

IT TAKES FOUR TO TANGO: QUADRUPLE HELIX AND REGIONAL DEVELOPMENT IN SLOVAKIA

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Abstract: *The paper explores the application of the quadruple helix (QH) model in the creation and implementation of strategic documents of Slovak self-governing regions (NUTS III). Using the Programs of Economic Development and Social Development (PEDSD) as the main source, the study compares the involvement of the four helices - public sector, private sector, academia, and civil society - across all eight regions. To achieve this, a qualitative research design based on directed content analysis was employed, allowing the systematic identification of QH actor roles within the documents. The evaluation draws on a four-dimensional analytical scale capturing institutional involvement, level of participation, document emphasis, and impact on strategic content. The analysis reveals that the public sector remains the dominant actor, coordinating the planning process and ensuring alignment with national policies. The private sector is actively engaged in economically advanced regions, where industrial clusters and SMEs contribute to competitiveness and innovation, but less so in structurally disadvantaged areas. The academic sphere plays a fundamental role in shaping innovation and knowledge-oriented priorities, particularly in regions where universities directly coordinated or authored PEDSDs. By contrast, civil society exhibits the highest degree of variation: from active and institutionalized involvement in Bratislava, Nitra, Žilina, Banská Bystrica, Prešov, and Košice SGRs to largely symbolic or declarative engagement in Trnava and Trenčín SGRs. The findings suggest that while the QH framework is formally recognized across all regions, its practical application remains unbalanced. Stronger institutionalization of civic participation and more effective facilitation by regional authorities are needed to reduce asymmetries among helices and to realize the full potential of the model.*

Keywords: *quadruple helix model, regional development, Slovakia, strategic planning, participation*

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Introduction

The rapid evolution of globalization exerts pressure to adopt multidimensional and multisectoral approaches to effectively address ongoing changes. The complex challenges emerging from this dynamic are characterized by their resistance to resolution through simple, linear solutions or the actions of a single authority. Instead, their addressing requires coordinated simultaneous or sequential efforts from multiple actors (Kolehmainen et al., 2016).

In response to this need for collaborative problem-solving, contemporary discourse emphasizes the Quadruple Helix (QH) model as an extension of the Triple Helix model, highlighting the interdependence of government, business, and academia in fostering innovation (Etzkowitz, 1998). The QH model integrates civil society,

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acknowledging its critical role in co-creating and implementing sustainable innovations (Carayannis & Campbell, 2009).

This approach enables web-based services and Centers of Excellence to assist SMEs with multiple development scenarios tailored to their specific needs (Baltov et al., 2024). The model facilitates knowledge-sharing processes among stakeholders, with each helix playing distinct roles: bridging academics, resource-providing industry, observant government, and boundary-spanning civil society, creating a balanced framework for sustainability-driven collaboration (Hakeem et al., 2023). In practice, the quadruple helix addresses gaps in research and knowledge production while supporting innovation in creative industries through enhanced synergy between actors (Yusri et al., 2022). The inclusion of local communities as the fourth helix strengthens graduates' employable skills through outreach initiatives and collaborative partnerships, potentially leading to higher employment rates in knowledge-based societies and poverty alleviation through local community development (Shyiramunda & van den Bersselaar, 2024). In Finnish regions, the model facilitates civil society participation through three mechanisms: information exchange, feedback, and co-creation, supporting democratic participatory policy processes in regional research and innovation strategies (Roman & Feltnhofer, 2021). Similarly, Central European regions show that quadruple helix approaches strengthen regional competitiveness through smart specialization strategies, particularly in smart city development initiatives (Suzic et al., 2020).

In the Slovak context, it can be observed that regional strategic planning in Slovakia has undergone significant evolution following EU accession, with a particular emphasis on governance structures and innovation models. Smith (2007) examined strategic planning initiatives in the region, finding that bottom-up, endogenous approaches predominated but lacked coordination between local and regional development perspectives. Regional authorities faced legitimacy crises while attempting to fulfil coordinating functions, with alternative regionalization coexisting in overlapping spaces. The institutionalizing process created collaborative relationships between actors, though vertical integration remained challenging due to over-emphasis on local perspectives (Smith, 2007).

Zajko (2017) analysed Slovakia's Research and Innovation Strategy for Smart Specialization (RIS3), noting the country's struggle as a moderate innovator to implement the triple helix model effectively. The study recommended enriching the Slovak RIS3 strategy with open innovation paradigm facets to advance toward a quadruple helix concept, potentially elevating Slovakia among strong innovators in the EU context.

Also, on the broader scale, application of the QH model, especially in some EU regions and countries, is accompanied by several bottlenecks that are generally referred to as underdeveloped institutional contexts (Benner, 2019). Different studies revealed the following difficulties: identifying the appropriate spatial level for policy implementation, the top-down planning approaches, and limited capacities for evidence-based policymaking (Capello, Kroll, 2016), the lack of public-private coordination mechanisms, and the prevailing hierarchical policymaking culture (Kleibrink, Larédo, Philipp, 2017), and intra-

governmental complexity (Kroll, 2015). Moreover, low levels of trust in government further exacerbate institutional inefficiencies (Kleibrink, Larédo, Philipp, 2017).

These issues are not fully explored in the Slovak context, and therefore, to address this gap, this paper analyzes the extent and quality of the Quadruple Helix model's application in all eight Slovak self-governing regions by utilizing the Programs of Economic Development and Social Development (PEDSD) as the primary source, as these are the central strategic planning documents where actor engagement is formalized, and employing a directed content analysis based on a four-dimensional qualitative scale (Institutional Involvement, Level of Participation, Document Emphasis, and Impact on Content) to systematically evaluate the role of the public sector, private sector, academia, and civil society.

To guide this investigation, the study addresses three research questions: (1) How are the four helices represented in regional PEDSDs? (2) What differences exist in the depth, form, and consistency of their involvement? (3) To what extent do the documents operationalize the core principles of the QH model in regional strategic planning?

The original contribution of the article lies in demonstrating how the QH framework can be systematically applied to strategic development documents - an underexplored domain - thereby revealing how actor roles, participatory mechanisms, and governance capacities become formalized within regional planning processes.

This analytical approach is methodologically grounded, as the QH model provides a structured lens for tracing collaborative interactions and institutionalized participation, making it particularly suitable for document-based content analysis where actor engagement is expressed textually and procedurally.

