculture-related innovation is also linked to a "technically" positive point of the instrument or, in other words, a perception that doing so will result in a relative advantage, such as the perceived increase in yield, cost efficiency and riskiness [15, 28,33-35]. For instance, Brugere et al. [36] report that the perceived effectiveness of innovation, intended as expected benefits, and the approval from other actors of the value chain are major drivers of innovation acceptance. Other positive perceptions associated with high levels of adoption include increases in trade flows and lower consumer prices and job creation [33,69].

From the previous consideration a gap in literature emerges, which concerns the consideration of just one layer of the aforementioned policy network. As a matter of fact, over the past decade, there has been a growing recognition among experts that the management of aquatic organisms, as well as the introduction of new technological tools, involves managing the actions of all the people who act on the resource [72]; in particular, it is relevant to understand their views [37]. Against this backdrop, analyzing the perspective of those who contribute to setting up policy targets in the fisheries and aquaculture sector and work to provide farmers with the necessary tools to undertake a sustainable and circular transition, is instrumental in gaining a more comprehensive picture.

3. Methods

This article fits into the context of understanding the thoughts of the FAPN dealing with the following research question: "*In your opinion, what does technological innovation in the fisheries and aquaculture represent?*".

Generally, qualitative research is most interested in understanding the complex dynamics of perception, as it may not only be subjective but may also express the thinking of a cultural group [71]. Qualitative methods have the potential to detect the nuances of a given behaviour and thus to observe individual variability, enriching the observed data. However, while it captures the peculiarities of human subjectivity, it is less structured research that in most cases does not allow for the reproducibility of the study, as quantitative methods do. On the other hand, quantitative methods rarely combine with the analysis of concepts in the sphere of the "Self" [38]. In this sense, hybrid methodologies, such as the Q Methodology, represent a bridge between qualitative and qualitative research able to overcome the weaknesses described [39]. Mixing these approaches allows us to analyze the different aspects of subjectivity and represent them in numbers, thus providing a hybrid tool useful to overcome the dichotomy between exclusively positivist or post-positivist approaches [40].

The QM has been theorised in 1935 by Stephenson and was created with the aim of studying human subjectivity [39]. It finds application from the medical and psychological sciences to the exploration of the sustainability in agriculture [41,42] and in the blue sectors [12,13]. The premise of this methodology is that human subjectivity can be studied by ordering established statements on a topic within a forced distribution. More specifically, it consists of five steps (Fig. 1).

The first step concerns the formulation of statements, or in other words the formation of the "concourse", which represents the general opinion and issues on a topic [43]. The concourse is usually gathered through the support of literature and by conducting focus groups of stakeholders interested in the topic.

The second step, called the development of the "Q set", concerns the selection of the statements among those that made up the concourse, which will be used in the interview. In order to select the items, they are usually traced back to common areas and then chosen. The chosen statements usually range from 30 to 50, based on the need for dimensions to be explored and the number of subjects to be involved in the survey [39,44].

The third stage is the selection of participants and is called the P-set, which is usually smaller than the Q-set [45], typically from 10 to 40 people.

The fourth phase, called Q-sort, is the central phase of the method. Individuals are asked to sort the chosen statements within a grid, firstly according to the degree of agreement, disagreement and neutrality and secondly on the basis of the intensity of their choice (e.g., from −4 to +4). Each individual will produce their Q sort, then the answers are collected and aggregated in a dataset.

In the last stage (fifth), scorecards produced in the previous step are factor-analyzed. Following this procedure, a reverse factor analysis will be produced, as it will be carried out on the individuals' profile (Q-sort) rather than on the set of variables, to reduce the general information to common lines of thought. These points of view are called "discourses" and represent the output of the method. Respondents whose Q-sorts are correlated share a similar frame [39].

The QM allows to identify the prevailing discourses whose interpretation contributes to enriching the debate on the diffusion of technological tools in fisheries and aquaculture, providing a new point of view on the subject.

In order to conduct the empirical study, the proposed five-step process was replicated.

