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Assessment of Organisational Innovation: An Analytical Framework for Higher Education Institutions

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Abstract

This study analyses the degree of organisational innovation (OI) in Spanish universities and its relationship with institutional competitiveness, proposing a robust analytical framework for its assessment. A mixed, sequential and explanatory design was used, integrating a documentary analysis of R&D indicators, semi-structured interviews with 15 university managers and the validation of an OI questionnaire applied to 387 engineering students and graduates. Qualitative data were analysed with ATLAS.ti 9 and quantitative data were analysed using confirmatory factor analysis and structural equation modelling (SEM) in AMOS v.27, obtaining satisfactory fit indices (CFI = 0.970; RMSEA = 0.051). The results reveal moderate development of OI (Organisational Innovation), with significant differences between institutions according to their level of digitisation, strategic policies and organisational culture. Creativity emerged as the main predictor of key competencies such as active learning and technological design, while excessive institutional openness had negative effects on self-management.

Keywords: organisational innovation; institutional competitiveness; knowledge transfer; higher education; data ecosystem; innovation ecosystem; university governance

1. Introduction

The development of organisational innovation (OI) in universities is a complex process that directly affects their institutional competitiveness and the regional innovation system [1–3]. Organisational innovation involves transforming structures, processes, and organisational culture to generate agile and sustainable responses to environmental demands [4,5]. In recent years, Spanish universities have made progress in adopting strategies that combine the digitisation of their processes with transparency and accountability policies, improving their interaction with external actors and strengthening social trust in their substantive functions [6–8].

However, despite these modernisation efforts, significant gaps remain in R&D investment, university–business collaboration and participation in international innovation programmes, limiting the impact of universities on regional development and their alignment with European standards [9–11]. These shortcomings underscore the importance of having a robust analytical framework that allows for the systematic evaluation of the degree of organisational innovation and its effects on skills training, knowledge transfer and value creation in the innovation ecosystem [12–15].

It should be noted that organisational culture plays a key role in driving innovation [13,16–18]. Today, we know that universities that promote a climate of learning and

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collaboration tend to achieve higher levels of innovation and talent attraction, consolidating themselves as strategic agents of territorial development [13,19,20]. This approach is aligned with the Triple, Quadruple and Quintuple Helix models, which highlight the need for interaction between universities, industry, government, civil society and environmental sustainability as a driver of social value creation [1,7,15,18,21].

Theoretical Background

The characteristics of the models previously mentioned highlight the importance of analytical frameworks in this field. The Triple Helix model represents, in general terms, a description of economic growth based on three unstable elements that maintain dynamic exchanges and unfold in a spiral form, according to Etzkowitz and Leydesdorff [21]. It emphasises three "helices" that intertwine and generate "trilateral networks" (relationships in which the helices overlap) (see Figure 1). These networks underscore the importance of interconnections that transcend boundaries through interdisciplinary, transdisciplinary and cross-sectoral formats. The model refers to a set of interactions between academia, industry and government aimed at fostering economic and social development [22–24]. According to the OECD [11] sector classification, the "political" system represents the governmental sector, the "economic" system corresponds to the business sector, and the "educational" system represents the higher education sector.

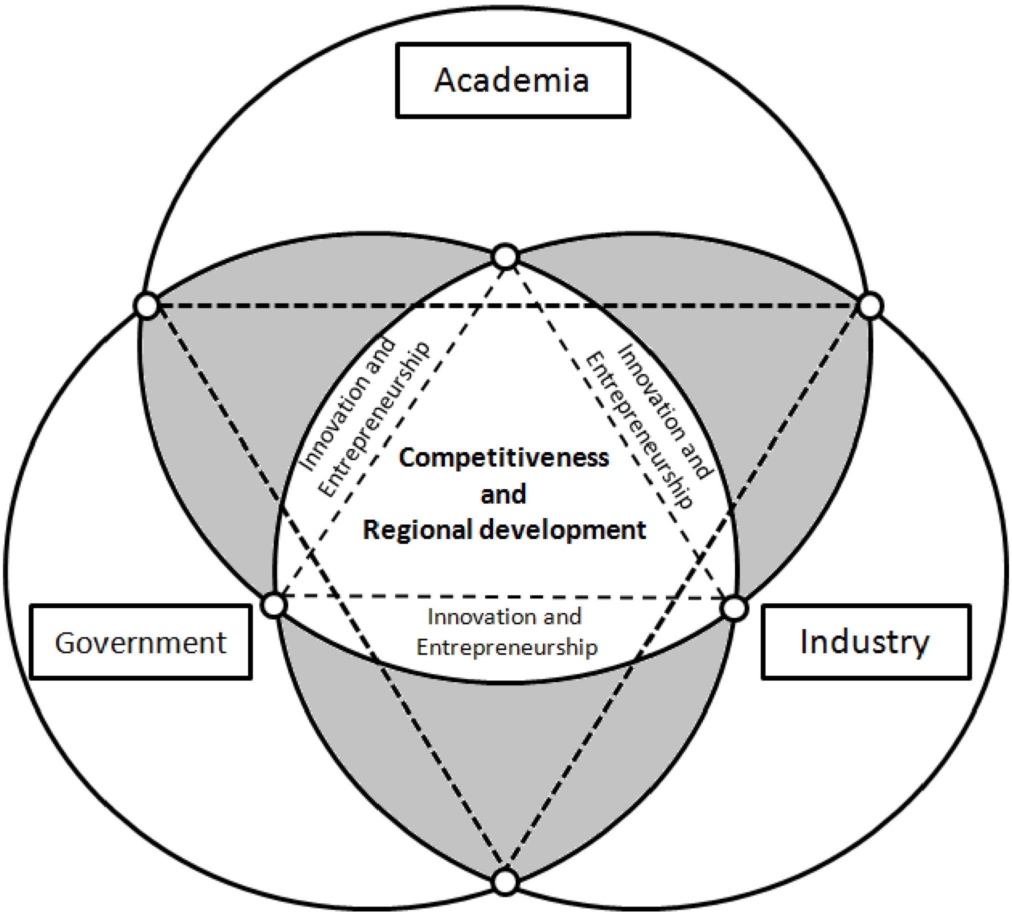

Figure 1. Triangulation of the Triple Helix: a conceptual framework. Note: Farinha and Ferreira [25].

Another model is related to the Quadruple Helix model, which extends the Triple Helix approach by incorporating a fourth subsystem: civil society, understood as the set of social, cultural and media actors that influence innovation processes. This model recognises that innovation is not generated solely through the interaction between universities, industry and government, but also depends on the active participation of citizens, end users and the sociocultural contexts in which knowledge is produced and applied [15,26] (see Figure 2). The Quadruple Helix highlights the importance of communication, social legitimacy and value co-creation, emphasising that innovation processes are more effective when they incorporate the needs, expectations and knowledge of society. In this way, innovation is conceived as an open, participatory and socially contextualised process, with direct implications for territorial development and social sustainability [12,23,26].