The remainder of the paper is structured as follows. First, the institutional and socio-economic characteristics of Slovak self-governing regions are introduced, providing the contextual basis for the analysis. The subsequent sections examine in turn the role of the public sector, private sector, academic institutions, and civil society in the preparation and implementation of regional Programs of Economic Development and Social Development. This is followed by a comparative discussion that situates the Slovak case within broader debates on the quadruple helix model. Finally, the conclusion synthesizes the main findings, identifies persistent asymmetries between the helices, and outlines implications for regional policy and future research.

Literature Review

The current academic discussion on regional policy and innovation governance centers on the paradigm shift from centralized planning to multi-actor cooperation. This literature review systematically traces the evolution of innovation models from the Triple Helix to the Quadruple Helix framework and analyzes the operationalization of the latter within European regional strategic planning, focusing specifically on documents like the Slovak Programme of Economic Development and Social Development (PEDSD).

1. Transition from Triple Helix to Quadruple Helix Model

The discourse surrounding innovation and regional development has progressively moved beyond linear models towards more interactive and network-centric frameworks. This evolution is perhaps best captured by the progression from the Triple Helix (TH) model to the Quadruple Helix (QH) model.

The foundational Triple Helix model conceptualized the innovation process as an interactive spiral of linkages among three core institutional spheres: university (academia), industry (business), and government (Etzkowitz, 1998). The TH model was instrumental in shifting focus from government or firm-centric models to one that highlights the critical role of universities in driving economic growth and creating new firms through knowledge transfer (Carayannis, Campbell, 2012).

Building on this, the need to address complex societal issues and ensure the sustainability and legitimacy of innovation led to the development of post-TH concepts. Carayannis and Campbell (2009) introduced a refined model, which integrates the three original helices with a crucial fourth actor: civil society or the 'public'—the Quadruple Helix (QH) model. This inclusion acknowledges that innovation is no longer solely a techno-economic process but must be rooted in societal values and needs (Morales et al., 2025).

The QH framework formally defines the four interdependent spheres:

- academia (the knowledge base): the generator of fundamental knowledge and human capital,
- industry (the economic base): the driver of technological innovation and market exploitation.
- government (the regulatory base): the provider of stable conditions, funding, and legal frameworks.
- civil society (the user/societal base): including media, arts, culture, and citizens; this helix provides essential feedback on societal needs, drives social innovation, and confers legitimacy and co-ownership on the innovation process (Roman & Fellnhöfer, 2022; Roman et al., 2020).

2. Application of the QH Model in Regional Development

The theoretical foundations of the QH model find their most significant practical application within the framework of European regional policy, particularly in the governance of innovation. The integration of quadruple helix stakeholders into strategic planning documents varies considerably across regions and development stages. Strategic documents mentioned across studies include Smart Specialisation Strategies (RIS3), regional development plans, and general innovation strategies (Andriienko, 2025).

The evidence suggests three prevalent models of helix integration: (1) highly formalized structures with dedicated intermediary agencies (e.g., Lithuania) (Andriienko, 2025), (2) participatory mechanisms embedded within existing regional governance (e.g., Finland) (Andriienko, 2025), and (3) informal coordination with limited institutional support (e.g., Poland) (Łacka, 2020). Regions with stronger formal mechanisms demonstrate more substantive co-creation evidence, including co-developed policy

priorities and co-governance structures, while those relying on informal processes show weaker collaborative outcomes.

The QH model acts as the normative ideal for multi-actor governance in regional strategic planning. Strategic documents, such as the Slovak Programs of Economic Development and Social Development (PEDSD), are intended to function as integrated frameworks where the priorities and inputs of all four helices are formalized and actionable (Sedlačko, 2007). Effective governance in this context is defined by the capacity of regional authorities to facilitate genuine horizontal collaboration and translate the diverse perspectives of all four actors into coherent, implementable policies (Willi, Pütz, Müller, 2018).

The degree of helix integration into strategic documents serves as a reliable indicator of implementation depth. Lithuania's 500+ stakeholders in S3 design and Finland's participatory foresight process represent substantive integration producing co-created priorities and governance structures (Andrienko, 2025). Poland's informal stakeholder interaction in strategy development reflects shallower integration (Łacka, 2020), while Romania shows intermediate integration through a particular project participation but with noted gaps in stakeholder connections (Aldea Lopponen, 2025). This deep integration is crucial because formal planning documents institutionalize commitments, allocate resources, and create accountability mechanisms. Regions achieving deeper strategic document integration show stronger outcomes across innovation funding, competitiveness improvements (Suzic, Ulmer, Schumacher, 2020), and social capital development (Horváth, Kovács, Szóke, 2015). This validates the focus on strategic document involvement as a meaningful dimension of quadruple helix implementation rather than merely procedural formality.

3. The Quadruple Helix in Slovak Strategic Documents

The Programme of Economic Development and Social Development (PEDSD) of Slovak Regions represents a critical strategic document that can leverage the Quadruple Helix model to drive comprehensive regional innovation and growth.

It is defined as a key medium-term strategic document in Slovakia, crucial for planning and managing development at both the regional (Higher Territorial Units/self-governing regions) and local (municipalities, towns) levels. The obligation for self-governing bodies to prepare the PEDSD is set out in Act No. 539/2008 Coll. on the Support of Regional Development, as amended. It is typically prepared to align with the European Union's programming period (e.g., 2021 – 2027, with an outlook until 2030).

Based on the valid legislation, the core purpose of the document is:

- to identify the territory's strengths and weaknesses, its potential, and its development needs (analytical section);
- to define the strategy, vision, objectives, and priorities for development across various sectors (economy, social sphere, environment, transport, education, culture, etc.);
- to ensure the optimal, balanced, and sustainable economic and social development of the area.

The PEDSD is the fundamental document serving as the basis for securing funding, particularly from the European Structural and Investment Funds (ESIF) and state subsidies. If a territorial unit does not have an approved PEDSD in compliance with the valid methodology, it is ineligible to apply for these resources.

Crucially, the PEDSD is built upon the principle of partnership and territorial cooperation, where the involvement of actors from the Quadruple Helix model (from government self-administration through academics and businesses to citizens) is essential for the legitimacy, quality, and successful implementation of the development strategy in the region. Furthermore, the Quadruple Helix model provides a robust framework for integrating all helices in collaborative regional development (Roman et al., 2020).

In the Slovak context, such a strategic approach is particularly important, as it enables cross-sectoral partnerships that can address complex regional economic challenges (Vojtech et al., 2019). The model's strength lies in its ability to facilitate knowledge creation, institutional bridging, and participatory policy-making (Galvão et al., 2017). By embracing this approach, the strategic document can potentially enhance regional competitiveness, stimulate innovation, and create more responsive economic development strategies that account for the diverse needs of local stakeholders (Vrablikova et al., 2023).