In the study, the concourse (first step) was identified firstly by including the literature specifically addressing innovation in fisheries and aquaculture [46] and secondly, using a qualitative approach. Indeed, a focus group was conducted with 6 experts in the field gathered from the world of academics, industry and the world of institutions, characterized by different viewpoints on the meaning of technological innovation in the fisheries and aquaculture sectors [47], with the aim of stimulating a discussion on a set of statements collected in the literature.

The group of experts, in a pilot study, helped us to delimit the dimensions to be investigated and choose the appropriate statements for each dimension. Based on results of the literature review, the focus group and stakeholders' semi-structured interviews, the statements were classified in five main categories: economic sustainability, social sustainability, environmental sustainability, innovation complexity of use, innovation and marketing strategy [48]. To code the statements in the different categories, an interactive process among research group participants was applied.

Then, from the discourse the final Q-set was defined (second phase) after eliminating items with equal meaning or scarcely traceable to one of the identified dimensions. The Q-set included 33 statements, balanced among categories, and characterized by pros and cons positions.

Respondents were asked to sort the 33 statements within a distribution by expressing a degree of agreement, neutrality or agreement (values from −4 to +4) (Fig. 2).

The P-set (third phase) consists of 21 stakeholders of the Italian FAPN. Actors were identified considering all three layers, thus interviewing policy makers and directors of agencies in the sectors, members

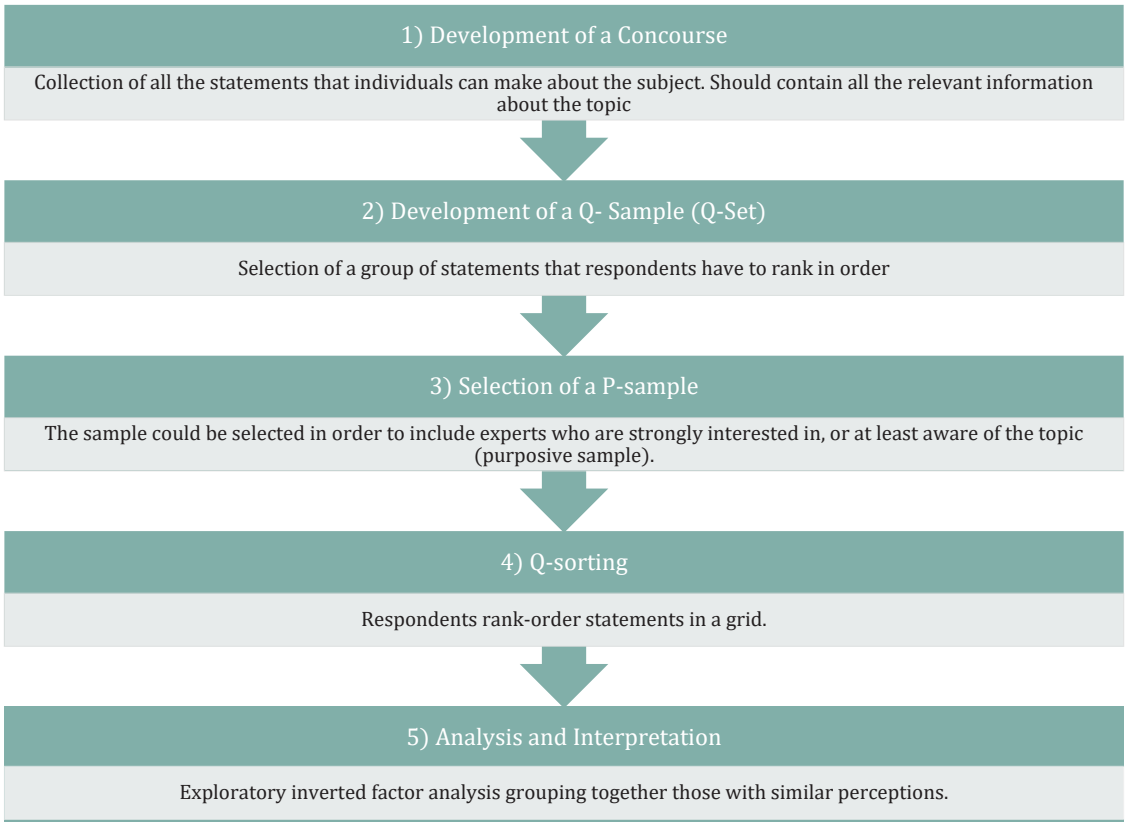

Fig. 1. Steps in the Q methodology. *Source:* [74].

