The role of communication in shaping participants' perceived outcomes in EIP-AGRI Operational Groups

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Abstract

Operational Groups (OGs) are a key element of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI), designed to foster innovation through multi-actor collaboration. While communication is widely recognised as crucial to the functioning of OGs, empirical evidence on how different communication dimensions relate to project outcomes remains limited. This study addresses this gap by analysing how three core dimensions of communication, namely information, interaction, and participation, jointly affect participants' perceived project outcomes within OGs. Using data from an online survey of Italian OG partners and applying partial least squares structural equation modelling, the results show that participation has the strongest positive association with perceived project results, followed by interaction, while information alone plays a more limited role. The findings highlight the importance of active engagement in shaping outcome perceptions in multi-actor innovation settings and provide insights into improving the design and governance of EIP-AGRI OGs.

Keywords: EIP-AGRI; Operational Groups; communication; perceived project outcomes; PLS-SEM
JEL codes: C38; Q16; Q18

1 Introduction

The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) is an initiative of the European Union aimed at promoting innovation in the agricultural and forestry sectors (EU SCAR, 2012). Launched in 2012, EIP-AGRI seeks to enhance the productivity and sustainability of European agriculture by fostering collaboration among farmers, researchers, advisors, and other stakeholders. The initiative facilitates the exchange of knowledge and innovative solutions to address agricultural challenges such as climate change, natural resource management, and food security. One of the main tools of EIP-AGRI is the establishment of Operational Groups (OGs), composed of various actors working on specific projects to develop and implement new technologies and sustainable agricultural practices. OGs were introduced by the 2014-2020 Common Agricultural Policy (CAP) to foster competitive and sustainable farming and forestry through an interactive approach to innovation (European Commission, 2019; Van Oost & Vagnozzi, 2021). The CAP 2023-2027 continues to support the EIP-AGRI initiative and OGs as key instruments for spreading knowledge and innovation in agriculture (Art. 127 of Regulation EU 2021/2115).

There are almost 3,600 OGs at the European level, registered in the EIP-AGRI database[1], of which over 1,500 are officially marked as completed in the system. In Italy, 838 OGs were financed, and approximately 750 are recorded as completed in the national database[2], meaning that both project activities and administrative procedures have been finalised. For their implementation, regional authorities allocated approximately €262 million.

[1] Available at https://eu-cap-network.ec.europa.eu/projects/search_en (last accessed in November 2025).

[2] Available at https://www.innovarurale.it/it/pei-agri/gruppi-operativi/bancadati-go-pei (last accessed in November 2025).

Given the involvement of different actors with varying competences and responsibilities, communication processes within OGs are fundamental to their functioning. Communication occurs at various levels and times, for example when strategic decisions need to be made and shared, when partners meet to solve practical issues, or when partners must be informed about the activities carried out.

Research on the effectiveness of communication in influencing project outcomes within the context of OGs remains limited. One reason is that OGs are a relatively recent initiative, leading to a scarcity of available data. Another reason is that existing studies have primarily focused on specific aspects of communication, particularly interaction. However, interaction is just one of the ways in which communication takes place within an OG; it also unfolds through participation and information exchange. Participation can be passive, when it involves mere physical or virtual presence, or active, when stakeholders influence and share control over development initiatives, decisions, and resources that affect them (Luyet et al., 2012). Information exchange, on the other hand, refers to the dissemination of knowledge and data throughout the project lifecycle (Gamil & Abd, 2021).

Notably, interaction among participants does not necessarily lead to the production or exchange of useful information for the project, nor does it imply full participation in all project activities. In other words, interaction can occur without meaningful information exchange or full engagement in the project. The same applies to participation, particularly in its passive form, and even more so to information sharing. When considered together, these three dimensions of communication may have a significant impact on project outcomes, influencing collaboration dynamics, knowledge transfer, and decision-making effectiveness.

Existing studies have focused on the impact of these factors when considered individually on the effectiveness of EIP-AGRI projects (Arzeni et al., 2023; Harrahill et al., 2022; Maziliauskas et al., 2018; Molina et al., 2021). These studies are important for understanding the influence of specific aspects; however, they do not measure the effects resulting from the joint action of different factors or the relative importance of each factor for project outcomes. Therefore, there is a need for a more comprehensive and systematic analysis to capture these relationships.

The objective of this study is to assess the impact of the communication process, along three core dimensions, namely information, interaction, and participation, on the results achieved by OGs. Specifically, the analysis focuses on participants' perceived outcomes, measured in terms of satisfaction with the results obtained by the OG. This choice is grounded in the consideration that, in multi-actor innovation projects, perceived outcomes often represent the most meaningful and feasible indicator of project performance, as they capture how stakeholders evaluate results in relation to their expectations and level of involvement. This is particularly relevant for EIP-AGRI OGs, whose heterogeneity and absence of standardised quantitative performance indicators (Bonfiglio, 2023) make perceived outcomes one of the few viable approaches for assessing project results.