Data and Methodology

This study applies a qualitative research design with a focus on content analysis of strategic documents – in particular the Programmes of Economic Development and Social Development of all 8 self-governing regions (NUTS III) in Slovakia – Bratislava Self-Governing Region (BA SGR), Trnava Self-Governing Region (TT SGR), Trenčín Self-Governing Region (TN SGR), Nitra Self-Governing Region (NR SGR), Žilina Self-Governing Region (ZA SGR), Banská Bystrica Self-Governing Region (BB SGR), Prešov Self-Governing Region (PO SGR) and Košice Self-Governing Region (KE SGR).

1. Description of Regions

Slovakia is divided into eight self-governing regions that correspond to the EU NUTS III level and are the principal territorial units for regional development planning in Slovakia. The regions are: Bratislava Self-Governing Region (BA SGR), Trnava Self-Governing Region (TT SGR), Trenčín Self-Governing Region (TN SGR), Nitra Self-Governing Region (NR SGR), Žilina Self-Governing Region (ZA SGR), Banská Bystrica Self-Governing Region (BB SGR), Prešov Self-Governing Region (PO SGR), and Košice Self-Governing Region (KE SGR). Each region produces a medium-term strategic framework commonly called Program of Economic Development and Social Development (PEDSD), which functions as the basic regional strategic document used for designing and coordinating regional policy and investment. Some basic data regarding the eight self-governing regions of Slovakia can be found in Table 1.

Table 1. Selected indicators of self-governing regions of Slovakia

Region	Area (km ²)	Population (in 1 000)	GDP/capita (in 2023)	Unemp. rate (in 2025 in %)	Muni.	Enter.	Uni.
BA	2 053	733	54 811	3,25	89	109 544	11
TT	4 147	556	30 034	3,69	251	27 608	3
NR	4 502	594	23 406	3,69	276	21 734	2
TN	6 343	690	24 297	3,86	354	33 462	3
ZA	6 809	689	23 981	4,72	315	29 218	2
BB	9 455	661	21 176	8,28	516	25 845	4
KE	8 973	815	17 113	9,94	665	26 149	2
PO	6 752	792	23 137	8,74	461	31 957	4

Legend: BA – Bratislava Self-Governing Region, TT – Trnava Self-Governing Region, TN – Trenčín Self-Governing Region, NR – Nitra Self-Governing Region, ZA – Žilina Self-Governing Region, BB – Banská Bystrica Self-Governing Region, PO – Prešov Self-Governing Region, KE – Košice Self-Governing Region, Un. Rate. – unemployment rate in 2025, Muni. – number of municipalities, Enter. – number of enterprises – legal persons, Uni. – number of universities located in the region

Source: website of Self-Governing Regions and the PEDSDs of Regions

The regional economic and innovation landscape of Slovakia exhibits significant variation, which has implications for the application of the QH model. The Bratislava SGR demonstrates a strong research and private sector presence, characterized by prominent higher education institutions and dense clusters of services, IT, finance, and automotive suppliers. This concentration allows QH initiatives to leverage existing R&D capacity and international networks; however, urban inclusion, housing, and transport challenges remain important considerations.

In the western and central regions, including Trnava, Trenčín, Nitra, and Žilina SGRs, the economic structure is more mixed, combining industrial bases with agricultural activities. Here, there is substantial potential for industry–university collaboration and applied research, and regional strategic documents frequently emphasize competitiveness and skills development.

By contrast, the eastern and more rural regions, such as Košice, Prešov, and Banská Bystrica SGRs, tend to have lower GDP per capita and higher unemployment in certain areas. Strategic documents in these regions typically prioritize job creation, social inclusion, and local entrepreneurship, suggesting that QH initiatives may be most effective when focused on fostering local innovation ecosystems, supporting social enterprises, and implementing targeted workforce retraining programs.

2. Analytical Framework of the Study

The analytical framework is grounded in the Quadruple Helix (QH) model, which conceptualizes innovation and development processes through the interaction of four key societal actors: public administration, academia, private sector, and civil society. The primary objective is to assess the degree, form, and quality of QH actors' involvement in the formulation and implementation of the Program of Economic Development and Social Development (PEDSD) of Slovakia's self-governing regions.

The empirical material consisted of the latest PEDSD documents, valid in the most recent programming periods, mostly for the years 2021–2027, 2023–2027, 2021–2030, or 2022–2030 (for details, see references). But in the case of Trnava SGR, the latest published version was for the years 2016–2022. All the documents were retrieved from the official portals of the self-governing regions and related public databases. Only officially adopted and final versions of the programs were included in the analysis to ensure comparability. In addition, methodological manuals and national-level guidelines were reviewed to contextualize the process of document preparation.

A directed content analysis was used to systematically examine the documents. The coding framework was elaborated by the author, and it was structured around four dimensions of actor involvement, with each assessed according to a qualitative scale. Further, each characteristic was associated with a number (in brackets) that allows for better data visualisation. The full description of the characteristics is included in Annex 1.

The qualitative scale was as follows:

1. Institutional Involvement
 - Essential / Steering / Executive (4)
 - Formal Partnership / Expert (3)
 - Indirect / Weak (2)
 - None (1)
2. Level of Participation
 - Direct and Intensive / Steering (4)
 - Direct and Consultative (3)
 - Passive / Low (2)
 - Minimal (1)
3. Document Emphasis
 - High and Constant (4)
 - Medium / Targeted (3)
 - Low / Marginal (2)
 - None (1)
4. Impact on Content
 - Fundamental (4)
 - Significant (3)
 - Indirect / Partial (2)
 - Minimal / None (1)

This four-dimensional qualitative scale enabled the evaluation of actors' involvement based on concrete textual evidence rather than subjective impressions. This evidence was identified during the reading of all eight PEDSDs by the author. The assessment process included the evaluation of the document content, identification of individual chapters, assessment of the description of document design, and preparation and also the analytical, strategic, and implementation sections of the document.

Each PEDSD document was coded independently. A comparative synthesis was then performed across all self-governing regions, identifying commonalities and differences in the application of the Quadruple Helix model.

The analysis was restricted to official, publicly available documents, which may not fully capture informal interactions or behind-the-scenes negotiations. Furthermore, while the qualitative approach provides in-depth insights, it does not permit statistical generalization of the findings.

Findings

This section presents the empirical results of the Quadruple Helix (QH) model application across the eight self-governing regions of Slovakia, detailing the involvement and specific roles of the four distinct pillars: the public sector, private sector, academic sphere, and civil society. The analysis confirms that while all four sectors are engaged in the development and implementation of the Program of Economic Development and Social Development (PEDSD) documents, the intensity and form of this involvement vary significantly across regions, leading to a demonstrable government-centric approach where the public sector is the dominant driver. The subsequent subsections systematically examine the function and influence of each helix, highlighting regional differences and the overall dynamics of multi-sectoral cooperation in strategic regional planning.