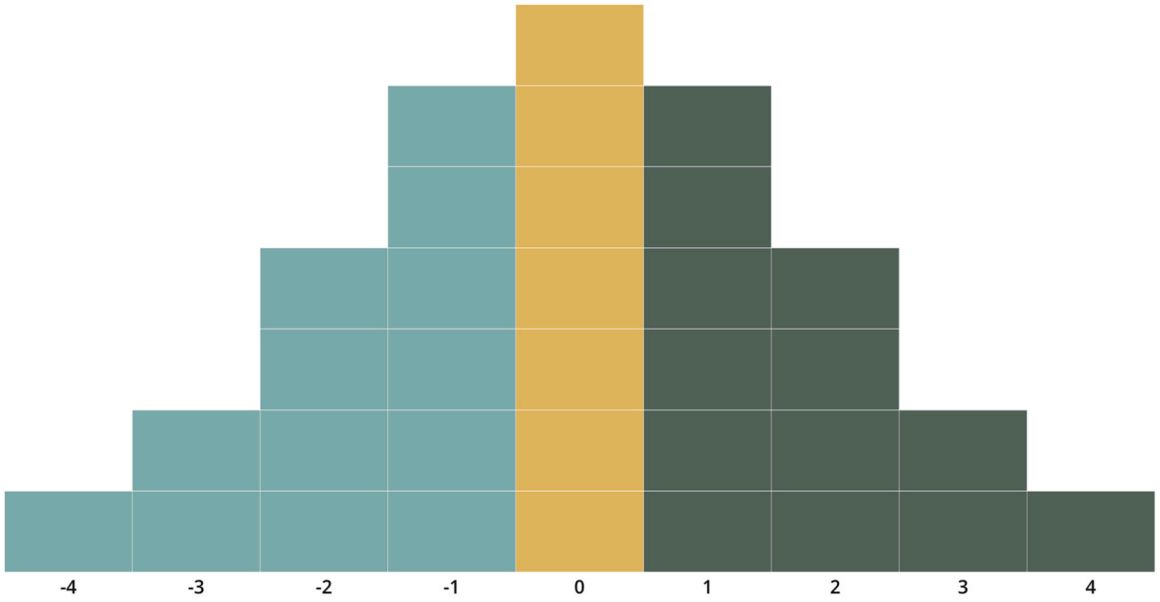

Fig. 2. Example of Fixed Quasi-Normal Distribution. Ranking values range from − 4, through "zero", to + 4. A total of 33 items could be accommodated in the distribution illustrated.

of trade associations and organizations of producers and finally also civil society actors, such as professors and researchers and citizens, who by their act of consuming give information and express opinions. Then, 21 Q-sorts were collected (fourth phase); the number is consistent based on the literature [49].

Principal component analysis (PCA), applied on the 21 Q-sorts produced, subsequently created the discourses of the study (fifth phase). PCA reduces data to a few summary factors, which are a linear combination of previously selected variables, and each indicates similar respondents' views. PCA makes the "component" more specific [50]. The main analytical principle is to correlate individuals' entire reactions. Unlike normal PCA, the QM correlates respondents' profiles rather than variables, and the results consist of a few separate and structured discourses revealing the respondents' views.

Q-sorts, factors, factor loadings, and Z-scores help explain the QM's results [49]. A factor is a calculated figure that represents the average ranking of similar responses. It illustrates how a hypothetical respondent who shares the group's views might prioritise statements. All respondents may not entirely embody a factor, but they often resemble one more than others. Factor loadings, which range from − 1 to + 1, determine Q-sort-factor correlation. The factor with the most loadings best represents a respondent. Z-scores and factor scores establish the order of statements inside each factor since they represent their relative location. The continuous z-score is a weighted average of a state's values from the most closely related factor Q-sorts. Factor scores are whole number values obtained from z-scores used to rebuild and understand a factor's Q-sort.

All analyses were performed using SPSS v.28 and Q method software.