To analyse the joint effects of communication dimensions on perceived OG outcomes, Structural Equation Modelling (SEM) is adopted (Hair et al., 2021). In particular, this study employs Partial Least Squares SEM (PLS-SEM) to model and estimate relationships among multiple dependent and independent variables simultaneously. Latent variables are described by multiple measured indicators. The data used to construct these indicators are derived from an online survey administered to partners of Italian OGs.

To the authors' knowledge, this study is among the first to analyse the communication process within OGs by breaking it down into its main dimensions and evaluating their simultaneous effects on perceived outcomes. It can therefore be considered a novel contribution to the literature on the impact of OG organisational models. This study is relevant for both policymakers and planners, as the results can first demonstrate the effectiveness of communication and then highlight the relative importance of different aspects of the communication process, helping to identify areas that should be improved to further enhance the effectiveness of OGs.

The remainder of this article is structured as follows. Section 2 describes the theoretical framework linking the communication process to perceived project outcomes, the core dimensions of process communication, and the research hypotheses tested. Section 3 details the dataset and the model used. Section 4 presents the results, which are discussed in Section 5. The final section provides concluding considerations.

2 Theoretical framework: communication and perceived project outcomes

2.1 Perceived project outcomes and their determinants

In multi-actor innovation projects, such as EIP-AGRI OGs, participants' perceptions of project outcomes, measured as the degree of satisfaction with project results, represent a valid, and in some cases the only feasible, proxy for project performance when quantitative and comparable indicators are unavailable. Perceived outcomes capture how participants evaluate the usefulness and effectiveness of project results. Although they do not measure actual impacts, they provide meaningful information on a project's capacity to achieve its intended goals and to generate value for the actors involved, in line with the idea that project success is socially constructed and depends on how stakeholders interpret whether their expectations have been met (McLeod et al., 2012).

Importantly, perceptions of project outcomes may vary depending on the roles of the partners involved. For instance, research institutes may evaluate project outcomes primarily in terms of successful experimentation and knowledge generation, whereas farmers may focus on economic effects such as cost reductions or revenue increases. Consequently, the same project outputs may be interpreted differently across partner types. This heterogeneity reinforces the relevance of perceived outcomes as an evaluation approach, as they capture how different actors assess project results in relation to their expectations and roles.

Project outcomes, whether actual or perceived, are influenced by multiple factors. The literature has identified a wide range of determinants of project success and failure (Alias et al., 2014;

Anantatmula & Rad, 2018; Belassi & Tukel, 1996; Fortune & White, 2006; Harish & Shruti, 2022; Purna Sudhakar, 2012; Ramos & Mota, 2014; White & Fortune, 2002; Pinto & Slevin, 1987,1988,1989). Among these determinants, communication consistently emerges as one of the most influential, particularly in collaborative and knowledge-intensive settings (Katz, 1982; Griffin & Hauser, 1992; Hauptman & Hirji, 1996; Schreiner et al., 2009; Frank Cervone, 2014; Kamuriwo & Baden-Fuller, 2016; Bstieler et al., 2017; Gamage, 2022).

Communication within collaborative projects can be analytically decomposed into three complementary dimensions: information, interaction, and participation. While closely intertwined in practice, each dimension activates distinct mechanisms through which communication may influence perceived project outcomes.

Information refers to the production, dissemination, and accessibility of project-related knowledge, including objectives, rules, activities, and results. From an economic perspective, adequate information reduces information asymmetries among participants, lowers uncertainty, and improves the quality of decision-making. By clarifying roles, expectations, and technical content, information helps reduce coordination failures and the risk of misallocation of resources, thereby increasing the likelihood that project activities effectively contribute to the achievement of project objectives and, consequently, to higher perceived outcomes.

Interaction captures the frequency and intensity of exchanges among project participants. Through repeated interactions, actors engage in mutual learning, align expectations, and consolidate working relationships. These processes enhance trust and facilitate coordination and collective problem-solving among participants. As a result, interaction is expected to support the effective implementation of project activities and improve the quality of outputs, which in turn positively affects participants' satisfaction with project outcomes.

Participation refers to the extent to which actors are actively involved in project activities and decision-making processes. Active participation increases stakeholders' effort and commitment, as participants perceive greater ownership of project decisions and results. Moreover, participation allows the integration of diverse forms of knowledge and practical experience, improving the relevance and applicability of project outputs. From an economic standpoint, participation enhances monitoring and evaluation, reduces opportunistic behaviour, and facilitates adherence to project rules, timelines, and budgetary constraints, thereby contributing to more effective project execution and higher perceived outcomes.

Taken together, these dimensions define the channels through which communication affects perceived project performance. Information constitutes a necessary but insufficient condition, as it provides the knowledge base required for action. Interaction and participation activate the mechanisms, such as uncertainty reduction, improved coordination, increased effort, and more efficient use of resources, through which communication translates into higher satisfaction with project outcomes.