1. The role of the public sector in the application of the QH model in self-governing regions

The involvement of the public sector in the creation and implementation of the Program of Economic Development and Social Development (PEDSD) of self-governing regions is a key element of the application of the QH model at the regional level in Slovakia. The analysis of documents from all eight regions shows that the public sector plays a dominant and irreplaceable role in all phases of the process – from procurement, through coordination, to implementation and monitoring (Fig. 1).

In the western Slovak regions (Bratislava, Trnava, Nitra, and Trenčín SGRs), the involvement of public administration is characterized by a high degree of formalization and centralized management. The Bratislava SGR used the expert potential of the Institute of Regional Policy and international know-how (e.g. the JASPERS working group), while emphasizing the direct involvement of all municipalities and city districts. The Trnava SGR based the process on commissions and representatives, thus ensuring a close link to the legislative and competence frameworks of local government. The Nitra and Trenčín SGRs developed participatory mechanisms at the level of strategic planning regions, with an emphasis on coordination with state agencies and employment offices. In the northern Slovak environment (Žilina SGR), public administration presented itself as an initiator and integrator, which created an extensive network of thematic and territorial working groups with the participation of approximately 80 experts and representatives of local governments. This

model of participation allowed not only formal involvement, but also real co-creation of strategic priorities, for example, in the area of transport accessibility and digital transformation.

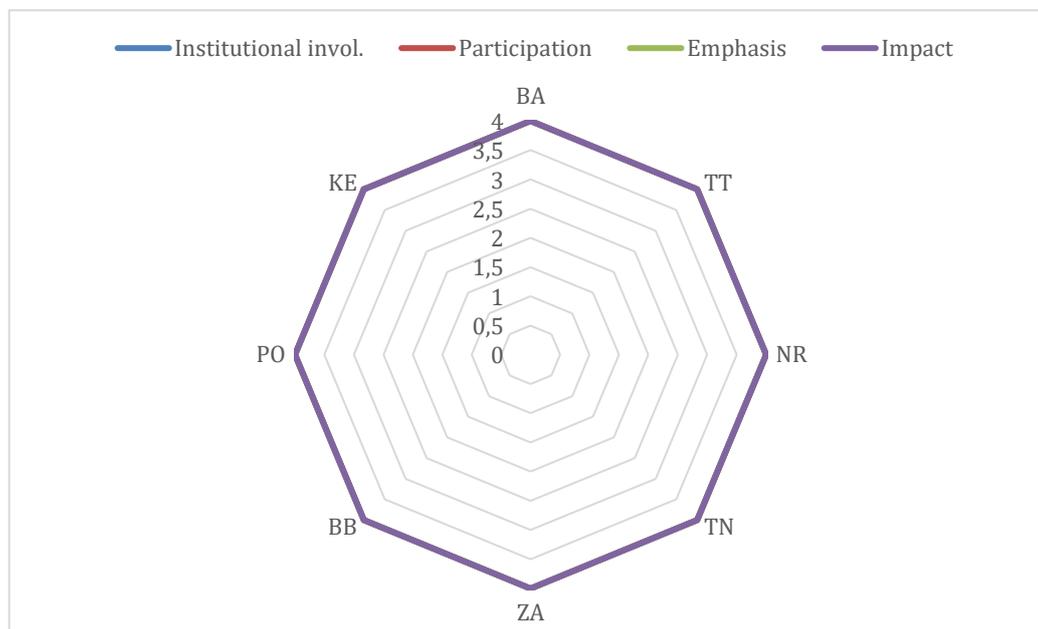


Figure 1. Public sector involvement in strategic planning

Source: own processing

The Eastern and Central Slovak regions (Banská Bystrica, Prešov, and Košice SGRs) show an even more pronounced dominance of the public sector, as the self-governing regional offices themselves were the main processors of PESD documents. In the Banská Bystrica SGR, the authoring team was formed internally within the regional development department, which ensured a strong link between the document and the region's own competencies and needs. Similarly, the Prešov and Košice SGRs processed the PESD through internal capacities, while creating new institutional structures (Partnership Councils and cooperation councils). In these regions, the majority of municipalities were directly involved in the process, and thousands of project plans were collected, which served as the basis for the creation of project pipelines.

A comparison of all regions indicates that the public sector is not only the bearer of legal competencies in the process of creating and implementing PESD, but also the main guarantor of participatory mechanisms. Its dominant role ensures consistency with strategic documents at the national level and creates a framework for integrating the inputs of other actors. From the perspective of the application of the QH model, this means that Slovak regions are currently characterized by a government-centric approach, where the public sector is the key driving force and partners from other helices enter the process mainly on a consultative and project-oriented level. This model brings a high degree of coordination, but at the same time points to the challenge of how to strengthen autonomous and innovative inputs from the academic, business, and civil spheres, which could enrich strategic documents with a wider range of perspectives and solutions.

2. The role of the private sector in the application of the QH model in self-governing regions

An analysis of the Programs of the Economic Development and Social Development in all eight self-governing regions of Slovakia shows that business entities are perceived as key socio-economic partners and their needs are systematically reflected in strategic documents. However, the degree and forms of involvement show regional differences - from direct participation in working groups to consultation mechanisms (Fig. 2). As shown in Figure 2, particularly strong business involvement is seen in Bratislava, Nitra, and Košice regions compared to more consultative participation elsewhere.