4. Results

The QM is applied to identify common factors between the views of different individuals on the topic of innovation in the fisheries and aquaculture field. The intercorrelation matrix was calculated using the centroid procedure by rotating the solution using the varimax criterion [49]. Afterwards, the criteria for selecting the factors were determined, starting with those with eigenvalues greater than one, but only four were investigated according to the interpretability criteria. The characteristics of the factors are represented in Table 1.

The factor scores are weighted averages (Z-scores) of the values assigned to each instruction by the people who defined it. To make the results easier to understand, the Z-scores in Table 2 have been changed to the values of the original scale [− 4 to + 4]. In Table 2, therefore, for each statement we will have a value that can vary from − 4 to + 4. The results must be interpreted per single factor (per column) and per difference between factors (per row). Therefore, for the first aspect, the more the value is in the extremes of the range, the more it means the statement characterizes that particular factor; while for the second, the greater the difference between the values assigned to the individual statements, the greater the difference between the factors. The table illustrates the relative importance of each statement in each of the four groups that emerged from the factor analysis, and a quick glance at the table reveals the contrasts and similarities between the various points of view.

The four prevailing thoughts that the analysis highlighted are in the following sections.

4.1. Discourse 1 - A key to achieving sustainability and improved competitiveness of the supply chain

The first discourse includes members who most support the potential of the technology for the fisheries and aquaculture sectors. Members that fall into this group share the thought that technological innovation represents a way to boost both the environmental and economic sustainability of production. Among the benefits, they emphasize the potential of reducing the impact on the environment and the risks to human health, and finally, the possibility of reducing production costs and making the breeding of native species economically sustainable. The adoption of these tools also has repercussions on the organisation of the value chain itself, as it improves the organisation and the bargaining power of producers. The importance of developing an environment that

Table 1
Factor characteristics.

	factor 1	factor 2	factor 3	factor 4
No. of Defining Variables	10	4	5	2
Avg. Rel. Coef.	0.8	0.8	0.8	0.8
Composite Reliability	0.97561	0.94118	0.95238	0.88889
S.E. of Factor Z-scores	0.157	0.242	0.218	0.334

Table 2
Statements belonging to the Q-set.

Statement	Factor 1 Rank	Factor 2 Rank	Factor 3 Rank	Factor 4 Rank
1. The use of new technological tools in fisheries and aquaculture to be more sustainable towards the environment	4	2	0	-2
2. A practice that is badly suited to the specificities of individual farms	-2	2	-1	0
3. The use of new technological tools that cause harm to the environment	-3	-2	0	-1
4. The use of new technological tools to monitor adverse climatic events	0	1	4	-1
5. The possibility of performing activities without altering marine spaces	0	3	1	-2
6. A practice that is too complex for the knowledge/experience of fish farmers	-1	1	-1	1
7. A technology that is easy to understand	-1	-2	-4	1
8. A technology that is easy to use technically	0	-1	-3	0
9. The use of new technological tools requiring organisational and structural adaptations difficult to implement	0	0	0	0
10. A technology that involves only young producers	-1	-4	1	-2
11. The use of new technological tools to reduce production costs	2	-1	1	-1
The use of new technological tools to increase yields	1	-3	2	3
13. A practice that is not sustainable without economic support (e.g. bank loan, etc.)	0	4	1	-3
14. The use of new technological tools that partly replaces labour	0	-3	1	0
15. A technology suitable for large farms	-1	0	2	3
16. A technology already widespread in Italian territories	-2	-1	-1	-4
17. A practice that makes work easier to carry out	1	-2	3	4
18. A new practice/technology that shows results in the long term	0	2	0	1
19. A technology to improve the working conditions of the employees in the company	1	-1	0	1
20. A strategy that can only be pursued through the development of an environment that includes the collaboration of research institutions, the territory and the world of fisheries and aquaculture	3	3	0	2
21. A new technology to support farm management that can only be used by sharing risks and benefits with a group of farmers	-1	0	3	0
22. A simple purchase of machinery	-2	-1	-2	2
23. A useless tool for the fisheries and aquaculture sector	-4	-1	-1	0
24. Useful tools for brand-identity of companies	-1	1	2	1
25. Technological tools useful only in the processing or marketing phases	-2	-2	-1	2
26. The use of technology is linked to knowing how to use and	1	1	1	-1

(continued on next page)

