European Scientific Journal for Dual Higher Education

Vol. 2, No. 1, (2026)
ISSN (online): 3052-7015

THE ROLE OF DUAL EDUCATION PROGRAMMES IN SMART SPECIALISATION STRATEGIES: THE CASE OF MONDRAGON UNIBERTSITATEA'S FACULTY OF ENGINEERING

*Maite Couto-Ortega*ORCID: 0000-0003-1014-1192, [1], *Leire Markuerkiaga*ORCID: 0000-0002-7588-5910, [1*] *and Laida San Sebastian*ORCID: 0000-0002-6184-1589, [1]

[1] *Mondragon University, Spain*

Keywords:
Dual education programmes
Mobility of students
Knowledge transfer
Entrepreneurial university
Smart Specialisation Strategies

Article history:
Received: 15 January 2026
Revised: 13 April 2026
Accepted: 14 April 2026

Abstract
Universities have become key actors within regional innovation ecosystems through their roles in knowledge transfer, talent development, and industry collaboration. Dual education programmes, particularly at undergraduate level, enhance practical learning, facilitate the transition to employment, and reinforce university-industry engagement. In the Basque Country, the Smart Specialisation Strategy (S3) prioritises smart manufacturing, cleaner energy, and personalised health, relying on universities to advance these domains through structured learning and applied research. However, limited empirical evidence exists on the contribution of Bachelor's (BT) and Master's (MT) theses conducted in companies. This study examines BT/MT projects at MGEP and reveals stronger BT alignment with S3, especially in smart manufacturing, as well as consistent alignment across provinces.

1 Introduction

The literature underscores the need for regional innovation strategies to build competitive advantages, although the concept remains imprecise when applied territorially. The European Commission promotes Smart Specialisation Strategies (S3) as a concrete territorial approach (McCann & Ortega-Argilés, 2018).

The relationship between university-industry collaboration (UIC) and S3 is multifaceted. While S3 seeks to strengthen regional innovation capacities, its implementation can create tensions, including reduced research investment and weakened UIC (Mascarenhas et al., 2022). However, when aligned with S3 priorities, UIC enhances knowledge transfer and innovation (Mascarenhas et al., 2022). Broader technological diversification also calls for rethinking university-industry dynamics (Calza et al., 2019). Universities play a central role in regional development, especially in peripheral regions, as illustrated by the Region Värmland-Karlstad University partnership (Kempton, 2015).

Regional Innovation Strategy (RIS3) provides a framework for aligning research and innovation with regional priorities. In the Basque Country, these include smart manufacturing, cleaner energy, and personalised health (Euskadi, 2020). The success of this strategy depends on active university engagement in talent development and knowledge transfer (Burbridge & Morrison, 2021).

* Corresponding author
E-mail address: lmarkuerkiaga@mondragon.edu

Within this framework, student mobility through Bachelor's (BT) and Master's Thesis (MT) collaborations represents a key channel for transferring academic knowledge to industry. However, empirical evidence on how such structured mobility supports RIS3 remains limited.

This study examines how Mondragon Unibertsitatea's Faculty of Engineering (MGEP) contributes to RIS3 through BT and MT projects developed with companies. We analyse their alignment with strategic priorities while exploring differences between BT and MT, territorial patterns across Gipuzkoa, Bizkaia, and Araba, temporal trends, and the relationship between degree specialisation and RIS3 domains. Ultimately, the study advances understanding of how student thesis projects support RIS3 areas (advanced manufacturing, energy, and health) and reinforce universities' role as active regional innovation agents. Specifically, this paper aims to answer the following research questions: (i) How are BT and MT projects distributed by year? (ii) Which degree or master's programmes produce the highest number of projects? (iii) Which provinces have the highest concentration of projects? (iv) To what extent is the concentration of projects driven by regional business density? (v) What percentage of projects are aligned with S3 areas? and (vi) With which strategic area are S3 projects aligned?