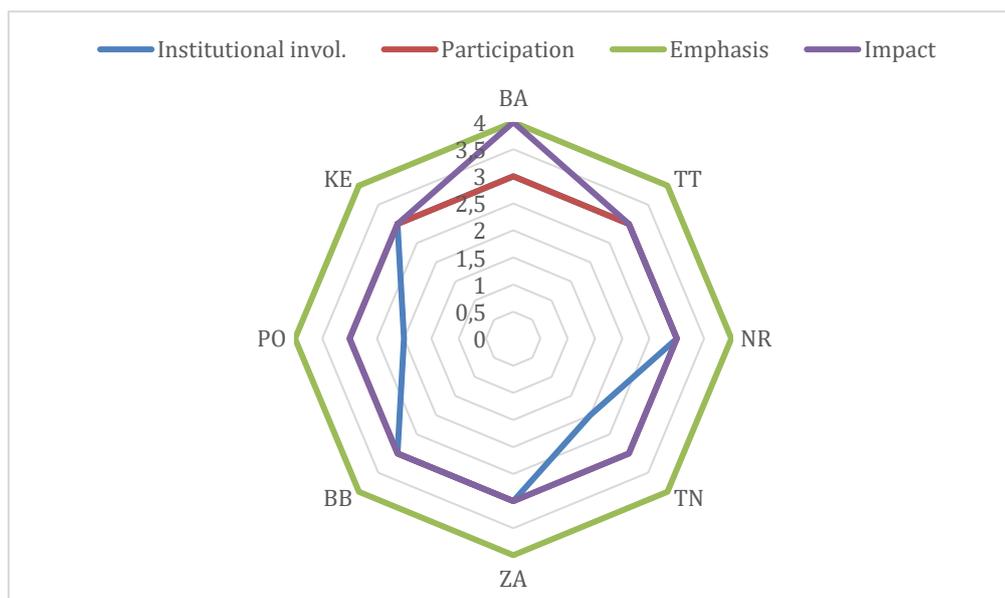


Figure 2. Private sector involvement in strategic planning

Source: own processing

The Bratislava SGR stands out for its strong and formalized involvement of the business sector, including the largest employers, chambers of commerce, and professional associations. More than 400 entities were involved in the process, and their inputs significantly shaped the strategic goals aimed at supporting SMEs, start-ups, and technology transfer. A similarly high level of participation was also recorded in the Nitra and Košice SGRs, where entrepreneurs acted as full members of working groups and actively participated in formulating priorities in the areas of industry, agriculture, innovation, and tourism.

The Trnava and Žilina SGRs emphasize the role of industrial clusters, chambers of commerce, and SMEs, which are identified as carriers of competitiveness and innovation. Their participation was mainly consultative in nature, but the result was the inclusion of measures to support cluster policy, internationalization of SMEs, and digital transformation of enterprises. In the Trenčín SGR, the private sector is explicitly less represented in the preparatory phase, but its importance in the implementation of the strategy is clearly declared - especially in relation to the modernization of industry and the revitalization of brownfields.

The Banská Bystrica and Prešov SGRs involved the business sector as part of wider partnerships, mainly through thematic working groups and questionnaire surveys. In both

cases, the economic dimension of the documents is elaborated in detail, and the priorities aimed at strengthening the business environment, supporting innovation, and digitalization reflect the requirements of regional enterprises. A specific feature of the Banská Bystrica SGR is the emphasis on cooperation within the triple helix, which systematically connects the business, public, and academic sectors.

Overall, it can be stated that in all regions the business sector is perceived as a key addressee of strategic priorities and measures, while its involvement goes beyond the symbolic level. Participation ranges from consultation forms to direct co-creation of the content of documents, which allows for a more effective connection of regional strategies with the needs of the labor market, innovations, and competitiveness. From the perspective of the QH model, this means that Slovak regions are already currently supported by a relatively robust business pillar, the strengthening of which may be the key to the transition to a knowledge-based and innovative economy.

3. The role of the academic sphere in the application of the QH model in self-governing regions

The academic sphere represents a fundamental pillar in the four-helix model (QH), which directly influences the quality of regional strategies with its expertise, research and development potential, and role in shaping human capital. An analysis reveals significant regional differences in the scope and intensity of university and research institution involvement in creating strategic documents (Figure 3). The study proved particularly high academic engagement in Bratislava, Nitra, and Trenčín, and comparatively lower involvement in Trnava.

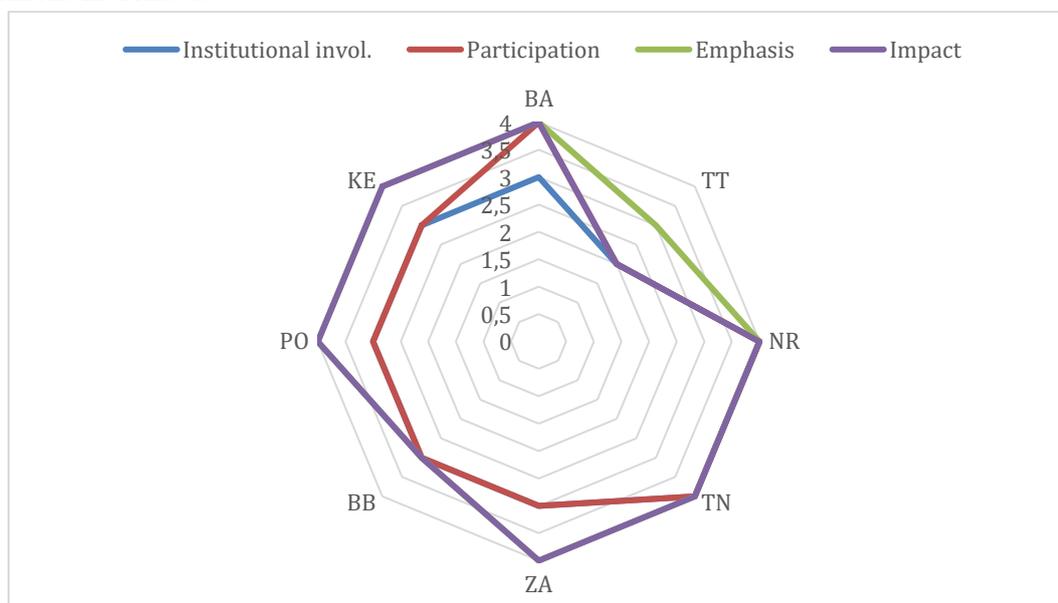


Figure 3. Academic sphere involvement in strategic planning

Source: own processing

The Bratislava SGR is characterized by the systematic and intensive involvement of the academic sector, which was perceived as a key partner for innovation and human

capital development. Representatives of universities, the Slovak Academy of Sciences and institutions with an academic background participated in the analytical and strategic parts of the document, contributing to the formulation of priorities focused on modern education, research and innovation. A similarly high level of participation can be observed in the Nitra and Trenčín SGR. In Nitra, the Slovak University of Agriculture played a key role in the development of the PESD, with university experts coordinating the work of thematic working groups and guaranteeing the methodology of the document. In Trenčín SGR, the document was developed directly by an academic entity – the SPECTRA Center of Excellence of the Slovak University of Technology, which ensured a fundamental influence of academic expertise on the structure and content of the strategy.

Significant and formal involvement can also be observed in the Žilina, Košice and Prešov SGRs. The University of Žilina and the Jessenius Faculty of Medicine of Comenius University in Martin were identified as key institutions of the regional innovation ecosystem, which directly shaped measures to support innovation hubs, clusters, and research centres. In Košice SGR, cooperation was based on three universities and eight departments of the Slovak Academy of Sciences, with the Technical University playing a special role in the creation of the regional hydrogen strategy and the Innovation Centre of the Košice Region. In Prešov SGR, the academic sphere was represented through the University of Prešov, which acted as the expert guarantor of the document and contributed to the priorities focused on innovation, education and stabilization of human resources.