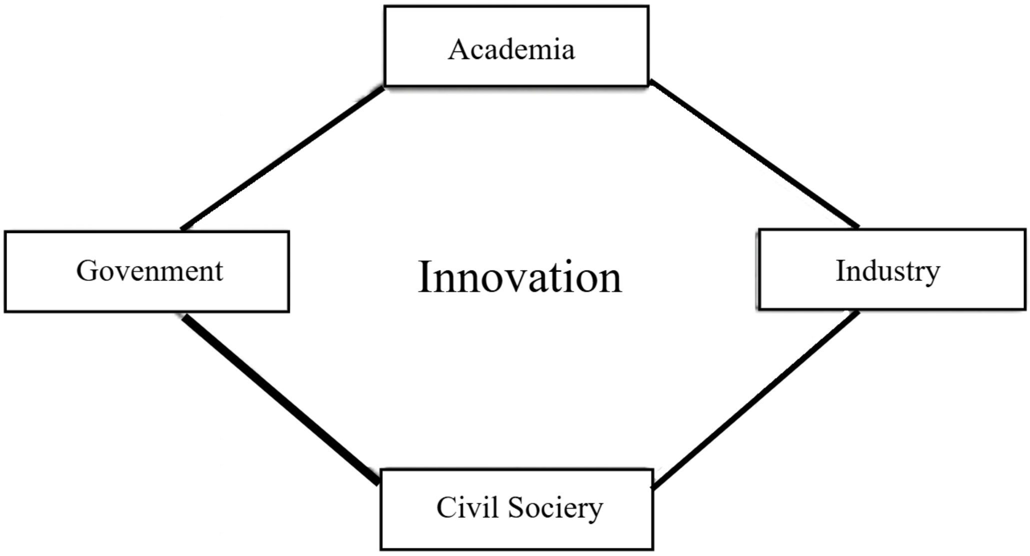

Figure 2. Organisational Innovation in Universities: The Quadruple Helix Perspective. Note: Own elaboration.

Organisational innovation is understood as a key factor in the ability of university education to adapt to complex environments and respond to the demands of the innovation ecosystem. From the perspective of the Triple, Quadruple and Quintuple Helix models, the role of interaction between universities, industry, government, civil society and the environment is highlighted as a foundation for institutional and territorial development. In this context, institutional competitiveness does not depend solely on external factors, but also on internal organisational capacities that enable the alignment of resources, strategies and management processes [15,26].

The literature evidences the persistence of mismatches between the competencies developed in university education and labour market demands, linked not only to curricular aspects but also to organisational and cultural dynamics [15,26]. Organisational innovation can contribute to reducing these gaps by fostering more flexible learning environments oriented towards the development of key competencies.

On this basis, the present study proposes a conceptual model in which organisational innovation acts as an antecedent of competency development and institutional competitiveness, and formulates the following hypotheses:

- H1: Organisational innovation positively influences competency development.
- H2: Competency development positively influences institutional competitiveness.
- H3: Organisational innovation positively influences institutional competitiveness.

In this context, the present study seeks to respond to the need to identify the extent to which University education develop organisational innovation and analyse its relationship with institutional competitiveness. To this end, a methodological framework is proposed that allows this process to be evaluated and strengthened in a systematic and sustainable manner, contributing to the formulation of university policies that are more coherent and aligned with environmental challenges [27]. In theory, the interaction between universities, businesses and government has been conceptualised through the Triple Helix model, which proposes these relationships as a driver of innovation [17,21]. Subsequently, the Quadruple Helix model broadens the perspective by incorporating civil society as a key actor, while the Quintuple Helix integrates the natural environment, emphasising the need to link innovation and sustainability in institutional strategies [18,28].

Furthermore, universities act as strategic agents in regional innovation systems (RIS3), articulating human capital, knowledge infrastructures and collaboration networks to generate sustainable competitive advantages [2,15,29]. From an educational innovation perspective, this role requires higher education institutions to develop flexible structures that favour interaction with external actors and knowledge transfer, generating tangible impacts on regional development [30–32]. According to Villa [33], the development of innovative skills in graduates must be consistently aligned with the institutional mission and the social and productive demands of the environment. University education not only generates qualified human capital but also responds to the needs of a labour market characterised by technological transformation and the knowledge economy [12,22,23,27].

Previous literature recognises the strategic role of universities within innovation systems and institutional competitiveness, as well as the relevance of models such as the Triple, Quadruple, and Quintuple Helix to explain their interaction with the environment. However, a gap persists in the empirical operationalisation of organisational innovation in higher education, particularly regarding the explicit linkage between organisational structures, competency development, and competitive impact. Existing studies tend to focus on partial indicators such as scientific output, technology transfer, or digitalisation without integrating these elements into an analytical framework that allows for an understanding of how organisational innovation translates into institutional and territorial value. In response to this limitation, the methodological framework proposed in this study represents a substantive advance by articulating organisational, cultural, and competency-based dimensions within an empirically validated model. This model not only enables the diagnosis of the level of organisational innovation in universities but also identifies its differential effects on the development of institutional competitiveness.

2. Materials and Methods

This study is part of a mixed, sequential and explanatory design that integrates qualitative and quantitative approaches to analyse organisational innovation (OI) in University education and its link to institutional competitiveness and regional development.

2.1. Objective and Research Question

The main objective is to design and validate an analytical framework for evaluating organisational innovation in University education, establishing its relationship with the development of competencies and institutional competitiveness. Table 1 shows the objectives, associated hypotheses, and expected outcomes.

Research question: To what extent do Spanish universities develop organisational innovation and how can its impact on institutional competitiveness and the regional innovation system be systematically evaluated?

2.2. Research Design and Phases

The research was carried out in two complementary phases: In the qualitative phase, semi-structured interviews were conducted with senior university management (vice-rectors for innovation, directors of strategic planning and heads of knowledge transfer) with the aim of identifying institutional perceptions, barriers and enabling factors for innovation.

In the quantitative phase, an ad hoc questionnaire was used to measure the dimensions of IO and its relationship with skills development, following the recommendations of Hair et al. [34] for the design of multivariate instruments.

Table 1. Study objectives, associated hypotheses, and expected outcomes.

Study Objective	Associated Hypothesis	Expected Outcomes
To analyse the influence of organisational innovation on competence development	H1: Organisational innovation has a positive influence on competence development	A positive relationship is expected between organisational innovation practices and the development of key competences.
To examine the relationship between competence development and institutional competitiveness	H2: Competence development has a positive influence on institutional competitiveness	Higher levels of competence development are expected to be associated with greater institutional competitiveness, understood as positioning capacity, graduate employability, and value generation within the surrounding environment.
To evaluate the direct effect of organisational innovation on institutional competitiveness	H3: Organisational innovation has a positive influence on institutional competitiveness	Higher levels of competence development are expected to be associated with greater institutional competitiveness, understood as positioning capacity, graduate employability, and value generation within the surrounding environment.

Note: Own elaboration.

2.3. Participants

The qualitative sample consisted of 15 university managers from 10 public universities and 5 private universities in different autonomous communities in Spain (Basque Country, Catalonia, Madrid, Andalusia, Valencian Community, and Castile and León). Institutional diversity (large, medium and small), professional experience (3–15 years in management positions) and gender balance (8 women and 7 men) were ensured.

The quantitative sample consisted of 387 students and graduates from engineering programmes at the University of the Basque Country (EHU), covering degrees in Industrial Organisation, Mechanics, Telecommunications, Electronics, Civil Engineering, Chemistry and Renewable Energy, thus providing broad coverage of the main branches of engineering taught at the institution. The gender distribution of the sample included 103 women (26.6%) and 284 men (73.4%), proportions that approximate the actual distribution of enrolment in EHU engineering degrees (around 25% women and 75% men, according to recent institutional data), which reinforces the representativeness of the data and the external validity of the results.