Based on this conceptual framework, the following sections review empirical studies linking information, interaction, and participation to project success and derive the hypotheses tested in this study.

2.2 Information

In project management, information distribution is essential to ensure that project information is provided in a timely manner throughout all phases of the project (Gamil & Abd, 2021). Lin et al. (2005) highlighted that information asymmetry can negatively impact knowledge transfer, while Peppard & Ward (2005) noted that, when employees rely on heterogeneous and sometimes incomplete or unreliable information sources regarding project changes, they may develop divergent interpretations that complicate mutual understanding and hinder the successful implementation of enterprise systems. Henderson (2008) argues that effective communication in project management depends on the ability to understand and clearly convey information, a competency that significantly influences team satisfaction and productivity. Bredillet et al. (2015) claim that classical project management standards rely on the assumption that full, relevant, and transparent information is available. Such transparency enables project actors to make rational choices, set goals, and take normative decisions. According to Gupta et al. (2022), effective access to, sharing of, and use of digital information strengthen organisational risk mitigation and support more informed decision-making. Oliveira & Albertin (2023) found that failures in the communication process, particularly due to information asymmetry, are the main factors leading to unsatisfactory results. Therefore, they concluded that effective information distribution and symmetry facilitate cooperation and significantly influence project success.

In a project carried out by an OG, the information that should be shared encompasses various aspects, including objectives, challenges to be addressed, organisational methods and rules to be followed, activities and experiments to be conducted, involved parties, tasks assigned to each individual, and both interim and final results achieved. By reducing information asymmetries and uncertainty, effective information sharing improves coordination and decision-making among project members, thereby increasing the likelihood that project activities translate into satisfactory outcomes for participants. The research hypothesis tested is therefore as follows:

H1: The production and dissemination of information among project members positively influence participants' perceived project outcomes in OGs.

2.3 Interaction

The interactive model, also known in the literature as the cooperation model or cyclical model (Johannessen, 2009), is distinguished from the linear model. In innovation studies, the linear model primarily relies on formal and codified knowledge (explicit knowledge) generated through R&D activities, assuming that innovation is mainly driven by research investments. In contrast, the interactive model emphasises the interplay among various sources of knowledge, including tacit knowledge, experiential learning, and social interactions. It highlights the role of relationships, feedback loops, and contextual factors, such as cultural and institutional settings, in shaping innovation processes (Lundvall, 2007). This model values diverse types of knowledge and their interconnections as critical resources, with interactive learning identified as the key process (Lundvall, 1992). Distinct characteristics of the interactive innovation model include a focus on collaboration rather than competition (Lundvall & Johnson, 1994; You & Wilkinson, 1994) and a flow of knowledge and information that does not have to be linear or continuous (Keresztes & Endresz, 2020).

In the agricultural context, the interactive approach to innovation represents the core of the EIP-AGRI initiative (EU SCAR, 2012). This approach establishes that project interventions must involve the interaction of various stakeholders, including farmers, consultants, researchers, processing industries, and others directly engaged in identifying, developing, and adopting specific innovative solutions (Cronin et al., 2021).

In an OG, interaction among members should facilitate the exchange of knowledge and information regarding the types and methods of applying and disseminating innovations that best suit the involved farms and address their challenges. Consistent with the interactive innovation model, these repeated exchanges foster mutual understanding and trust among participants, facilitating coordination and the effective implementation of project activities. Although the effectiveness of this approach in ensuring project success is well established, the evidence in the context of OGs is less clear, as there are relatively few studies that have analysed it. However, existing studies agree on the presence of a positive relationship. Maziliauskas et al. (2018) showed that a lack of actual cooperation between farmers, researchers, and consultants negatively impacts EIP-AGRI. Molina et al. (2021) concluded that interaction is a fundamental element that should be considered and activated in all phases of a project to learn from each other, learn together, co-create, and innovate. Arzeni et al. (2023) found that a greater frequency of contacts is a recurring characteristic of OGs that have achieved the most satisfactory results. They concluded that the key principles of the interactive approach are effective in achieving the objectives of Italian OGs. Through interactive learning and frequent exchanges, interaction enhances the quality, relevance, and applicability of project outputs, which in turn positively affects participants' satisfaction with project outcomes. Therefore, the research hypothesis tested in this study is as follows:

H2: Interaction among project members positively influences participants' perceived project outcomes in OGs.

2.4 Participation

The process of participation in a given project can have both advantages and disadvantages (Edelenbos & Klijn, 2006; Michels & de Graaf, 2017,2010). Stakeholder support for projects tends to increase when stakeholders perceive that their views have been duly considered through participatory processes. Additionally, participation can enrich the project by incorporating diverse knowledge, expertise, and insights from different stakeholders. Furthermore, it can enhance the legitimacy of decisions. However, participation is not without challenges. Stakeholders might prioritise their own interests over the collective goals of the project. Moreover, extensive participation can be time-consuming and does not necessarily lead to better outcomes. This is especially true when participation is merely formal, without real influence on project decisions and resources (Luyet et al., 2012).