On the contrary, in the Trnava SGR, the involvement of the academic sphere was rather indirect and limited, although the document explicitly acknowledges the importance of universities and research institutions for the support of innovation and the development of the knowledge economy. The Banská Bystrica SGR represents a medium level of involvement, where universities and research institutions participated mainly through consultation mechanisms and working groups, resulting in the inclusion of triple helix cooperation as a basic principle of SMART regional development.

Overall, it can be stated that the academic sphere is involved in Slovak regions at several levels - from symbolic partnership (Trnava SGR) through consultation and expert involvement (Banská Bystrica, Žilina, Košice, Prešov SGRs) to the management and implementation role of the processors of strategic documents (Nitra, Trenčín, Bratislava SGRs). In regions with the most intensive involvement of academic institutions, this was directly reflected in the structure of documents, in a strong emphasis on innovation, the knowledge economy, and in the creation of specific project packages. This confirms that the academic pillar of the QH model is not just a theoretical framework, but in the conditions of Slovak regions, represents an active actor that fundamentally influences the content and implementation potential of strategic documents.

4. The role of civil society in the application of the QH model in self-governing regions

The analysis shows significant differences in the level of civil society involvement in the processes of creating and implementing strategic documents. This pillar of the QH model represents a key factor in the development of inclusive and innovative regional policies, but its

application is differentiated in individual regions (Fig. 4). Figure 4 illustrates strong civil society participation in the Bratislava, Nitra, Žilina, Banská Bystrica, Prešov, and Košice regions, contrasted with notably weaker involvement in Trnava and Trenčín.

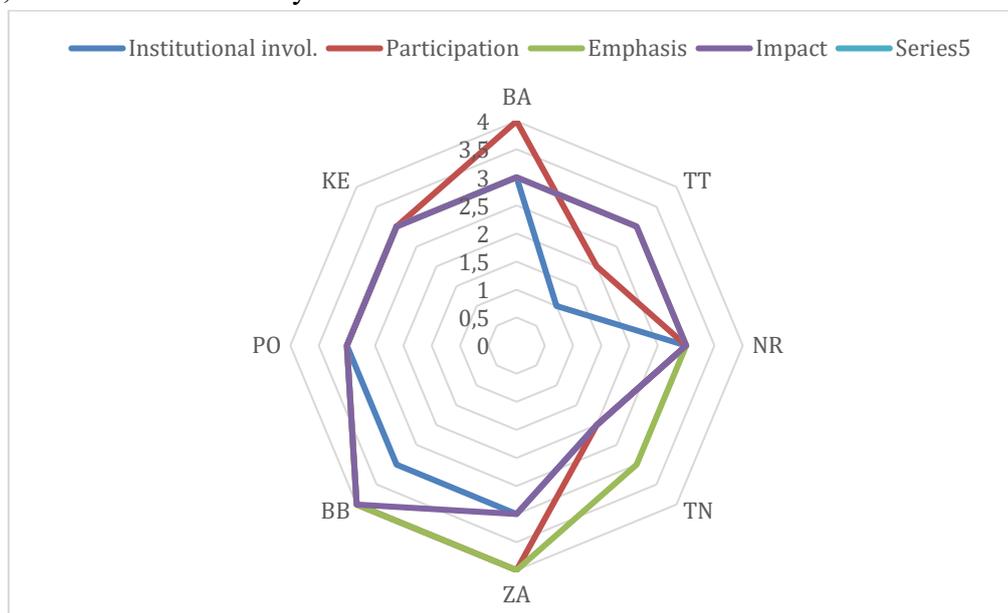


Figure 4. Civil society involvement in strategic planning

Source: own processing

In the Bratislava SGR, civil society involvement was the most intensive and broadest, with formal partnerships between the church and non-profit organisations in the areas of social care, education, environment, and culture. The participation process was supported by working groups, questionnaire surveys, and public discussions, with up to 93% of comments being incorporated. The result is a significant influence of the civil sector on the content of the strategy, especially in the topics of social inclusion and deinstitutionalisation of social services.

In contrast, the Trnava SGR shows rather passive involvement. Although the document acknowledges the role of civil society in the implementation of social and environmental policies, its institutional representation is lacking, and participation has been limited mainly to public comment. Similarly, in the Trenčín SGR, civil society is present mainly at the level of declared cooperation in the implementation of objectives, while direct evidence of its active participation in the development of the strategy is absent. In contrast, the Nitra, Žilina, Banská Bystrica, Prešov, and Košice SGRs provide examples of more systematic and multi-level involvement. In Nitra SGR, civil society associations participated directly in working groups, which allowed them to influence the development of specific measures (e.g., cycling or community development). In Žilina SGR, non-profit organizations were explicitly part of the thematic groups, and their inputs were reflected in environmental and social policy priorities. The Banská Bystrica SGR went even further, creating a separate working group for civil society and enabling a bottom-up approach through questionnaires and online forms. The Prešov and Košice SGRs integrate the civil

sector as an equal partner, while the PESD reflects the needs in the area of marginalized Roma communities, social care, and environmental sustainability.

The comparative analysis, therefore, shows that civil society is perceived as an active co-creator of public policies in some regions (BA, NR, ZA, BB, PO, KE), while in others (TT, TN) its participation remains largely declarative and passive. From the perspective of regional strategy development, it can be stated that although civil society is at least formally recognized in all regions, the degree of its involvement ranges across a wide spectrum – from symbolic participation to direct co-creation of content. To strengthen the effectiveness of the quadruple helix model, it is therefore necessary to systematically support institutionalized forms of civil society participation and ensure feedback mechanisms that will enable its inputs to be transformed into implementable policies and measures.

Discussion

The comparative analysis of Slovak self-governing regions demonstrates that the application of the quadruple helix model is uneven, particularly in relation to the role of civil society. While some regions (e.g., Bratislava, Nitra, Žilina, Banská Bystrica, Prešov, Košice SGRs) fostered active and institutionalized participation of the civic sector, others (notably Trnava and Trenčín SGRs) displayed more symbolic or passive engagement. Similarly, Roman et al. (2020) noted that civil society participation in European Union research and innovation strategies for smart specialization has remained low, despite strong policy emphasis on the QH model. This heterogeneity raises important questions about the institutional preconditions and governance cultures that enable or limit genuine citizen participation. Castillo-Vergara et al. (2024) identified government support as crucial for facilitating civil society participation, though technological dynamism did not directly influence societal engagement, revealing misaligned priorities between ecosystem actors. Further studies on regional innovation systems and governance could provide valuable insights here, especially regarding the relationship between formalized participatory mechanisms and the actual influence of civil actors on policy outcomes.