Table 2 (*continued*)

Statement	Factor 1 Rank	Factor 2 Rank	Factor 3 Rank	Factor 4 Rank
continuously exchange data and information				
27. Technology that does not allow the recruitment of new employees	-3	1	2	0
28. Technology that improves animal welfare conditions increases consumer acceptability	1	0	-2	-2
Technology allows for a greater use of renewable energy sources in the production cycle.	1	2	-2	-1
30. Technology helps increase levels of biosecurity	2	0	0	-1
31. Technology helps make the breeding of indigenous species economically and environmentally sustainable	2	0	-2	-3
32. Technological innovation helps to improve the organisation of the supply chain	3	0	-1	1
33. Technological innovation improves the position of the producer in the supply chain	2	1	-3	2

involves the collaboration of research institutions, the territory and the actors of the fisheries and aquaculture value chain is the only possible way for the effectiveness of the transfer of innovation in the context. In this sense, they believe that by developing an environment conducive to innovation, it can be well applied to the specificities of individual companies.

4.2. Discourse 2 A capital-intensive practice beneficial only to the environment

The common thought of these members is that the new technologies allow producers to be less impactful towards the environment, and in particular to breed without altering marine spaces. They even believe that technology allows for a greater use of renewable energy sources in the production cycle. With respect to the socio-organisational dimensions, they believe that adoption does not lead to the replacement of labour, the improvement of working conditions or the simplification of work; whereas for the economic dimension, they argue that technology does not lead to maximising yields. The barrier they emphasize is that adoption requires a considerable economic effort, and therefore cannot be pursued without external support, given that the results are, according to them, achievable in the long term. Moreover, in this case, the transfer of innovation is seen as a strategy that can be pursued only through the development of an environment that involves the participation of context-related stakeholders. Finally, this discourse believes that adoption is not only a prerogative of young people, and they emphasize that technology should adapt more to the everyday operations and specificities of the farm, in terms of existing values and organization.

4.3. Discourse 3 A technically complex tool for managing the risks of adverse climatic events, but acceptable if shared

Those who belong to this discourse slightly support the potential of adopting technological innovations in fisheries and aquaculture. They clearly believe that the application of these tools is linked to the business reality, declaring themselves neutral on the importance of creating an institutional environment receptive to welcoming the diffusion of these technologies. In fact, it is the only group that disagrees with the statement "*technological innovation serves to improve the organisation of the fish supply chain*". They recognize their application mainly for monitoring adverse climatic events; while in a minority, economic and social benefits are highlighted such as the possibility of simplifying work, increasing yields and improving company brand identity. A strong characteristic of this group is the idea that technology is difficult to understand and use technically, justified by the perception that for them it is a tool for young people only. However, the role of collective action takes on an important value from the perspective of these people, who think that these tools can only be used by sharing risks, benefits and knowledge with a group of fish farmers.

4.4. Discourse 4 The purchase of useful tools to increase production yields and simplify work

People who fall into this group are those who believe that the application of technological innovation can lead to making work easier and lead to increased yields. In line with this thinking, they believe that this technology is particularly suited to large companies, which often tend to combine manual labour with automation to optimise operations. The vision they have is most focused on the role of technology that will improve productivity. It is precisely because of the greater ability of large firms to absorb higher costs that they associate a more receptive environment with the introduction of technology; in fact, they do not recognize the economic barrier as primary in this regard. Coherently with this perspective, they support technology's application in the processing and commercialization phases. Typical of this discourse is the idea that technology does not exert effects on improving the environmental and economic sustainability performance of the breeding activity.

5. Discussion

The study of the diffusion of technological tools for the fisheries and aquaculture sector is not extensive [15], and mainly delves into the complexity of adopting from the perspective of producers. However, recent studies are emphasizing that the goal of effectively anchoring innovation to a given context can be pursued through the development of a receptive environment, engaging research institutions, actors involved in the value chains and institutions involved in strategic decisions for the aquaculture and fisheries sectors [16,36,51,52]. It is for this reason that it is necessary to understand the point of view of the articulated set of actors making up what we have identified here as a policy network, or in other words the stakeholders involved in the political processes.