2.4. Instruments and Data Collection

Three main instruments were used:

- Innovation indicator matrices, constructed from official data from the INE, CRUE Spanish Universities, the European Innovation Scoreboard and the Science, Technology and Innovation Information System (SICTI), following the guidelines of the OECD Science, Technology and Innovation [11].
- A semi-structured interview guide, validated by expert judgement from a panel of five specialists in university management, educational innovation and knowledge transfer policies. The experts included three vice-rectors for innovation from public

universities, a director of strategic planning from a private university and a senior researcher in innovation systems, all with more than 10 years of experience in the field.

- Content validation was performed by calculating the content validity index (CVI) for each item, with values above 0.850 for relevance and consistency, and a Kendall's coefficient of concordance (W) of 0.890, indicating a high degree of agreement among judges. Following validation, the wording of two questions was adjusted to improve clarity. The interviews were conducted via videoconference, with an average duration of 45 min.
- Organisational Innovation (OI) assessment questionnaire, which underwent a rigorous process of content validation and psychometric analysis. Internal consistency was assessed using Cronbach's α coefficient (values between 0.800 and 0.900) and Composite Reliability (CR > 0.850), while convergent validity was confirmed through Average Extracted Variance (AVE > 0.500). In addition, discriminant validity was verified by applying the Fornell–Larcker (1981) criterion.

The interviews were transcribed and analysed in ATLAS.ti 9, using open, axial and selective coding to identify emerging categories and conceptual relationships.

2.5. Analysis Procedure

Data analysis was carried out using a methodological triangulation approach, which allowed the integration of qualitative and quantitative findings to strengthen internal validity and the interpretation of results:

- In the qualitative phase, the interviews were transcribed and processed in ATLAS.ti 9, applying open, axial and selective coding. From this process, semantic networks and co-occurrence diagrams were constructed, which facilitated the identification of emerging categories and the exploration of relationships between concepts.
- The interviews were fully transcribed and analysed independently, ensuring fidelity to the original discourse and consistency in the analytical process. The analysis was conducted following a process of open coding, axial coding and code co-occurrence analysis.
- In the initial phase of open coding, relevant units of meaning were identified directly from the text, generating initial codes that reflected the emerging concepts in the participants' discourse. Subsequently, through axial coding, the initial codes were grouped and reorganised into categories and subcategories, establishing relationships between conditions, actions and outcomes. Finally, a code co-occurrence analysis was carried out in order to identify the frequency and intensity of relationships between the emerging concepts. For this purpose, the ATLAS.ti table explorer was used to generate co-occurrence matrices and to visualise the relationships between codes through graphical representations, such as co-occurrence networks and flow diagrams. These tools facilitated the identification of dominant factors in the discourse and strengthened the interpretative validity of the findings.
- In the quantitative phase, descriptive statistics were calculated, and exploratory factor analysis (EFA) was performed in SPSS v.27 to examine the underlying structure of the data and ensure the relevance of the items. Subsequently, confirmatory factor analysis (CFA) and structural equation modelling (SEM) were performed in AMOS v.27 to test the theoretical model and verify the hypotheses.

The measurement model was evaluated using confirmatory factor analysis. The main fit indices χ^2/df (expected < 5), CFI and TLI (>0.900), RMSEA (<0.080) and SRMR (<0.050) were calculated. Convergent validity was also verified (factor loadings > 0.700 and AVE > 0.500). Finally, apparent validity was confirmed through expert review and content judgement.

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3. Results

This section presents the findings derived from the two complementary phases of the research: the qualitative phase, aimed at identifying emerging patterns of organisational innovation based on discourse analysis of university stakeholders, and the quantitative phase, focused on the empirical validation of the structural model that links the dimensions of organisational innovativeness with the professional competencies of students and graduates.

3.1. Open Coding

The results made it possible to identify and fragment the discourse of university managers into units of meaning, without imposing predefined categories, following an inductive approach. Based on the analysis of the interview transcripts, a set of initial codes was generated. This process resulted in 14 groups of initial codes, which were subsequently refined and reorganised in later analytical phases. These codes represent the most recurrent and significant themes in the managerial discourse. Table 2 shows the results of the open coding.

Table 2. Results of open coding: identified initial codes.

Code Group	Emerging Codes (Examples)	Discourse Content
Organisational innovation	Methodological innovation, management innovation, process innovation	Organisational and pedagogical changes
Digital transformation	Digitalisation, educational technology, digital systems	Strategic use of technologies
Institutional resources	Lack of resources, insufficient funding, infrastructure	Structural constraints
Teaching staff	Teaching engagement, resistance to change, staff training	Key role of teaching staff
University governance	Leadership, strategic planning, decision-making	Institutional management and direction
Knowledge transfer	Transfer, external collaboration, joint projects	Relationship with the environment
University–industry relationship	Business linkages, professional placements	Employability and cooperation
Innovation ecosystem	Networks, alliances, regional environment	Territorial articulation
Competency development	Active learning, autonomy, professional competencies	Educational impact
Institutional competitiveness	Positioning, rankings, reputation	Institutional comparison
Innovation evaluation	Indicators, technological output	Performance measurement
Responsibility and ethics	Values, social responsibility	Normative and ethical framework
Territorial development	Regional impact, social commitment	Social role of the university
Entrepreneurship	Entrepreneurial culture, applied innovation	Value creation

Note: Own elaboration based on ATLAS.ti 9 analysis.

3.2. Results of Axial Coding

Axial coding made it possible to reorganise and relate the initial codes identified during the open coding phase by establishing links between conditions, actions/interactions and consequences. This analytical process facilitated the reduction and structuring of the qualitative corpus into second-level analytical categories, consistent with the conceptual framework of the study on organisational innovation in university education.

As a result of this procedure, the emerging codes were grouped into seven axial categories, which provide an integrated explanation of the factors that condition and shape organisational innovation and its relationship with institutional competitiveness.

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3.3. Results of the Qualitative Phase

The co-occurrence analysis in ATLAS.ti 9 identified the most related categories in the interview corpus (Table 3). Noteworthy are the connections with teaching staff (9), lack of resources (5) and digitisation (4), which indicates that the teaching dimension and resource constraints are the main axes of the discussion on organisational innovativeness. Table 3 shows the results of the axial coding.

Table 3. Results of axial coding: categories and analytical relationships.

Axial Category	Integrated Codes	Analytical Role
Organisational innovation	Methodological innovation, management innovation, process innovation	Core of organisational change
University governance	Institutional leadership, strategic planning, decision-making	Guiding framework for innovation
Resources and capabilities	Lack of resources, funding, infrastructure	Structural conditions
Digital transformation	Digitalisation, educational technology, digital systems	Enabling factor
Linkage with the environment	Knowledge transfer, university–industry relationship, innovation ecosystem	External connector
Competency development	Teaching improvement, active learning, autonomy	Educational impact
Institutional responsibility	Social responsibility, ethics, organisational values	Normative and cultural framework

Note: Own elaboration based on qualitative analysis in ATLAS.ti 9.

Table 4 shows that teaching staff are the central node of the co-occurrence network, followed by the lack of resources and digitisation, indicating that the university's capacity for innovation depends largely on the involvement of teaching staff and the availability of technological and financial resources.