In the literature, existing studies tend to emphasise the positive role of participation. Chamala (1995) highlights that stakeholder participation can enhance the efficiency of natural resource management processes, as involving and empowering stakeholders leads to more widely supported and sustainable solutions. Other studies emphasise the contribution of participation in fostering project effectiveness through community ownership of the process (Kelly & Van Vlaenderen, 1995; Kolavalli & Kerr, 2002). Price & Mylius (1991) suggested that participation increases project ownership by beneficiaries and ensures project sustainability. Moreover, participation conveys valuable local knowledge, fostering better action plans (Price & Mylius, 1991; Stiglitz, 2002). Kelly (2001) found that participation leads to learning, which is often necessary for changing behaviour and practices. Thamhain (2010) highlighted that stakeholder commitment is crucial for project success, especially in complex multinational projects. It affects the achievement of objectives by fostering ownership, collaboration, and sustained dedication among diverse stakeholders. Makau et al. (2018) revealed that strong stakeholder participation improves the quality of project monitoring and evaluation, as it increases the availability of context-specific information, enhances transparency, and strengthens mutual accountability among participants, positively affecting cost, time, and scope. Samwel et al. (2023) concluded that stakeholder participation positively influences project success by enhancing decision-making, timeliness, quality, and adherence to budgets.

In an OG, members are required to participate in the planned activities for the application and dissemination of introduced innovations, with varying levels of involvement. Participation ensures the sharing of information, pursued objectives, and adopted tools, as well as synchronisation and adherence to deadlines in carrying out activities, and the monitoring and evaluation of achieved results. There are not many studies that analyse the effects of OG partners' participation in project initiatives on project success. However, existing studies highlight a positive relationship between the level of involvement, intended as active participation, and project success. In particular, Maziliauskas et al. (2018) concluded that, at the stage of implementing activities, active engagement and involvement of partners exert a strong influence. Harrahill et al. (2022), by examining an Irish OG aimed at producing and transforming biomass into energy, showed that partial involvement can be a limiting factor for project success. By fostering ownership, commitment, and effective monitoring of activities, active participation influences how participants evaluate project success and their satisfaction with the achieved results. Accordingly, the research hypothesis being tested is as follows:

H3: Participation in project activities positively influences participants' perceived project outcomes in OGs.

3 Materials and methods

3.1 The dataset

The data used derive from an online survey conducted in 2020 by the Italian National Rural Network (NRN) among the partners of OGs. The survey collected information on the organisation of the groups to understand how and whether the EIP interactive model was implemented and whether it influenced the achievement of project objectives.

The initial questionnaire comprised 17 questions, which were later supplemented with additional questions in a second stage to investigate the conditions experienced by OGs during the pandemic. These questions examined various aspects of OGs, including: (a) partners' roles, their stages of involvement in project preparation, and their main motivations for participating; (b) methods for ensuring internal and external communication, such as the nature of relationships, frequency of contacts, and tools for disseminating information; (c) the role of advisors in project implementation; (d) methods and tools for gathering partners' needs; (e) lessons learned from OG participation and levels of satisfaction among different actors; and (f) the specific conditions faced by OGs during the COVID pandemic.

The questionnaire was distributed to the coordinators of OGs listed in the national database managed by the Italian NRN and was made accessible via a link to all group participants, with the only requirement being that they had completed or were nearing completion of their project activities. In total, 517 respondents from 270 OGs participated. From the available questions, those deemed most relevant to the analysis were selected, based on their conceptual consistency with the latent constructs (information, interaction, participation, and perceived project outcomes). For a comprehensive view of the questionnaire and the related questions, refer to Arzeni et al. (2023).

The selected survey items and descriptive statistics are reported in the Appendix (Tables A1–A4), by construct type. The questions used a 5-point Likert scale. For items for which respondents provided null scores, the minimum value of the Likert scale (1) was assigned. This choice reflects the conceptual meaning of the items and preserves all participants in the analysis.

From the analysis of the average scores, several aspects can already be highlighted. The average level of satisfaction with the results achieved by the OGs is relatively high. Information was circulated mainly through direct contacts and documents reserved for project members. Interaction occurred primarily with the project leader and the innovators. Finally, participation was mainly remote and conducted through plenary meetings. The responses provided were used to construct the indicators measuring the constructs, as described in the following section.

3.2 The model

SEM is used to model and estimate relationships between multiple dependent and independent variables simultaneously. The aspects being analysed are not directly observable and are measured indirectly through various indicators. Unlike conventional multivariate analysis methods, SEM takes measurement error in observed variables into account when estimating relationships (Hair et al., 2021). Two widely used SEM approaches are covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM). CB-SEM focuses on reproducing the observed covariance matrix and is primarily employed to test theoretical models. It provides robust model fit indices and allows for rigorous hypothesis testing. However, CB-SEM requires relatively large sample sizes, assumes multivariate normality, and can be sensitive to violations of these assumptions, making it less suitable for small samples or exploratory research. PLS-SEM, on the other hand, is a variance-based approach that aims to maximise the explained variance of the dependent constructs. It is particularly advantageous when dealing with smaller sample sizes, non-normal data distributions, or complex models with formative indicators. Its main limitation is the lack of global goodness-of-fit measures comparable to those of CB-SEM, which may reduce its suitability for strictly confirmatory studies.