It is through the QM that this study has captured main thoughts regarding the anchoring mechanisms of the innovation processes in the aquaculture and fisheries sectors. By making human subjectivity measurable, this method draws on the strengths of both qualitative and quantitative methods and applications on the primary sector are now becoming more widespread [13,42,53,54].

Four main discourses emerged from the analysis: the first discourse represents those who strongly support the potential of innovation, which can not only help make the breeding of native species economically and environmentally sustainable, but also improve the bargaining power of the weakest links in the chain. And this confirms the view of many studies (e.g., [10] and [32] that argue that innovation can be a driver for blue sectors to become more responsible in guaranteeing sustainable values [33,55,73].

The second thought recognizes in technology the potential to reduce the impact on the environment and even to embrace a logic of a circular economy, arguing that it can increase the introduction of renewable energy in the sector. Beyond their positive attitude towards innovation, they also recognize two barriers. First, innovation has been seen as a high capital-intensive practice that could be adopted only with external financial support. This is well emphasized by studies dealing with innovation adoption in the blue sector [56] and more in general in the agricultural field [23,57]. Furthermore, according to this discourse,

technological innovation should be able to adapt to different farm specificities, confirming the presence of the well-known compatibility issue of the innovation literature [25,59,60].

The third discourse considers innovation as a mere tool, difficult to accept due to its technical complexity from the point of view of understanding and use, as Vecchio et al. [17] are also important antecedents to the adoption. In fact, those who share this view are the only ones who think that technology is only for young people. For them the application is linked to the possibility of predicting adverse climatic events and in a certain way as a sort of "risk management" tool. In this sense, and consistent with the literature on risk management for the primary sector [35], they intend the adoption of these tools only if shared. Similarly, participation in mutual funds for the fish sector implies risk sharing for the prediction of adverse climatic events [54].

The fourth embraces a more industrial vision, emphasizing how technological progress can boost productivity by simplifying work, as some studies have reported (e.g., [61]. Within this discourse, no effect of innovation on producing social or environmental benefits emerged; rather, the economic benefits of adoption were pointed out, but only within corporate governance. It is in this group that it is sustained as a tool that can only be adopted by large companies. Those who share this thinking are the only ones who think that technology is easy to understand technically.

What emerges is that the four discourses differ mainly in two aspects: the approach to innovation and the perceived effectiveness in terms of expected benefits (on-farm, off-farm level) (Fig. 3). In particular, we define effectiveness at "off farm level" as those expected benefits produced by innovation beyond producers' control.

On the basis of previous considerations, it is possible to identify two main approaches to innovation:

1. The first is the **"progressive approach towards innovation"**, adopted by the first and second discourses. This approach is adopted by all those who admit the effectiveness of innovation at company level and think about the broader potential that these new tools can exert, particularly in achieving sustainability goals and reducing the impact on the environment (off-farm level). In this sense, technological innovation is not perceived as a mere tool but, in a more systemic perspective, capable of producing benefits, in terms of competitiveness, also to the whole value chain. These two discourses support the importance of developing an environment receptive to innovation, encouraging information exchange and learning processes within the policy network. Following this vision, discourse 1 could represent the perspective of "Strong Progressives" experts, while discourse 2 that of "Moderate progressives" experts belonging to the policy network.
2. The second is the **"conservative approach towards innovation"** and mainly concerns the thinking of discourses 3 and 4. In particular, innovation is seen merely as a tool, whose potential lies solely in the business perspective. In particular, it is discourse 4 that emphasizes the possibility of increasing productivity and simplifying work by combining manual work and automation at company level, while Group 3 recognizes it as an environmental risk management tool. In this sense, discourse 3 could represent the perspective of "Moderate Conservatives" experts, while discourse 4 that of "Strong Conservatives" experts belonging to the policy network.

The two approaches may reveal a different conceptualisation of innovation. The conservative approach perceives it mainly as a "*business innovation*", or, in other words, of a commercial nature, since, according to Sawhney et al. [63] and Charatsari et al., [62], it is oriented to satisfy market needs and gives a relative advantage to those who adopt it. This could be confirmed by the strongly utilitarian view they have, as a means of achieving business profit. Moreover, they do not associate the adoption of innovation with the achievement of sustainability aspects, for them above all technology is not linked to the achievement of social and environmental benefits.