Table 4. Co-occurrences between codes.

Code	Frequency
Teaching staff	9
Lack of resources	5
Digitisation	4
Lack of relationships with companies	3
Lack of an innovation ecosystem	2
Responsibility and ethics	2

Note: Own elaboration based on ATLAS.ti 9.

The results make it possible to visualise the concepts that, from the perspective of the interviewed vice-rectorate representatives, are most closely related to the concept of organisational innovation within the university. The diagram in Figure 3 shows that the most prominent concepts are knowledge, value, knowledge transfer and teaching improvement. In this regard, knowledge, teaching improvement and knowledge transfer stand out as the measures with the greatest impact on organisational innovation.

Finally, technology emerges as the code most strongly associated with the concept of digital transformation.

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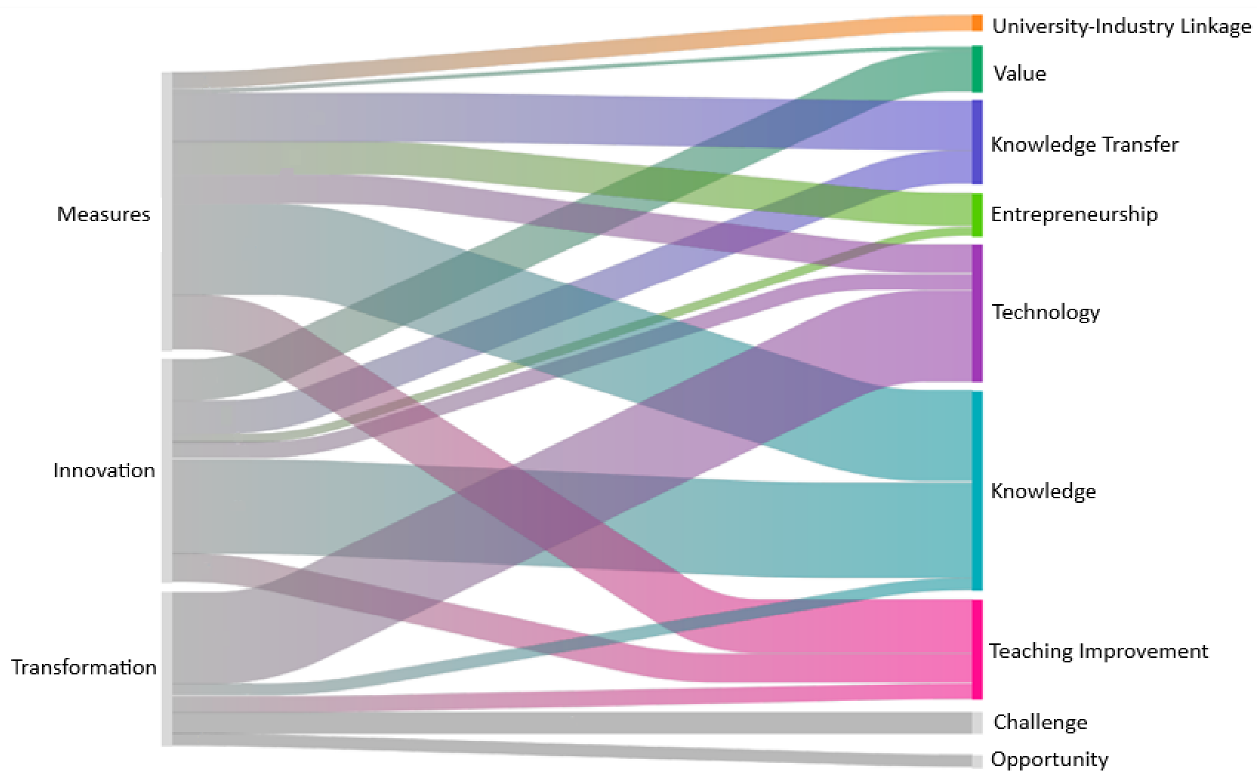

Figure 3. Sankey diagram. Note: Own elaboration.

Figure 4 represents the co-occurrence network generated in ATLAS.ti 9, where the category "Competitiveness" emerges as the central node, acting as the articulating axis of all the other categories identified. The figure reveals a pattern of high-density connections, indicating that competitiveness is not an isolated construct but is shaped by multiple interrelated factors in the university context.

In the upper right quadrant of the network, connections with methodological innovation, management innovation, and process innovation stand out, suggesting that institutional innovation practices are a direct driver of competitiveness. In the left sector, nodes related to resources, technology, digitisation, and financing emerge, acting as enabling capacities for innovations to materialise. Links can be observed with the terms teaching, research, transfer and labour market insertion, indicating that university competitiveness is driven by the articulation between the substantive functions of the university (teaching, research and links with the environment).

3.4. Results of the Quantitative Phase

Based on the findings of the qualitative phase and the documentary analysis of innovation indicators, a questionnaire was constructed and refined to measure the dimensions of organisational innovativeness (OI). The instrument was validated by expert judgement as described in Section 2 and pilot tested to adjust the wording of the items. It was then distributed to 387 engineering students and graduates from the University of the Basque Country (EHU), which allowed for empirical validation of the measurement model and progress towards the estimation of the structural model.

Table 5 presents the structure of the measurement instrument used in the quantitative phase of the study. The questionnaire was constructed by combining two main sources: the competencies from The Future of Jobs Report WEF [35] and the organisational innovativeness scale from Ruvio et al. [36].