A further issue relates to the geographical and socio-economic context of participation. The more urbanized and economically advanced regions (e.g., Bratislava SGR) exhibited both higher civil sector activity and a stronger institutional framework for participation. By contrast, more rural or structurally disadvantaged regions often emphasized the civil society agenda mainly in relation to social inclusion and marginalized groups, but the quality of engagement varied. This pattern raises the question of whether the depth of civil society involvement is structurally conditioned by the region's economic profile, institutional capacity, and traditions of civic engagement. Analysis of Italian regions demonstrates that economic development and historical land distribution, not social engagement per se, predict effective democratic participation and governance quality (Solt, 2004). In U.S. counties, collaboration is driven more by business

involvement than robust civil society, with participation often limited to "token" citizen input mechanisms rather than meaningful, organized engagement (Campbell et al., 2017). Comparative literature on regional disparities and governance asymmetries could help confirm or challenge this interpretation.

In addition to the civil society dimension, the analysis also highlights the need to critically reflect on the role of the public and private sectors within the QH framework. The public sector, represented by regional self-governments, often acts as the formal initiator and coordinator of strategic documents, but its capacity to genuinely facilitate multi-actor cooperation varies. In some regions, the process remains largely top-down, limiting the transformative potential of collaborative governance. This is in contrast with the findings of Smith (2007), who found that public sector coordination faces legitimacy challenges, as demonstrated in Slovakia's Presov region, where regional authorities struggled with their coordinating function despite bottom-up strategic planning predominance. Such development, however, suggests some advancement in the field and improvement of the facilitation role of public authorities.

On the other hand, the private sector shows a strong presence, particularly in economically advanced regions (e.g., Bratislava, Trnava, Žilina SGRs), where industrial clusters, service industries, and foreign investors provide a natural base for innovation-oriented strategies. However, in less developed regions, private sector participation is weaker and often confined to specific industries such as agriculture or tourism. Such situation is supported also by evidence from Nartisa et al. (2012), who also stated that private sector participation appears particularly strong in economically developed contexts, as evidenced by comparative analysis between public and private sectors in Europe. However, private sector strategic planning exhibits certain characteristics: organizations tend to focus on short-term gains through daily actions while sometimes lacking long-term vision (Nartisa et al., 2012).

This unevenness raises questions about how public authorities can create enabling environments for broader business engagement and how private actors can be encouraged to see strategic planning not merely as an administrative exercise but as an opportunity for co-shaping regional development trajectories.

Finally, the Slovak experience points to broader implications for the quadruple helix model itself. While the theoretical framework assumes an equal role for government, academia, business, and civil society, the analysis suggests that the balance among helices remains uneven. Similar findings were declared by Hakeem et al. (2023), who found that while the Japanese sustainability project achieved a "balanced QH model" with distinct stakeholder roles, there was initially a significant gap between theoretical understanding and practical application.

Civil society's role is sometimes recognized only declaratively, while business and academic actors tend to dominate strategic planning. Similarly, Hasche et al. (2019) demonstrated the complexity of helix relationships in a Swedish regional innovation

system, concluding that the fourth helix (civil society) is far more complex than simply being a separate entity, as it encompasses various users and value-adding relationships.

This highlights a persistent tension within the model: whether it can truly function as a symmetrical partnership, or whether power asymmetries between the helices inevitably shape its practical application.

Recommendations

The analysis suggests that while the Quadruple Helix (QH) model is formally recognized, its application in Slovak self-governing regions remains government-centric and unbalanced. To move beyond a consultative, project-oriented partnership towards genuine co-creation and maximize the model's potential for sustainable innovation, the following recommendations are proposed, drawing inspiration from high-performing Slovak regions (like Bratislava, Nitra, and Košice SGRs) and international best practices (like Finland's co-creation models).

The public sector currently holds a dominant and irreplaceable role in coordination, procurement, and implementation. The challenge is to shift this role from centralized control to genuine facilitation and bridging between the other helices.

One possible way could be to create permanent, multi-helix Partnership Councils (as seen in Prešov and Košice SGRs) or Regional Innovation Councils with formal decision-making or veto power, not just consultative status. This moves engagement from a one-off planning phase to continuous governance. Another recommendation would be to address the bottleneck of low levels of trust noted in Central European contexts. This involves greater transparency in PEDSD funding allocation and publishing clear feedback on how inputs from other helices were incorporated (or why they were not). Finally, to train regional public servants on multi-actor facilitation and open innovation methodologies would enhance their ability to integrate autonomous inputs from academia and business, rather than merely coordinating a plan they internally authored.

In the case of the business sector, it can be stated that while it is robustly involved in economically strong regions (Bratislava, Nitra, Košice SGRs), its role in other regions is often consultative or solely focused on implementation. Engagement should be broadened to include strategic foresight and co-investment.

The private sector's participation in working groups, especially for SMEs and companies in structurally disadvantaged regions (Banská Bystrica, Prešov, Košice SGRs) could be directly funded or co-financed to encourage their participation. Introduction of a voucher system for SMEs to hire university expertise to solve problems, directly linking the private and academic helices. Another solution could be to move beyond general chambers of commerce involvement and formalize thematic working groups focused on emerging sectors (e.g., digital transformation, circular economy, hydrogen strategy, as seen in Košice SGR) to ensure business inputs are highly relevant and future-oriented.

The academic sphere already plays a fundamental role in regions where it was directly involved in document authorship (Nitra, Trenčín, Bratislava SGRs). The key recommendation is to formalize this "management and implementation role" across all regions, especially where involvement is limited (Trnava SGR). This could be done for example by requiring every PEDSD to undergo a mandatory review and validation of its analytical and strategic sections by a consortium of regional universities. This ensures that planning is evidence-based and incorporates international best practices. Another possibility is to create Memoranda of Understanding between regions and universities to co-develop regional statistics, conduct socio-economic analyses, and perform monitoring and evaluation of PEDSD implementation. This formalizes the academic role beyond the planning phase. Finally, it is possible to utilize university networks to translate PEDSD strategic priorities into educational programs and lifelong learning opportunities, directly linking human capital development to regional strategic goals.