In this study, PLS-SEM was chosen due to its ability to handle small datasets, fewer assumptions regarding data distribution, and its focus on explaining and predicting the variance of the outcome variables, which aligns with the exploratory and predictive nature of the research (Sarkar et al., 2021; Chin et al., 2020). This type of model has already been used in several studies examining the relationships between potential explanatory factors related to communication and project outcomes. For instance, using a PLS-SEM model, Iqbal et al. (2017) analysed the impact of teamwork on project success. Gamil & Abd (2021) studied the relationship between the causes and effects of poor communication and information exchange in construction projects. Kurdi et al. (2023) analysed the impact of several factors, including communication, collaboration, and engagement, on team social networking and performance.

PLS-SEM includes two main components: the structural model and the measurement models. The former connects the constructs, that is, the latent variables that are not directly measurable. The latter illustrate the relationships between these constructs and their indicators, which are the directly measured variables. One measurement model contains the exogenous latent variables, corresponding to the constructs that influence other constructs, while another contains the endogenous latent variables that are explained by the model.

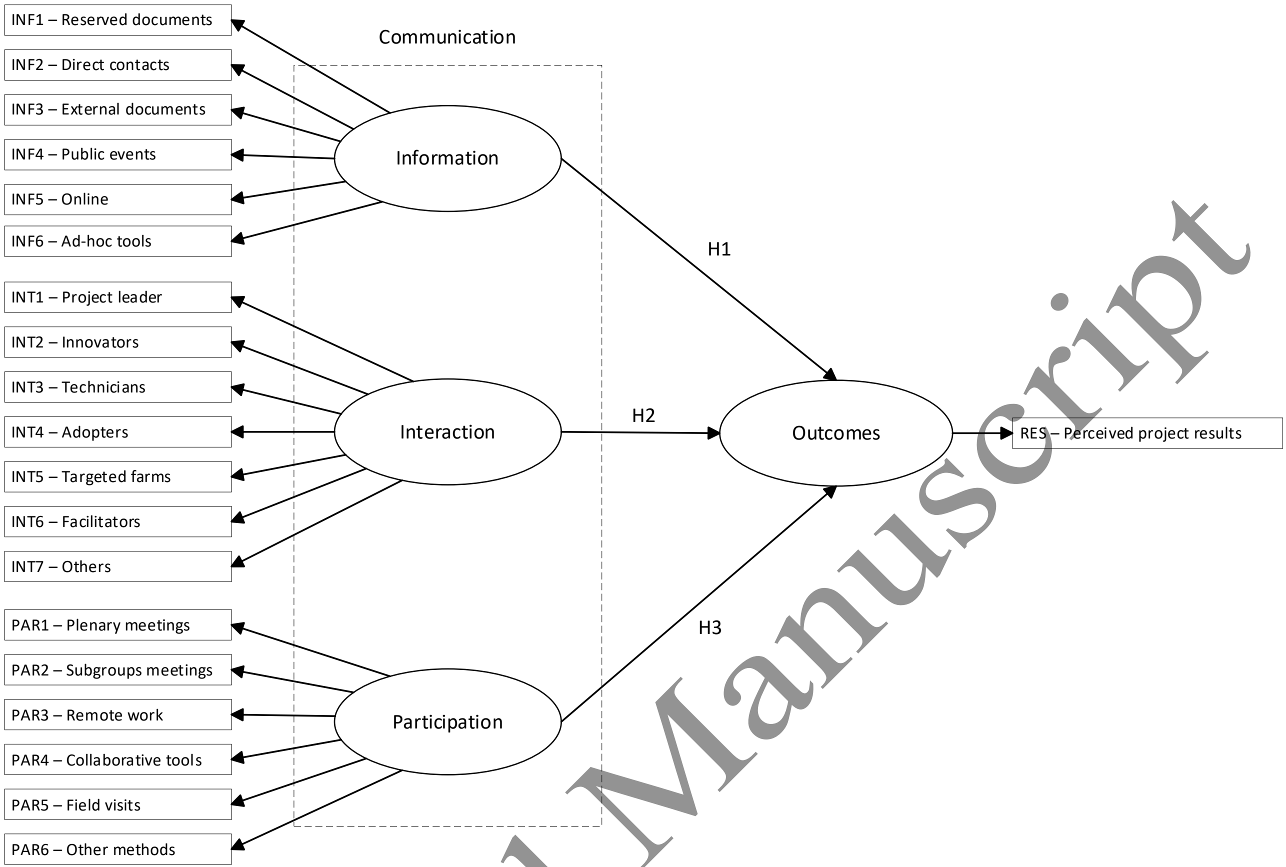
PLS-SEM can accommodate either formative or reflective measurement indicators. With formative indicators, the indicator variables predict or “cause” the construct. Conversely, with reflective indicators, it is assumed that the construct causes the measurement of the indicator variables. In this study, the concepts analysed can be expressed through multiple indicators. Changes in the latent variables are likely to lead to changes in the indicators. Moreover, these indicators are interchangeable, as the concept is reflected in the different indicators, which share a common theme. Therefore, a reflective approach is adopted.