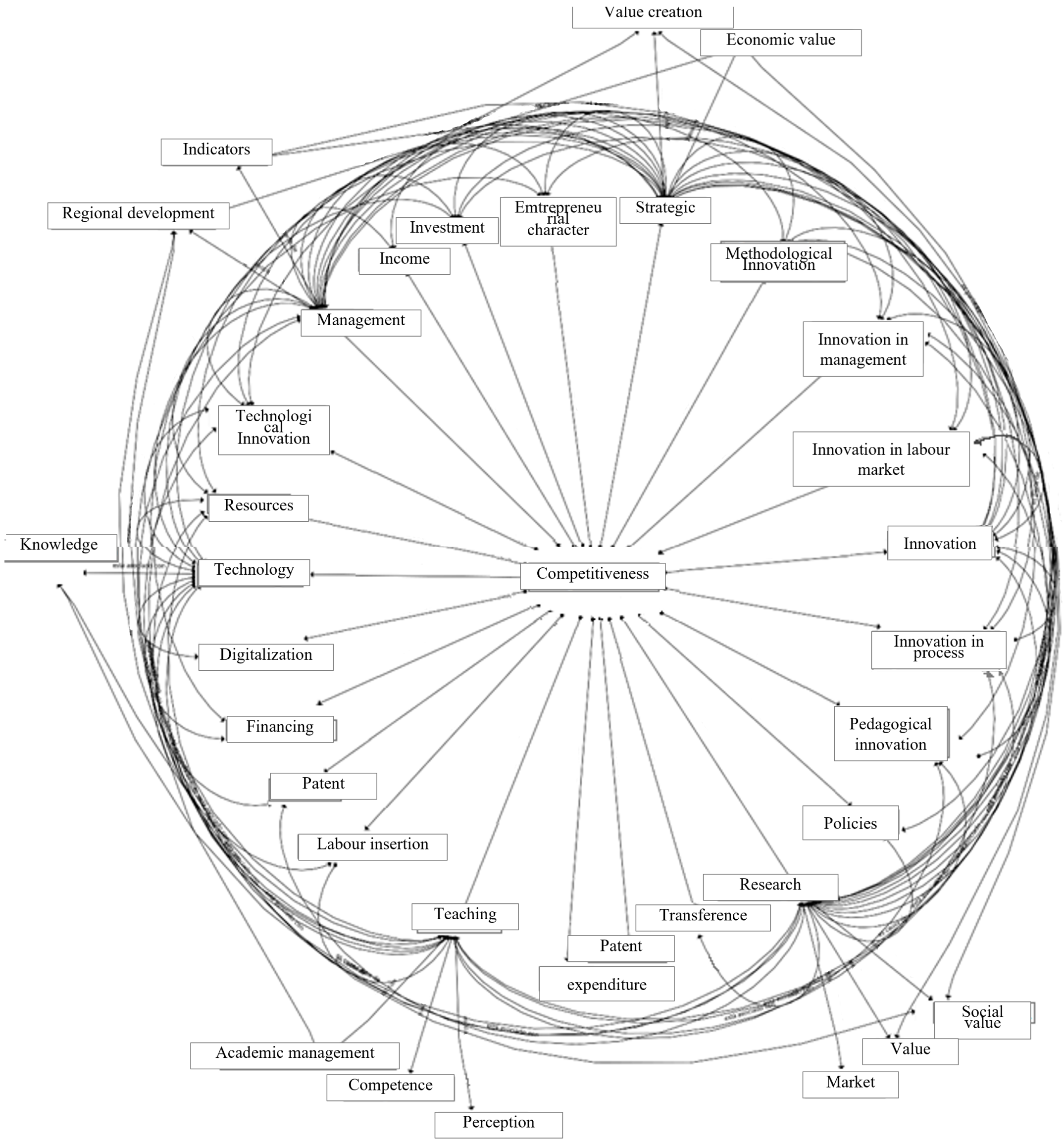

Figure 4. Radial distribution of the code network. Note: Own elaboration.

In total, the instrument comprised 31 items, distributed across eight factors. From the WEF [35], five factors associated with problem solving and self-management were included (analytical thinking and innovation, complex problem solving, creativity and initiative, reasoning and ideation, and resilience), as well as two items linked to the use and development of technology and one item on leadership and social influence.

Four key dimensions of organisational innovativeness were adopted from the scale developed by Ruvio et al. [36]: creativity (5 items), openness (4 items), future orientation (4 items) and risk-taking (4 items). These dimensions allow for the evaluation of organisational practices aimed at fostering innovation, idea generation and institutional willingness to adopt change.

3.5. Validation of the Instrument

Table 6 shows the normality statistics, factor loadings, and average extracted variance (AVE) values for the factors in the measurement model. The results confirm that the data meets the assumptions of univariate normality, given that the asymmetry and kurtosis values are within the recommended range (±2) for confirmatory factor analysis. In terms of convergent validity, all factor loadings exceed the minimum threshold of 0.600, with most above 0.700, indicating that the items are representative of their constructs [34]. Noteworthy are the high values in the Technology Use and Development factor, where the item Technology Use, Monitoring, and Control has a loading of 0.888, demonstrating strong explanatory power.

Table 5. Structure of the Organisational Innovation Assessment Instrument.

Reference Scale	N° Items	Factor	N° Factor	Items Included
Schwab and Zahidi [37] The Fute of Jobs	10	Problem solving, use and development of technology	5	Analytical thinking and innovation; Complex problem solving; Critical thinking and analysis; Creativity, originality and initiative; Reasoning, problem solving and ideation.
			2	Use, monitoring and control of technology; Technology design and programming.
		Self-management	2	Active learning and learning strategies; Resilience, stress tolerance and flexibility.
		Teamwork	1	Leadership and social influence.
Ruvio et al. [36] Organisational innovativeness	21	Creativity	5	Creativity is encouraged; Ingenuity in problem solving; Development of new services; Respect for creativity within the organisation; Use of original approaches to problem solving.
		Creativity	4	Seeking new answers; Immediate availability of support for new ideas; Receptiveness to change; Seeking new ways to approach problems.
		Future orientation	4	Setting realistic goals; Sharing a vision for the future; Clearly communicating future direction; Realistic strategic vision for departments.
		Risk-Taking	4	Assessing risks to obtain benefits; Promoting innovative strategies; Willingness to take risks; Rejecting a "safe" approach.

Note: Own elaboration.

The AVE values exceed the threshold of 0.500 in all factors, confirming that the variance explained by the items is greater than the measurement error and supporting the convergent validity of the instrument [38]. In particular, the factors Openness and Orientation and proactiveness have an AVE of 0.695, indicating that they are well-defined constructs with high internal consistency. Furthermore, the overall fit indices of the model (χ^2 = 206.752, CFI = 0.970, TLI = 0.960, RMSEA = 0.051, SRMR = 0.047) confirm a satisfactory fit.

Table 7 shows the internal consistency indices of the factors and items that make up the organisational innovation assessment questionnaire. First, the Cronbach's alpha (α) values for all dimensions exceed the recommended threshold of 0.700 [24], confirming the adequate internal consistency of the instrument.

The composite reliability (CR) presents values between 0.722 and 0.902, reinforcing the validity of the scales, as they are all above the minimum acceptable value of 0.700 [34]. Within the dimensions, Orientation and Proactiveness obtained the highest reliability value (α = 0.900; CR = 0.902), indicating that the items that comprise it are strongly correlated and consistently measure the construct. On the other hand, Self-Management has the lowest alpha value (α = 0.719), although it remains within the acceptable range, suggesting that it could benefit from a review or expansion of items in future studies to improve its robustness.

Table 6. Normality and convergent validity test.

Factor	Skewness	Kurtosis	Factor Loading	AVE
Problem solving				0.622
Analytical thinking and innovation	−0.841	0.327	0.722	
Complex problem solving	−0.904	0.607	0.818	
Reasoning, problem solving and ideation	−0.865	0.298	0.821	
Use and development of technology				0.679
Use, monitoring and control of technology	−0.698	0.214	0.888	
Technology design and programming	−0.558	−0.307	0.754	
Self-management				0.564
Active learning and learning strategies	−0.901	0.427	0.830	
Resilience, stress tolerance and flexibility	−0.830	0.002	0.663	
Creativity				0.650
Creativity was encouraged	−0.115	−0.771	0.765	
Most teachers teach their classes creatively	−0.176	−0.580	0.771	
The creativity of students is respected	−0.005	−0.667	0.829	
The university promotes innovation	−0.206	−0.813	0.855	
Openness				0.695
University is prone to change	−0.031	−0.830	0.828	
New ideas proposed by students are accepted	−0.106	−0.739	0.839	
Orientation and proactiveness				0.655
Specific objectives, orientation or suggestions are established regarding each student's future career	0.208	−0.876	0.831	
Effective measures are taken to ensure that all students have information about the different opportunities for their future employment	0.268	−0.854	0.920	
Students are given orientation on their future entry into the labour market	0.251	−0.743	0.908	
New opportunities are offered to students	−0.342	−0.383	0.648	

Note: Model fit indices (Robust): χ^2 = 206.752, df = 104; CFI = 0.970; TLI = 0.960; RMSEA = 0.051; SRMR = 0.047. N = 387.