The progressive approach, on the other hand, takes a broader view of innovation, with the aim for some of ensuring positive externalities on the value chain, and for others on the environment. Indeed, here innovation adoption is associated with the achievement of sustainability goals.

The points of view also have other discriminating elements or elements of contact.

All four discourses remained roughly neutral on the fact that the use of new technological tools in fisheries and aquaculture requires

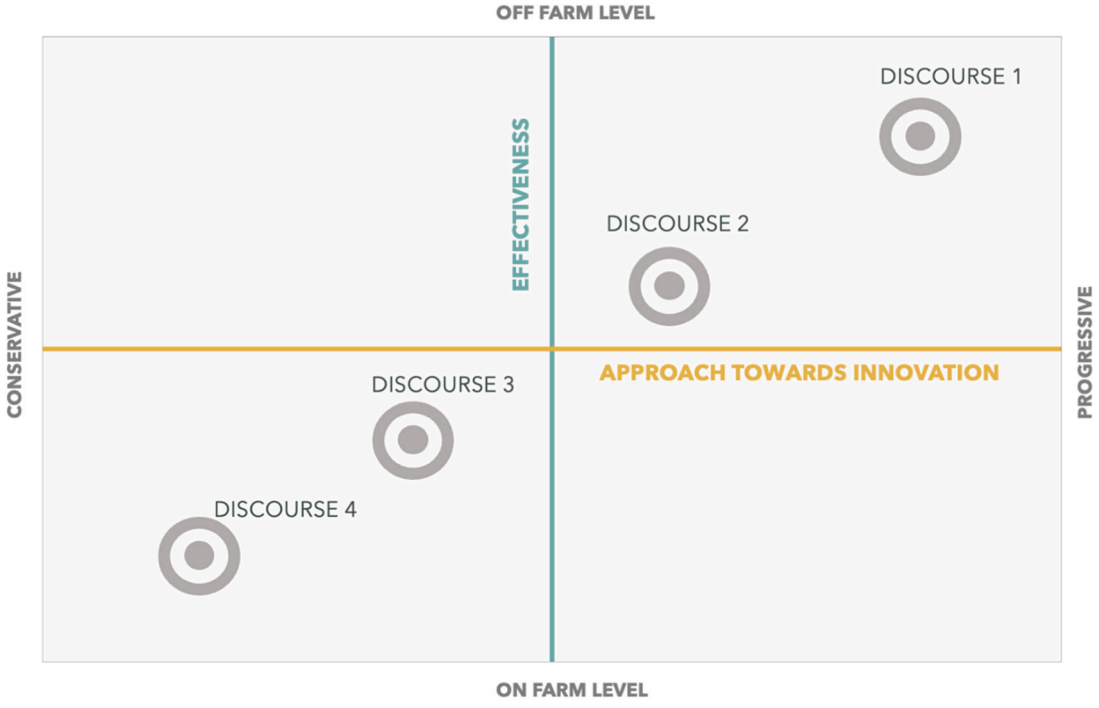

Fig. 3. Hypothetical discourse positioning diagram based on respondents' attitude toward innovation and perceived effectiveness.

organisational and structural adaptations that are difficult to implement, instead emphasized by scholars (e.g [36] from the point of view of producers). In any case, discourses 1, 3 and 4 think that it can simplify the everyday work routine. Similarly, the views (−1 to 1) about whether innovation is too complex for the knowledge/experience of producers or whether it can improve the working conditions of employees on the farm were fairly aligned. However, discourse 1 is the only one that disagrees that the adoption of innovation prevents the hiring of new employees. Furthermore, discourses 1, 3 and 4 all agreed that the use of new technological tools in fisheries and aquaculture will lead to economic benefits such as increased yields. Finally, Discourses 1, 2 and 3 agreed that adoption will help current production systems to reduce their impact on the environment, while discourse 4 expressed the contrary.

6. Conclusions

The results of our analysis could offer solutions but also new challenges to be explored. First of all, the Q methodology proved to be an adequate method to represent in numbers the field of the cognitive sphere, which has been mainly analyzed using qualitative methods [38,64]. Despite the limits linked to the representativeness of the sample that can be analyzed, given the maximum size that can be interviewed [49], the tool is well suited to delve into the complex thoughts coming from groups of stakeholders [65], which in this paper are represented by those of the FAPN. This could be a useful basis to provide new insights to policy makers, giving them new perspectives to rethink the policies put in place to pursue the objective set in the new EMFAF of a strong diffusion of innovative technologies.