2 Literature review

The relationship between Regional Innovation Strategy (RIS3) and Smart Specialisation Strategies (S3) is closely intertwined, with RIS3 serving as a prerequisite for EU regions to receive funding for research and innovation (Panori et al., 2017). Both approaches share common ground in fostering regional innovation, with RIS3 building upon experiences from cluster policies (Aranguren & Wilson, 2013). The implementation of RIS3 requires a shift from plans to processes, emphasising the importance of leadership and an entrepreneurial discovery process (Wilson et al., 2015). The success of RIS3 policies is heavily dependent on the capacity of regional government institutions to coordinate and facilitate interventions, with sound institutional frameworks playing a crucial role in innovation processes (Rodríguez-Pose et al., 2014). These strategies aim to support science, technology, and innovation investments where there are clear synergies with existing productive capacities and capabilities, ultimately driving regional development and innovation (Aranguren & Wilson, 2013).

2.1 The Basque country's regional innovation Strategy and Smart Specialisation strategy

RIS3 is defined as a set of interactive networks that foster innovation through localised learning and knowledge transfer (Ferretti & Parmentola, 2015; Stoimenova, 2019). These strategies emphasise regional engagement and stakeholder interaction to enhance innovation capabilities and have been promoted by the European Commission to boost competitiveness (Stoimenova, 2019). However, integrating RIS3 with other policies, such as Responsible Research and Innovation (RRI), remains challenging due to differences in scale and perspectives (Fitjar et al., 2019). Although applied in Europe, the United States, Japan, and Korea (Lim, 2006), ambiguity persists regarding their definition and implementation (Ferretti & Parmentola, 2015).

The Basque Country's regional innovation system has driven structural change and competitiveness through technological centres and targeted policies reducing reliance on traditional industries (López-Rodríguez et al., 2010). These efforts positioned the region as a leader in R&D&i investment and innovative firms (López-Rodríguez et al., 2010).

S3, initially an academic concept, has become central to EU regional policy, although it faces methodological and governance challenges (Foray et al., 2011; Griniece et al., 2017). Ferreira et al. (2025) highlight their systemic potential, while Hassink & Gong (2021) critique reliance on traditional science and technology models.

The Basque Country exemplifies effective S3 implementation, supported by flexible governance (Navarro et al., 2011) and continuity in development strategies (Arancegui, 2015). S3 Euskadi builds on diversified specialisation, leveraging enabling technologies (advanced manufacturing, bioscience, and nanoscience) and five priority markets (Euskadi, 2020) (Figure 1). Success depends on collaborative governance and adaptive leadership (Aranguren et al., 2015).

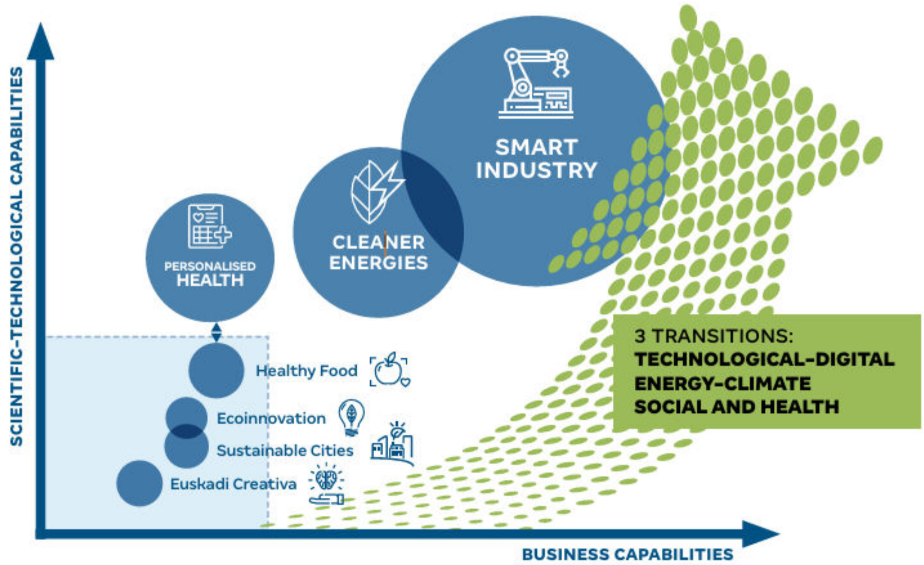

Figure 1. The Basque Country's Smart Specialisation Strategy (Euskadi, 2020)