In relation to the corrected item-total correlations, most items exceed a value of 0.600, which shows a satisfactory contribution of each item to its underlying factor.

Table 8 shows the results of the structural model. The hypotheses were largely confirmed. The model shows that there is a significant positive linear relationship (p-value < 0.10) between creativity and problem solving (β = 0.415, p = 0.011), the use and development of technology (β = 0.388, p = 0.036) and self-management (β = 0.656, p = 0.000). There is a negative and significant relationship between the university's openness to self-management by students and graduates (β = −0.409, p = 0.012). The relationships between openness and problem solving, and between openness and the use and development of technology, were not significant (p = 0.147 and p = 0.130, respectively). The results show that there is a negative and significant influence of orientation and proactiveness on problem solving by students and graduates (β = −0.169, p = 0.038) and on their self-management (β = −0.196, p = 0.030). The relationship between orientation and proactiveness and the use and development of technology was not significant. The negative and significant paths identified in the model, particularly between openness and self-management, suggest that high levels of institutional openness may introduce increased coordination demands and external pressures that limit students' capacity self-management. Similarly, excessively directive orientation and proactiveness may reduce opportunities for autonomous learning. These results are reported here in a descriptive manner and are discussed in greater depth in Section 4.

Table 7. Assessment of reliability and convergent validity of the instrument.

Factor	Corrected Item-Total Correlation	Cronbach's Alpha If Item Is Removed	Cronbach's Alpha (α)	Composite Reliability (CR)
Problem solving			0.829	0.831
Analytical thinking and innovation	0.647	0.803		
Complex problem solving	0.712	0.738		
Reasoning, problem solving and ideation	0.701	0.747		
Use and development of technology			0.802	0.807
Use, monitoring and control of technology	0.635	0.688		
Technology design and programming	0.693	0.682		
Self-management			0.719	0.722
Active learning and learning strategies	0.602	0.691		
Resilience, stress tolerance and flexibility	0.565	0.685		
Creativity			0.882	0.881
Creativity was encouraged	0.719	0.857		
Most teachers teach their classes creatively	0.729	0.854		
The creativity of students is respected	0.773	0.837		
The university promotes innovation	0.753	−0.813		
Openness			0.820	0.823
University is prone to change	0.689	0.801		
New ideas proposed by students are accepted	0.713	0.792		
Orientation and proactiveness			0.900	0.902
Specific objectives, orientation or suggestions are established regarding each student's future career	0.772	0.859		
Effective measures are taken to ensure that all students have information about the different opportunities for their future employment	0.847	0.830		
Students are given orientation on their future entry into the labour market	0.844	0.832		
New opportunities are offered to students	0.603	0.917		

Note: Model fit indices (Robust): χ^2 = 206.752, df = 104; CFI = 0.970; TLI = 0.960; RMSEA = 0.051; SRMR = 0.047. N = 387.

Table 8. Validity of the proposed structural model.

Relationship	β (Standardised Estimate)	Est./S.E.	*p*-Value	Result
Creativity → Problem solving	0.415 **	2.554	0.011	Significant
Creativity → Use and development of technology	0.388 **	2.102	0.036	Significant
Creativity → Self-management	0.656 ***	4.089	0.000	Highly significant
Openness → Problem solving	−0.227	−1.452	0.147	Not significant
Openness → Use and development of technology	−0.272	−1.512	0.130	Not significant
Openness → Self-management	−0.409 **	−2.526	0.012	Significant (negative)
Orientation and proactiveness → Problem solving	−0.169 **	−2.071	0.038	Significant (negative)
Orientation and proactiveness → Use and development of technology	0.025	0.291	0.771	Not significant
Orientation and proactiveness → Self-management	−0.196 **	−2.172	0.030	Significant (negative)

Note: Model fit indices: χ^2 = 206.752, df = 104, CFI = 0.970, TLI = 0.960, RMSEA = 0.051, SRMR = 0.047. ** $p < 0.050$, *** $p < 0.010$. N = 387.

Table 9 shows the results of the multigroup analysis by gender show that there are no significant differences between men and women in the structural model (p = 0.292 > 0.05). This indicates measurement invariance; i.e., the model behaves in the same way in both gender groups.

Table 9. Moderating effect of gender.

Model	χ^2	gl	p-Value	Invariant
No restrictions	373.88	245		
Fully restricted	363.11	236		
Number of groups		2		
Difference	10.77	9	0.292	Yes

Note: N = 387.

Table 10 presents the results of the multigroup analysis to evaluate the moderating effect of the educational level of parents or guardians on the organisational innovation model. The unrestricted and fully restricted models were compared, applying the structural invariance test using the χ^2 difference ($\Delta\chi^2$).

Table 10. Multigroup Analysis by Parental Education Level.

Moderating Variable	Model	χ^2	gl	p-Value	Invariant
Level of education of father/guardian	No restrictions	347.41	236		
	Fully restricted	370.78	245		
	Number of groups		2		
	Difference	23.37	9	0.005	No
Level of education of mother/guardian	No restrictions	363.01	236		
	Fully restricted	378.06	245		
	Number of groups		2		
	Difference	15.05	9	0.090	No

Note: N = 387.

For the educational level of the parent/guardian, the result was statistically significant ($\Delta\chi^2$ = 23.37, df = 9, p = 0.005), indicating that the model is not invariant across groups. In other words, the educational level of the parent/guardian moderates the relationships between the latent variables of innovation and institutional competitiveness, suggesting that the effects of the model may vary according to this factor.

In contrast, for the mother/guardian's level of education, the difference was not statistically significant ($\Delta\chi^2$ = 15.05, df = 9, p = 0.090), so the invariance of the model is accepted in this case. This implies that structural relationships remain stable regardless of the mother/guardian's educational level.

Figure 5 represents the structural model validated by SEM, showing the relationships between the three dimensions of organisational innovativeness (Creativity, Openness and Orientation, and Proactiveness) and the six competencies assessed (analytical thinking and innovation, reasoning and problem solving, use and design of technology, active learning, and resilience).

The solid arrows reflect significant and positive relationships, highlighting the role of creativity as the most robust predictor, especially for self-management and complex problem solving. The dashed arrows represent non-significant relationships, in which no statistical evidence of association was found. Interestingly, the Openness dimension shows negative relationships with some competencies, suggesting that excessive openness can create tensions in autonomous learning processes.

Table 11 reveals a robust pattern of positive and significant associations between creativity and virtually all the competencies assessed, with particular emphasis on active learning (β = 0.576, p < 0.010) and technology design and programming (β = 0.482, p < 0.010), confirming the central role of creativity in the development of innovation competencies. In contrast, openness shows a negative and significant relationship with technology design and programming ($\beta = -0.366$, $p < 0.050$) and with active learning ($\beta = -0.379$, $p < 0.010$), suggesting that high levels of openness do not necessarily favour the acquisition of these competencies.