The two macro perspectives identified give rise to two different thoughts. If on the one hand, for conservatives, technological innovation represents only a process of modernisation of the organisation, therefore adoption is only a purchasing process; on the other hand, for progressives, it is something that can provide benefits in terms of sustainability also beyond the farm boundaries. These different perceptions could be taken into consideration by policy makers, who should draw different paths to support innovation.

Current policies are actively promoting the implementation of measures and regulations that support the transfer of innovation, and the "progressive" approach demonstrated to follow that direction. Their aim is to facilitate the transition of the production system towards a progressive pathway towards innovation.

However, according to the study's results, this view is not supported by the entire FAPN. The existence of a substantial conservative faction gives rise to a significant people-policy gap. In fact, the more conservative thinking (Discourses 3 and 4) gave little recognition to the potential of technological innovation to produce benefits in terms of economic, social and environmental sustainability.

In this sense, this study highlights the need to take more account of the often-neglected point of view of experts of the policy networks in order to match the effectiveness of innovation policy with the needs of the fisheries and aquaculture sectors.

These issues become crucial at a time of great uncertainty, in the Knightian [66] sense of the term: the aquaculture sector was directly involved in the ecological transition but faced one of the most important crises after a two-year period, marked first by the COVID-19 pandemic crisis, then by the war between Russia and Ukraine. Another threat to be mentioned is climate change, which during the Glasgow Cop26 was renamed the climate crisis. In times dominated by uncertainty, the European Commission's challenge to strengthen the role of knowledge and information becomes a priority and could be the key to the development of a sector that is key to ensuring food security which has now returned to the centre of the international debate. The EU's Green Deal and the European long-term vision for future economic and social development pointed to technological innovation as the solution to facilitate the sustainable transition of the agri-food sector [58]. In this scenario, the study proposes a new way of analyzing the cognitive sphere of the stakeholders and a new tool to be used by policy makers to improve the effectiveness of the written measures in order to put into practice the indications coming from the political direction of the European Commission. Moreover, it implements a new approach to identify scalable and differentiated solutions to favour the diffusion of technological innovations for the two dominant thoughts. In this way, the realisation of European renewal heavily relies on the advancement of responsible research and innovation (RRI), or, in other words, the adoption of innovation is related to the "responsibility" to produce ethical and social values as well as sustainability, avoiding negative effects in the future of the fisheries and aquaculture sectors. In this study, the discourses could help the policy network to formulate "Responsible" policies for these sectors. The results confirm the need to support the principles of "reflexivity" and "inclusion" in responsible innovation policies for the fisheries and aquaculture sectors. PN should on the one hand be aware of a lack of knowledge and open to public dialogue and, on the other, it should take into account the thinking of all the actors in the supply chains, giving voice to all their needs and interests [17,25]. The markedly conservative thinking emerged from the analysis conceptualizes innovation as a mere technological tool whose adoption is scarcely related to the achievement of sustainability objectives. This perspective will have to be further explored, as this vision will directly or indirectly, depending on the type of PN layers, influence the future reshaping of the policy output of the 2021–2027 European Maritime, Fisheries and Aquaculture Fund programming for Italy.

A better understanding is needed, on the one hand, to enrich the framework for innovation uptake in fisheries and aquaculture and, on the other hand, to support an effective path of responsible policy innovation. These reflections can be the starting point for proposing a more inclusive policy for the governance of water and the blue bioeconomy, which could pay attention not only to marine and coastal areas, but also to the management of the aquatic resource inland. The absence of a cohesive and inclusive policy, also in terms of spatial and relational perspective, which is evident in the agricultural sector, hinders the ability to conduct significant evaluations of blue policies related to regional innovation networks, water-focused spatial planning and environments [2,70].

Data Availability

Data will be made available on request.

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Author statements

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. Contributions has been made by all the authors on all the terms, from the conceptualization, data curation and analysis to final validation and supervision. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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