The Basque experience underscores the importance of institutional frameworks, experimental processes, and broader stakeholder engagement, including SMEs and civil society (Aranguren & Magro, 2022; Morgan et al., 2020).

2.2 University-industry collaboration activities: student mobility

University-Industry Collaboration (UIC) constitutes a foundational element of contemporary innovation ecosystems, facilitating knowledge co-creation, technological development, and regional economic growth. It is broadly understood as the interaction between higher education institutions and non-academic organisations to exchange and generate knowledge and technology (Ankrah & Al Tabbaa, 2015; Bekkers & Freitas, 2008; Siegel et al., 2003). UIC encompasses a diverse set of direct and indirect collaborative activities extending beyond research (Davey et al., 2011, 2018), with "business" construed as including all non-academic actors (Clauss & Kesting, 2017).

The literature presents multiple conceptualisations of UIC: cooperative R&D partnerships between universities and firms (Bozeman et al., 2013; Perkmann & Walsh, 2007; Petruzzelli, 2011); a mechanism supporting the transition to a knowledge-based society (Ranga & Etzkowitz, 2013); bidirectional linkages enabling the diffusion of ideas, skills, and human capital (Plewa et al., 2013); interorganisational exchanges of tangible and intangible resources (Perkmann et al., 2013); and processes generating novel knowledge for both partners (Hardy et al., 2003). Such definitions reflect the breadth of UIC practices, ranging from intellectual property licensing to collaborative R&D (Gulbrandsen et al., 2011).

Informal interactions, driven by personal ties and geographical or social proximity, are recognised for their positive impact on local industry (Breschi & Lissoni, 2001), although their interplay with formal UIC remains underexamined. Formal interactions, typically contract-based, exhibit substantial heterogeneity (Bekkers & Freitas, 2008) and closely align with universities' core missions of education, research, and valorisation (Galan-Muros & Davey, 2017). While patents, licences, and academic entrepreneurship have dominated scholarly attention (Agrawal & Henderson, 2002; Isaksen & Karlsen, 2010; Laukkanen, 2003; Lehmann & Menter, 2016; O'shea et al., 2005; Phan & Siegel, 2006; Rothaermel et al., 2007; Shane, 2004), evidence indicates that the scope of UIC is considerably broader (Davey et al., 2018; Mascarenhas et al., 2025).

Education-oriented collaboration, particularly work-integrated learning (WIL), has gained prominence as an avenue for strengthening university-industry collaboration (UIC) by providing students with practical experience, facilitating their transition to professional contexts, and narrowing the cultural and structural gaps between academia and firms (Rampersad, 2015). This practical engagement aligns with recent literature emphasising that student mobility is emerging as a critical strategic pillar within regional innovation frameworks, acting as a primary conduct for 'knowledge spillovers' between universities and regional industries (Mascarenhas et al., 2025). By embedding students within industrial networks, WIL not only facilitates the flow of tacit knowledge but also addresses the structural gaps identified in S3, where leading research institutions and private firms often remain separated (Rodríguez Ochoa et al., 2025).

The choice of UIC activity is shaped by the nature of the knowledge exchanged (Bekkers & Freitas, 2008) and firms' absorptive capacity (Agrawal & Henderson, 2002; Hewitt-Dundas, 2013). Early-stage, low-commitment collaborations such as guest lecturing contrast with resource-intensive joint R&D typical of mature partnerships (Alunurm et al., 2020; De Man, 2004).