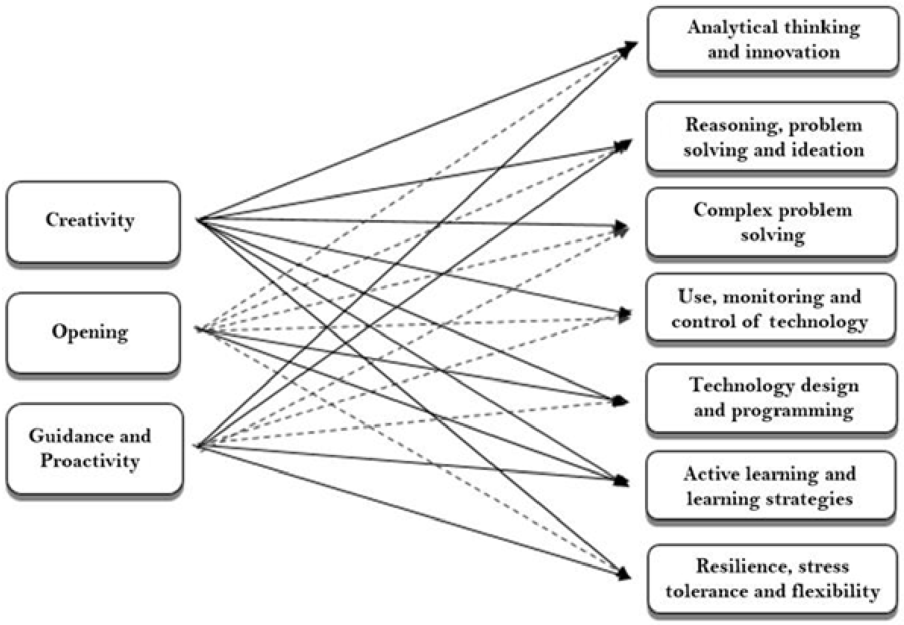

Figure 5. Final structural model of relationships between dimensions of organisational innovation and key competencies. Note: Own elaboration.

Figure 6 illustrates the associations identified between higher-order cognitive skills (analytical thinking and innovation, reasoning and problem solving, and ideation and complex problem solving) and four key cross-cutting skills: use of technology, design and programming, active learning, and resilience. The solid arrows represent significant relationships, confirming that the development of cognitive skills is strongly associated with the use and control of technology, as well as with active learning.

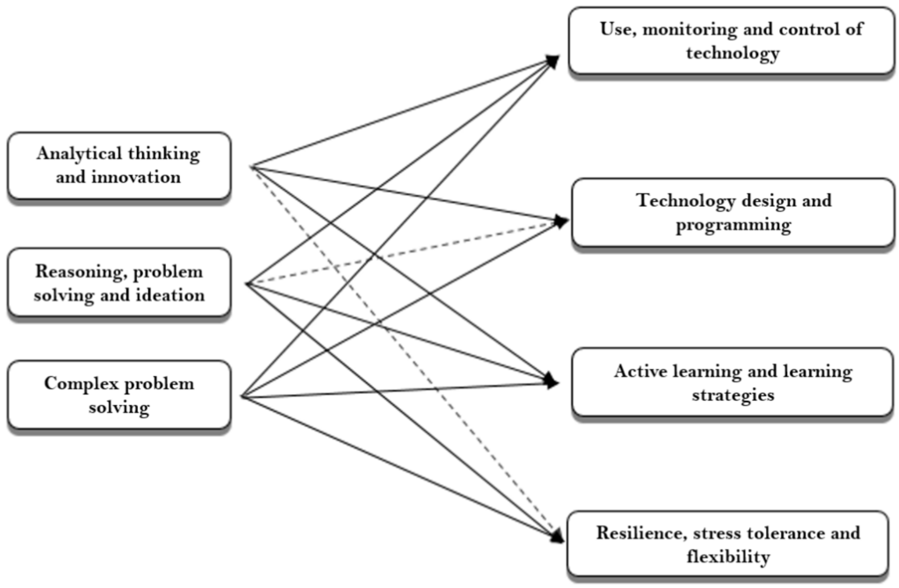

Figure 6. Relationships between Cognitive Competencies and Technological and Socio-emotional Competencies. Note: Own elaboration.

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Table 11. Validity of the proposed structural extended model.

Model Variables	Estimate (β)	*p*-Value
Creativity → Analytical thinking and innovation	0.392 ***	0.008
Creativity → Reasoning, problem solving and ideation	0.297 *	0.051
Creativity → Complex problem solving	0.327 **	0.028
Creativity → Use, monitoring and control of technology	0.266 *	0.098
Creativity → Technology design and programming	0.482 ***	0.004
Creativity → Active learning and learning strategies	0.576 ***	0.000
Creativity → Resilience, stress tolerance and flexibility	0.362 **	0.012
Openness → Analytical thinking and innovation	−0.190	0.184
Openness → Reasoning, problem solving and ideation	−0.134	0.364
Openness → Complex problem solving	−0.222	0.121
Openness → Use, monitoring and control of technology	−0.175	0.258
Opening → Technology design and programming	−0.366 **	0.024
Opening → Active learning and learning strategies	−0.379 ***	0.007
Openness → Resilience, stress tolerance and flexibility	−0.181	0.218
Orientation and proactiveness → Analytical thinking and innovation	−0.164 *	0.057
Orientation and proactiveness → Reasoning, problem solving and ideation	−0.137 *	0.056
Orientation and proactiveness → Complex problem solving	−0.156 **	0.028
Orientation and proactiveness → Use, monitoring and control of technology	−0.112	0.148
Orientation and proactiveness → Technology design and programming	0.038	0.633
Orientation and proactiveness → Active learning and learning strategies	−0.129 *	0.092
Orientation and proactiveness → Resilience, stress tolerance and flexibility	−0.206 ***	0.006

Note: * $p < 0.100$, ** $p < 0.050$, *** $p < 0.010$. N = 387.

Table 12 summarises the standardised coefficients (β) of the structural equation model, highlighting relevant patterns in the relationship between cognitive skills and variables associated with innovation and self-management. The results show that analytical thinking and innovation have a positive and significant effect on the use, monitoring and control of technology ($\beta = 0.228$, $p < 0.001$), technological design and programming ($\beta = 0.219$, $p < 0.001$) and active learning ($\beta = 0.237$, $p < 0.001$), confirming that analytical thinking is a key driver for the development of technological competencies and self-management learning strategies. However, no significant relationship was found with resilience and flexibility ($\beta = 0.023$, $p = 0.755$), suggesting that this dimension alone does not explain the socio-emotional competencies required to cope with complex environments.

Table 12. Effects of Cognitive Competencies on Technological Performance, Active Learning, and Resilience.

Model Relationship	Estimate (β)	*p*-Value
Analytical thinking and innovation → Use, monitoring and control of technology	0.228 *	0.000
Analytical thinking and innovation → Design and programming of technology	0.219 *	0.000
Analytical thinking and innovation → Active learning and learning strategies	0.237 *	0.000
Analytical thinking and innovation → Resilience, stress tolerance and flexibility	0.023	0.755
Reasoning, problem solving and ideation → Use, monitoring and control of technology	0.282 *	0.000
Reasoning, problem solving and ideation → Technology design and programming	0.086	0.219
Reasoning, problem solving and ideation → Active learning and learning strategies	0.289 *	0.000
Reasoning, problem solving and ideation → Resilience, stress tolerance and flexibility	0.452 *	0.000
Complex problem solving → Use, monitoring and control of technology	0.203 *	0.003
Complex problem solving → Design and programming of technology	0.292 *	0.000
Complex problem solving → Active learning and learning strategies	0.355 *	0.000
Complex problem solving → Resilience, stress tolerance and flexibility	0.206 *	0.003

Note: * $p < 0.01$. N = 387.