Figure 1 shows the conceptual representation of the proposed model. There are four latent variables: information, interaction, participation, and perceived project outcomes. The first three are exogenous variables that explain the last one, which is therefore an endogenous variable. Each exogenous variable is represented by multiple reflective indicators, while the endogenous variable is measured by a single reflective indicator. Overall, the model comprises 20 indicators. Although some indicators may appear conceptually related across constructs (e.g. participation implying interaction or information exchange), these relationships are intentionally modelled at the construct level rather than through embedded or cross-loading indicators. This choice is consistent with the theoretical framework, which conceptualises information, interaction, and participation as analytically distinct yet complementary dimensions of communication. Conversely, modelling potential overlaps at the indicator level would increase model complexity without clear theoretical benefits and would make it more difficult to interpret the distinct functional roles of the constructs. The adequacy of this choice is assessed through discriminant validity and collinearity diagnostics.

To address potential heterogeneity in stakeholder perceptions, the PLS-SEM model was extended by explicitly accounting for the type of partner within the OG. A multi-group analysis (MGA) approach was adopted to investigate whether the relationships between information, interaction, participation, and satisfaction with project outcomes differ across roles. This approach allows us to test whether the impact of the constructs on perceived project outcomes is role-dependent, thereby partially addressing unobserved heterogeneity and providing a more nuanced interpretation of stakeholder satisfaction within OGs. To conduct a meaningful MGA, the respondents were categorised into three primary macro-groups based on their functional roles within the agricultural innovation ecosystem: (1) Farms (n = 130), representing the primary end-users and practitioners; (2) Research Institutes (n = 216), which aggregate universities and research centres due to their shared mission of knowledge production and scientific validation; and (3) Other (n = 171), comprising consultants, small and medium-sized enterprises (SMEs), and institutional actors who facilitate the bridge between research and practice. This categorisation was driven by two main considerations. First, from a theoretical perspective, it allows the isolation of the distinct behavioural drivers of those who produce innovation (Research) versus those who apply it (Farms). Second, from a methodological standpoint, this aggregation ensures that each sub-group maintains a sample size sufficiently large to achieve adequate statistical power in PLS-SEM bootstrap and permutation procedures (Hair et al., 2022).

The evaluation of the measurement and structural models was conducted following the approach proposed by Hair et al. (2021). For MGA, measurement invariance was first established using the Measurement Invariance of Composite Models (MICOM) procedure (Henseler et al., 2016) to ensure that differences in path coefficients were not confounded by group-specific construct interpretations. Detailed methodological procedures concerning the assessment of the global model, invariance testing, and the specific multi-group differences (MGD) tests are provided in the Appendix (Sections A.1, A.2, and A.3).

Figure 1 – Conceptual representation of the relationships between communication processes and perceived project outcomes in OGs



Note: Reflective measured indicators are represented in rectangles, while latent variables are represented in ellipses.

4 Results

The assessment of the measurement model indicates satisfactory reliability and validity. Internal consistency reliability is high for all reflectively measured constructs, convergent validity is achieved after removing one low-loading participation indicator, and discriminant validity is supported by the heterotrait–monotrait ratio (HTMT) criterion. This indicates that information, interaction, and participation capture empirically distinct dimensions of the communication process, supporting their separate inclusion in the structural model. The detailed reliability statistics, indicator loadings, HTMT ratios, and collinearity diagnostics are reported in the Appendix (Tables A5–A8).

Table 1 shows the bootstrapped structural paths, f^2 effect sizes, and in-sample explanatory power. The R^2 of the endogenous outcomes construct is modest but satisfactory, especially given that it is measured by a single item.

Out-of-sample predictive power was assessed using PLSpredict with two-fold cross-validation, as detailed in Appendix Section A.2.3. **Errore. L'origine riferimento non è stata trovata.** shows an approximately symmetric distribution of prediction errors for the endogenous outcomes construct; therefore, the Root Mean Square Error (RMSE) is used. The PLS path model has a lower RMSE than the naïve linear benchmark (0.912 vs 0.931), indicating satisfactory out-of-sample predictive power.

The structural paths in Table 1 are all positive and statistically significant at the 5% level. Participation shows the largest effect on perceived outcomes, followed by interaction and information. The ranking based on path coefficients is consistent with the f^2 effect sizes, confirming that participation and interaction contribute more substantially to the model's explanatory power, whereas information has only a limited effect size.