Civil society involvement is highly differentiated, ranging from intensive co-creation to passive engagement. The primary goal should be to institutionalize the participatory successes of high-engagement regions (BA, NR, ZA, BB, PO, KE) and overcome the declarative nature observed elsewhere (TT, TN). A possible solution could be to create a dedicated, formally recognized Regional Civil Society Council in every region, with guaranteed seats on the main PEDSD governance body. This moves participation beyond ad-hoc public comments. Positive development in this respect could also be achieved by supporting bottom-up approach by systematically using participatory budgeting or local action groups (LAGs) to enable citizens and NGOs to propose and manage smaller PEDSD-aligned projects, giving civil society a direct role in implementation and resource allocation. Lastly, the emphasis could be on implementing targeted outreach mechanisms (like online forms, workshops in smaller towns, and specific consultations for marginalized Roma communities, as seen in Prešov and Košice SGRs) to ensure that the civil society pillar genuinely represents the diversity of the region, and not just established NGOs.

Conclusions

The analysis of the eight self-governing regions of Slovakia (NUTS III level) demonstrates that the application of the quadruple helix (QH) model in the design and implementation of strategic documents is both visible and regionally differentiated. Across all cases, the public sector remains the dominant actor, exercising its legal and coordinating competencies and ensuring alignment of regional strategies with national frameworks. This guarantees consistency and coherence but also reveals a strong government-centric approach that risks limiting the independent contributions of other helices.

The private sector plays an increasingly important role, particularly in more economically advanced regions such as Bratislava, Trnava, and Žilina SGRs. Here, industrial clusters, foreign investors, and SMEs actively participate in shaping strategic

priorities, which often focus on competitiveness, innovation, and internationalization. In less developed regions, however, business engagement is weaker and tends to concentrate on specific industries, highlighting the need for targeted measures to enhance the business pillar of the QH model in peripheral areas.

The academic sphere demonstrates a significant and growing influence on regional strategy-making, particularly in regions where universities and research institutes have acted as guarantors or processors of strategic documents. Their expertise has directly translated into stronger emphases on innovation, human capital development, and knowledge economy projects. Nevertheless, some regions still treat the academic role as largely symbolic, suggesting uneven institutionalization of academic contributions across Slovakia.

Finally, the role of civil society is the most uneven of the four helices. In regions such as Bratislava, Nitra, Žilina, Banská Bystrica, Prešov, and Košice SGRs, civil actors have been integrated into participatory structures and, in several cases, co-created strategic priorities, especially in areas of social inclusion, deinstitutionalization, and environmental policy. In contrast, Trnava and Trenčín SGRs show minimal or largely declarative engagement of civic organizations, which raises questions about governance culture, institutional support, and the mechanisms needed to strengthen genuine bottom-up participation.

Taken together, the Slovak experience confirms both the potential and the limitations of the QH model in regional development. While the academic and private sectors already provide substantial inputs and the public sector ensures strategic coherence, civil society remains the most fragile helix, with highly variable levels of influence. This imbalance points to the need for more systematic institutionalization of participatory mechanisms, stronger facilitation by regional authorities, and new incentives for business and academia to collaborate beyond their immediate interests. Addressing these asymmetries will be essential if the QH model is to fulfill its promise as a framework for inclusive, innovative, and sustainable regional development in Slovakia.

Importantly, the study contributes a novel analytical lens by applying the QH model directly to strategic development documents, thereby illustrating how regional policy frameworks embed - or fail to embed - collaborative governance principles. This offers policymakers concrete insights into where institutional capacities are strong, where participatory mechanisms remain underdeveloped, and how targeted interventions may enhance regional governance. Furthermore, the four-dimensional qualitative scale introduced in this study represents a methodological advancement that can assist both scholars and practitioners in systematically evaluating actor involvement, participation, document emphasis, and strategic impact across diverse regional contexts.

Future research could extend these findings by incorporating qualitative methods such as interviews or focus groups with key stakeholders to understand better the dynamics of collaboration and the barriers to participation within each helix. Comparative studies across regions in Central and Eastern Europe could reveal whether similar governance structures produce comparable patterns of QH interaction. Additionally, applying the methodological framework to longitudinal data would allow researchers to assess how

helix relationships evolve, particularly in response to new policy instruments, regional development initiatives, or shifting socio-economic conditions.

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Annex

Annex 1: The qualitative scale for the assessment of the documents:

5. Institutional Involvement

- **Essential / Steering / Executive (4):** The actor is directly named as the processor, procurer, manager, or main coordinator of the document. Participation is formally embedded in the structure of the creation process and is key to the document's development.
- **Formal Partnership / Expert (3):** The actor is explicitly listed as a socio-economic partner, external co-author, expert guarantor, or member of steering or working groups. While not the main processor, the role is formally recognized and institutionalized.
- **Indirect / Weak (2):** The actor is mentioned only in general terms (e.g., "private sector representatives"), without naming specific institutions. Involvement is not formalized.

- **None (1):** The actor or its representatives are not mentioned in the context of document creation.

6. Level of Participation

- **Direct and Intensive / Steering (4):** The actor actively and repeatedly participated in managing the process, including membership in management teams, coordination bodies (e.g., Partnership Council), and thematic working groups, directly shaping the content at multiple meetings.
- **Direct and Consultative (3):** The actor participated in public hearings, thematic working groups, or consultations, mainly providing feedback, comments, and expert input.
- **Passive / Low (2):** Involvement was limited to surveys, submission of project intentions, or the opportunity to comment on draft versions online. Interaction was one-way, without active discussion.
- **Minimal (1):** The actor contributed only statistical or formal data, without direct involvement in shaping content.

7. Document Emphasis

- **High and Constant (4):** The actor and its agenda are central to the document across analytical, strategic, and implementation parts. Separate chapters or priorities are dedicated to the actor, who is also identified as a key implementer.
- **Medium / Targeted (3):** The actor is highlighted in specific sections, typically in the analytical part (e.g., industry, third sector) and in strategies (e.g., innovation, social inclusion), but is not a dominant theme throughout.
- **Low / Marginal (2):** The actor appears only in some sub-sections or in relation to less-prioritized measures.
- **None (1):** The actor is absent from the document or appears only marginally.

8. Impact on Content

- **Fundamental (4):** The actor's inputs are directly reflected in the vision, strategic priorities, and integrated project packages. Its expertise shaped the overall direction of the region's strategy.
- **Significant (3):** Inputs led to the formulation of specific objectives, measures, or activities directly aligned with the actor's interests (e.g., dual education for companies, community services for NGOs).
- **Indirect / Partial (2):** The actor's agenda is visible in the strategy (e.g., problem analysis, proposed solutions), but direct inputs are not documented.
- **Minimal / None (1):** The actor's influence on the document is not apparent.