In contrast, reasoning, problem solving, and ideation show a more robust pattern, with significant effects on technology use ($\beta = 0.282$, $p < 0.001$), active learning ($\beta = 0.289$, $p < 0.001$), and, notably, resilience ($\beta = 0.452$, $p < 0.001$), confirming its role in building adaptive and coping skills. Its relationship with technological design and programming, on the other hand, was not significant ($\beta = 0.086$, $p = 0.219$). Finally, complex problem solving emerges as the dimension with the greatest predictive consistency, showing significant associations with all dependent variables, with its impact on active learning ($\beta = 0.355$, $p < 0.001$) and technology design and programming ($\beta = 0.292$, $p < 0.001$) standing out.

4. Discussion

The results of this study address the research question by showing that university education in Spain exhibits a moderate level of organisational innovation, with significant differences associated with strategic policies, levels of digitalisation and organisational culture [26]. This finding is consistent with previous studies indicating that the innovative maturity of universities largely depends on their integration into regional innovation systems and on their ability to articulate policies, structures and routines that foster knowledge generation and transfer [10,22]. The structural equation model validated in this study provides further evidence regarding the mechanisms that explain organisational innovation. In particular, analytical thinking, complex problem-solving and the use of technology emerged as key predictors of organisational innovation, confirming Hypothesis H1. These results are aligned with international frameworks that emphasise the importance of cognitive and digital skills as drivers of institutional transformation [33,35]. Similarly, previous research has shown that strengthening teachers' digital competence and designing flexible learning experiences contribute not only to pedagogical innovation but also to organisational innovation [30,39]. With regard to Hypothesis H2, the results confirm a positive influence of competency development on institutional competitiveness. This finding reinforces the idea that competitiveness in university education is not limited to traditional indicators, such as scientific output or ranking positions, but is increasingly linked to institutions' capacity to educate graduates with relevant and adaptable competencies in response to a transforming labour market. The literature supports this view by conceptualising competitiveness as a multidimensional construct closely related to educational outcomes, employability and social impact [12,23,27]. The results also support Hypothesis H3, revealing a direct and positive effect of organisational innovation on institutional competitiveness. This finding is consistent with systemic innovation models that highlight the role of strategic collaboration between universities and external actors in promoting innovation, technology transfer and value creation within regional ecosystems [21,23,40]. In this regard, previous studies have shown that collaborations with SMEs not only strengthen firms' innovative capacity but also provide valuable feedback for improving the quality and relevance of university education and research [41].

However, one of the most theoretically relevant contributions of this study lies in the identification of negative or weak effects associated with high levels of openness and strong strategic orientation and proactiveness. In contrast to approaches that assume uniformly positive effects of these dimensions, the results suggest a more complex relationship. Excessive openness may lead to processes of organisational over-structuring, increased coordination demands and dispersion of strategic focus, thereby limiting institutional capacity to translate external interaction into effective improvements in learning and competitiveness.

From a cognitive and educational perspective, such processes may generate cognitive overload among both academic staff and students, weakening self-management, deep learning and creative processes. Similarly, overly directive orientation and proactiveness may intensify tensions between institutional control and academic autonomy, constraining bottom-up initiatives and reducing the space for pedagogical and organisational experimentation [1,2].

These findings engage with critical strands of the literature on university innovation, which warn against the uncritical adoption of open innovation and entrepreneurial logics in higher education contexts, particularly when governance structures and resources are insufficient to sustain them [14,20]. While systemic innovation models emphasise interaction and collaboration as key drivers of innovation, more recent studies stress the need for selective and strategically aligned openness, consistent with institutional missions and organisational capacities.

In this context, organisational culture emerges as a key factor. Institutions that promote climates of openness, collective learning and tolerance for risk tend to display higher levels of organisational innovation [13,17,26]. At the same time, the literature highlights that cultural transformation must be accompanied by transformational leadership and empowerment processes within the university community, in order to avoid dynamics of excessive pressure or organisational fragmentation [14,20].

From a methodological standpoint, the combination of qualitative analysis using ATLAS.ti and structural equation modelling in AMOS enabled the development of a robust and empirically grounded analytical framework for assessing organisational innovation. This approach meets established reliability and validity criteria [34,38] and responds to the need for instruments that explicitly connect innovation processes with institutional competitiveness and territorial impact, facilitating their use in university policy decision-making [2,26].

In comparative terms, similar patterns have been identified in other European and OECD higher education systems, where increasing demands for openness, accountability and performance coexist with constraints related to resources and organisational capacity. Without seeking to generalise the findings, this study contributes to the international debate by providing context-sensitive evidence that underscores the importance of balanced innovation strategies, aligned with institutional missions and actual organisational capacities [13,17,18].

In this study, the focus on students and graduates from engineering programmes constitutes a strength, as this field is closely linked to processes of organisational, technological, and competence-based innovation. Nevertheless, in order to avoid potential biases associated with a single academic discipline, future research should incorporate samples from other fields of knowledge.

5. Conclusions

The study confirms that organisational innovation in University Education is a strategic factor for institutional competitiveness and regional development. The results of the documentary analysis reveal a persistent gap with respect to European standards, especially in terms of investment in R&D, university–business collaboration and participation in international innovation projects, which justifies the need for analytical frameworks that allow for the systematic evaluation of progress in this area and guide university policies towards continuous improvement.

The integration of qualitative and quantitative phases made it possible to construct and validate a robust instrument for measuring organisational innovativeness, with adequate reliability and validity indices, ensuring its usefulness for comparative studies in different institutions and regions. The findings confirm that creativity emerges as the most influential dimension, acting as a driver of critical competencies such as active learning and the ability to design technology. Likewise, higher-order cognitive competencies, such as analytical thinking, reasoning, ideation, and complex problem solving, show strong associations with the use of technology, autonomous learning, and resilience, suggesting that these should occupy a central place in university curriculum planning.

The evidence suggests that the future of university competitiveness depends on the institutional capacity to articulate resources, academic leadership and collaboration with the environment, as well as on its commitment to the development of high-level cognitive and technological skills that prepare students for the challenges of the knowledge economy.

Limitations of the empirical study: the research focused on engineering students and graduates from the EHU, which allowed for consistent data and adequate control of the context. Future research could expand the sample to other universities and disciplines to reinforce the generalisation of the results. Future research could incorporate longitudinal designs that allow the examination of the dynamics and stability of these relationships over time.

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Abbreviations

The following abbreviations are used in this manuscript:

α	Cronbach's alpha
AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CR	Composite Reliability
CRUE	Conference of Rectors of Spanish Universities
CVI	Content Validity Index
df	Degrees of freedom
EFA	Exploratory Factor Analysis
EHU	University of the Basque Country
INE	National Statistics Institute of Spain
OI	Organisational Innovation
OECD	Organisation for Economic Co-operation and Development
p-value	Probability value
R&D	Research and Development
RIS3	Research and Innovation Strategies for Smart Specialisation
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modelling
SICTI	Science, Technology and Innovation Information System
SPSS	Statistical Package for the Social Sciences
SRMR	Standardised Root Mean Square Residual
TLI	Tucker–Lewis Index
WEF	World Economic Forum
W	Kendall's Coefficient of Concordance

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