As regards MGA, Step 1 of the MICOM procedure (configural measurement invariance) is established by using the same indicators and structural model across all groups. Step 2 (compositional invariance) is confirmed, as all permutation-based *p*-values for the composite correlations are non-significant (p-value > 0.05), indicating that the constructs are formed consistently across the three macro-groups. Step 3 (equality of means and variances) generally indicates equality, with the exception of a significant difference in the mean of Participation between the "Other" and "Research Institutes" groups (p-value = 0.042). Following Henseler et al. (2016), the establishment of configural and compositional invariance (Steps 1 and 2) is sufficient to permit the comparison of path coefficients across groups. All results related to Steps 2 and 3 of the MICOM procedure are reported in the Appendix (Tables A9–A10).

The MGD tests (Sarstedt, Chin, Keil, and Nitzl) consistently reject the null hypothesis of group equality (p-value < 0.05), indicating evidence of overall group-level differences in the structural model. However, specific pairwise comparisons for individual path coefficients using the non-parametric MGA approach proposed by Chin & Dibbern (2010) do not exceed the 5% significance threshold (Table 2). This suggests that participant roles exert systemic moderation on the overall performance of the structural model rather than altering individual relationships in isolation. Nevertheless, a descriptive analysis of the path coefficients reveals distinct behavioural patterns across stakeholders: Interaction emerges as the primary driver for the "Other" group, while participation proves to be the most influential factor for "Farms".

Table 1 – Structural path estimates, significance, and confidence intervals

	Original estimate	Bootstrap Mean	Bootstrap SD	T Stat.	2.5% CI	97.5 % CI	f^2 effect size
Information → Outcomes	0.103	0.106	0.038	2.678	0.032	0.183	0.011
Interaction → Outcomes	0.236	0.237	0.056	4.229	0.125	0.348	0.047
Participation → Outcomes	0.286	0.286	0.056	5.153	0.176	0.394	0.058
R^2 (Outcomes)	0.283						
R^2 adjusted (Outcomes)	0.279						

Figure 2 – Distribution of prediction errors for the perceived project outcomes construct

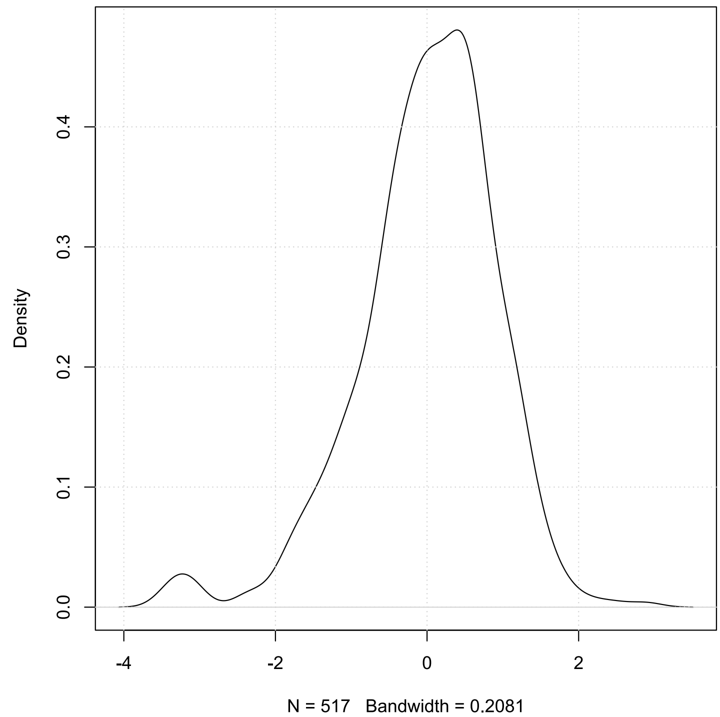


Table 2 – Path coefficients across participants' roles and MGA significance

	Research Institutes		Farms		Other		Significant MGA comparisons
Information → Outcomes	0.148	*	0.208	*	0.108		None
Interaction → Outcomes	0.236	**	0.223	*	0.341	***	None
Participation → Outcomes	0.248	***	0.321	**	0.207	*	None

Note: Coefficients are group-specific standardised path estimates. Asterisks denote within-group significance based on bootstrapping (* p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001). The last column reports significant pairwise differences between groups according to the Chin & Dibbern (2010) permutation-based MGA test with 10,000 resamples. "None" indicates that no pairwise group difference is significant at the 5% level.

5 Discussion

The results show that the communication process is positively associated with the perceived outcomes of EIP-AGRI OG projects, in line with existing literature. Among the three dimensions considered, participation exhibits a stronger relationship than interaction, and even more so than information. This finding partly contrasts with strands of the literature that primarily emphasise interaction as the key mechanism for fostering the application and dissemination of agricultural innovations (Arzeni et al., 2023), suggesting that more active forms of engagement may play a particularly relevant role in shaping participants' outcome perceptions. One possible explanation is that participation brings together individuals with heterogeneous skills, thereby enriching the pool of knowledge useful for the project (Edelenbos & Klijn, 2006). Moreover, participatory processes may increase support from partners for project activities by giving legitimacy to the decisions made and fostering a stronger sense of involvement in decision-making (Michels & de Graaf, 2010).