Academic classifications frequently distinguish between "soft" activities - consultancy, training, and the provision of skilled graduates - and "hard" activities, including patenting, licensing, and spin-off creation (Perkmann & Walsh, 2007; Philpott et al., 2011). Among the most comprehensive typologies is that proposed by Davey et al. (2018), which consolidates the principal UIC mechanisms identified in the literature (Table 1).

Table 1. Classification of UIC activities by domain (Davey et al., 2018)

UIC domains	*UIC activities*
Education	- Mobility of students - Curriculum co-design - Curriculum co-delivery - Dual education programs - Lifelong learning for people from business
Research	- Joint R&D - Consultancy for business - Mobility of staff
Valorization	- Commercialization of R&D results - Academic entrepreneurship - Student entrepreneurship
Management	- Governance - Shared resources - Industry support

Within the education domain of UIC, student mobility has become a central mechanism for knowledge exchange and for aligning higher education with labour market needs. Recognised as one of the eight core UIC domains, it contributes to academic entrepreneurship and human capital development (Dima A. M., 2017). From an enterprise perspective, mobility enhances innovation capacity and narrows the gap between theoretical and practical knowledge (Pavlin, 2016), while also strengthening trust-based partnerships and improving employability outcomes (Rudawska & Kowalik, 2019).

Student mobility is also identified as a channel for commercialising academic knowledge and addressing industry skill shortages (Treasury, 2003). Structured initiatives such as Erasmus+ show how mobility strengthens business education and fosters cross-border institutional collaboration (Mihaylova et al., 2024). Overall, the literature emphasises that mobility is not merely an educational practice but a strategic component of UIC, supporting innovation, workforce readiness, and internationalisation.

3 Methodology

A single-case study approach was chosen to understand how student mobility contributes to the Basque Country's S3. Case studies specifically emphasise contextual understanding (Saunders et al., 2009). Therefore, Mondragon Unibertsitatea's Faculty of Engineering (MGEP) serves as an exemplary case through which to explore how Bachelor's thesis (BT) and Master's thesis (MT) projects can support Basque Country's S3.

Mondragon Unibertsitatea stands out as a benchmark in knowledge transfer, ranking third among Spanish universities in this dimension according to the 2025 U-Multirank results. This recognition reflects its strong commitment to applied research and close collaboration with industry, particularly through dual education models, final projects developed within companies, and a high rate of graduates working in the surrounding region. The university also excels in attracting external research funding, further reinforcing its role as a key driver of innovation and regional development.

3.1 Case study overview

MGEP is a cooperative faculty strongly committed to social transformation, reflected in its participatory governance model. It forms part of MONDRAGON Corporation, a diversified business group operating in finance, industry, retail, and knowledge sectors (Arregui, 2006). MONDRAGON Corporation is currently the largest business group in the Basque Country and the tenth largest in Spain, comprising 95 autonomous cooperatives, around 80,000 employees, and 14 R&D centres. Within its knowledge area, Mondragon University plays a central role. Officially recognised by Law 4/1997, the university was founded through the association of three educational cooperatives: MGEP, the Faculty of Business Studies, and the Faculty of Humanities and Education Sciences. In 2011, the Faculty of Gastronomic Sciences (Basque Culinary Centre) joined the university.

MGEP has more than 50 years of experience adapting its educational model to changing socio-economic contexts. A cornerstone of this model is the dual education programme, which provides in-company learning through different formats adapted to student needs. The programme has been continually refined to meet national and European standards, address industry demands, and ensure a high-quality learning experience. Implemented across nine bachelor's and nine master's degrees, it engages around 800 students annually in collaboration with more than 200 companies. MGEP promotes long-term apprenticeships structured in two stages: an optional first stage during the 2nd-3rd years of the bachelor's degree and the 1st year of the master's, combining part-time study and work; and a compulsory second stage consisting of full-time Bachelor's/Master's Thesis Projects designed to bridge academic learning and professional practice.