Analysing the individual communication actions, it emerges that information reserved for members and direct contacts, although frequently used, is not as relevant for the information process compared with more public, accessible, and potentially verifiable sources of information. Regarding interaction, knowledge exchanges with those who innovate or apply innovation emerge as particularly important. At the level of participation, remote activities show the strongest contribution. This result may be influenced by the COVID-19 pandemic period during which the survey was conducted, which increased reliance on remote forms of collaboration. In any case, the pandemic has facilitated the spread of participatory methods that have now become part of daily practice.

Overall, the findings indicate that information provision alone is unlikely to be sufficient to shape positive outcome perceptions unless it is embedded within interactive and, above all, participatory communication processes. From this perspective, information, interaction, and participation appear complementary rather than substitutable. Strengthening information activities may therefore further enhance perceived outcomes when such activities are integrated with opportunities for dialogue and active engagement.

The analysis does not provide evidence on whether the overall level of stakeholder participation in OGs is low or insufficient. Instead, it highlights that, when participation is more pronounced, perceived project outcomes tend to be more positive. In this context, the practices discussed in the literature on stakeholder engagement (Hollmann et al., 2022) can be interpreted as illustrative examples of how participation may be facilitated in collaborative research projects, rather than as prescriptive rules or indications of existing shortcomings.

In this regard, results suggest that engagement should be segmented: while consultants, SMEs, and other institutional actors involved in OGs require a relationship-based approach where interpersonal interaction is the catalyst for perceived results, farmers demand an involvement-based strategy. For the latter, the mere provision of information is insufficient unless accompanied by active participation in the project's developmental stages. Within OG projects, the stakeholder engagement plan, including a strategy for collecting feedback from partners, can be detailed within the activity plan required by policymakers during the application phase. Alternatively, the engagement plan could be defined at a later stage to regulate the functioning of the OG through the creation of an internal document.

While drafting and managing the plan can be supported by communication specialists, previous studies highlight the importance of intermediary or brokerage functions in facilitating dialogue, mediating between different interests, and supporting coordination among partners (Parzonko et al., 2022). In the Italian context, these intermediary functions have often been only partially institutionalised, especially to manage the initial phases of aggregating subjects potentially interested in creating OGs. In most cases, they have been distributed among partners with different skills and specialisations, overloading partners with responsibilities beyond their expertise. This is also confirmed by the sample survey on which this study is based, which shows a lower frequency of contacts with facilitating subjects. Evidence from case studies suggests that when brokerage is weak, projects may face issues related to sharing problems and results, polarisation of viewpoints, and excessive dominance of one or more partners, potentially undermining otherwise valid projects (Ascione et al., 2022).

From a policy perspective, the findings of this study point to the importance of strengthening participatory and coordination mechanisms within OGs, without implying that existing levels of involvement are necessarily inadequate.

6 Concluding remarks

This study examined how different dimensions of communication, i.e., information, interaction, and participation, are associated with participants' perceived project outcomes within EIP-AGRI OGs. Using a PLS-SEM approach and survey data from Italian OG partners, the analysis provides evidence that communication processes matter, but not all dimensions contribute equally. Participation, especially for those who represent the main target of innovation (i.e., farms), emerged as the most relevant dimension associated with positive outcome perceptions, followed by interaction, while information alone showed a weaker association. These findings suggest that, in complex multi-actor innovation settings, the active involvement and engagement of participants play a more important role in shaping perceived project success than the mere circulation of information.

The study contributes to the literature on interactive innovation systems by offering an integrated analysis of communication dimensions and highlighting the importance of participation as a central mechanism in collaborative projects.

At the same time, several limitations must be acknowledged. First, the results are based on the responses provided by a limited sample of partners of completed OGs in a given period, while several other projects that could be analysed have concluded since the survey was completed. Second, the cross-sectional nature of the data limits the ability to assess dynamic effects of communication processes. Third, the dependent variable captures perceived outcomes rather than quantitative indicators of performance because of data unavailability. Using stakeholder perceptions to measure performance may lead to conclusions that are not applicable across different projects due to the unique environments in which each project operates (Liu & Walker, 1998). Moreover, stakeholders often have varying opinions on what defines good performance (De Graaf & Dewulf, 2010; Liu & Walker, 1998). Therefore, results should be interpreted accordingly.

Despite these limitations, the findings offer useful insights for policymakers and practitioners aiming to improve the design and governance of EIP-AGRI OGs by fostering meaningful participation among actors. Future studies should continue to expand the research on a larger sample, including all OGs that are gradually completed in the analysis. Moreover, they should combine perceptual indicators with objective outcome measures where possible and further investigate how communication processes affect the actual implementation and long-term impacts of innovation projects over time.

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