3.2 Participants and data collection

The study is based on the analysis of dual education projects from 2020 to 2024 at MGEP, for the nine bachelor's degrees and nine master's degrees offered by the faculty. It adopts a mixed-method approach to analyse the impact of BT and MT projects on regional innovation and knowledge transfer. The research design consists of the following steps:

1. Data collection: a dataset comprising BT/MT projects completed at MGEP from 2020 to 2024, categorised by level of study and discipline, sector, company, and research focus. A total of 2,224 projects were developed in 1,328 companies located in the Basque Autonomous Community (BAC) and engaged in several types of activities.
2. Classification of these projects according to the S3 priority sectors and other non-S3 sectors, using CNAE-2009 classification.
3. Critical analysis of project titles and descriptions using keywords linked to the RIS3 sectors, for projects developed in companies whose main CNAE code was not classified as belonging to S3.

3.3 Data processing and analysis

The statistical analysis was conducted using IBM SPSS Statistics software (version 31.0.0.0), which enabled both descriptive and inferential examination of the dataset comprising 2,224 BT and MT projects developed between 2020 and 2024. Projects were first classified according to the S3 strategic sectors using the CNAE-2009 code and keyword-based content analysis. Descriptive statistics were used to explore distributions across academic programmes, provinces, and S3 alignment. To assess relationships and differences, several inferential tests were applied:

independent samples t-tests evaluated the alignment of BT versus MT projects with S3 priorities; chi-square tests examined associations between thesis type, academic program, and S3 sectors; and one-way ANOVA was used to test temporal trends in S3 alignment. Effect sizes such as Cohen's d and eta squared were calculated to determine the practical significance of findings.

4 Results

The findings are divided into two sections. Section 4.1 thoroughly describes the characteristics of MGEP's BT and MT projects: year distribution, degree distribution, geographical distribution and alignment with S3 areas. Section 4.2 presents the findings from the statistical analysis used to address the research questions.

4.1 Descriptive statistics

To evaluate the contribution of student mobility projects to the Basque Country's S3, this section presents a detailed descriptive statistical analysis of 2,224 BT and MT projects developed at MGEP between 2020 and 2024. The descriptive analysis responds to several key questions: (i) How are BT and MT projects distributed by year? (ii) Which degree or master's programmes produce the highest number of projects? (iii) Which provinces have the highest concentration of projects? (iv) To what extent is the concentration of projects driven by regional business density? (v) What percentage of projects are aligned with S3 areas? and (v) With which strategic area are S3 projects aligned? (vi) Are S3 Strategic Areas Driven by Company Activity? These questions guide the exploration of patterns in academic engagement with regional innovation priorities.

4.1.1 How are BT and MT projects distributed by year?

This subsection presents a descriptive analysis of the distribution of BT and MT theses from 2020 to 2024 (Table 2). The results show a steady increase in the number of BT projects over the years, rising from 245 in 2020 to 307 in 2024. In contrast, the number of MT projects has remained relatively stable, fluctuating slightly between 151 and 174 annually. Overall, BTs consistently outnumber MTs each year.

Table 2. Distribution of BT and MT projects by year

			BT1_MT2		*Total*
			1	*2*	
YEAR	2020	Count	245	158	403
		% within BT1_MT2	17,4%	19,4%	18,1%
	2021	Count	256	164	420
		% within BT1_MT2	18,2%	20,1%	18,9%
	2022	Count	295	151	446
		% within BT1_MT2	21,0%	18,5%	20,1%
	2023	Count	305	174	479
		% within BT1_MT2	21,7%	21,3%	21,5%
	2024	Count	307	169	476
		% within BT1_MT2	21,8%	20,7%	21,4%
Total		Count	1408	816	2224
		% within BT1_MT2	100,0%	100,0%	100,0%

4.1.2 Which degree or master's programmes produce the highest number of projects?

The distribution of projects by degree and master's programme shows that the highest number of projects were generated by programme GM, followed by MH, GD, and GO (Table 3). These four programmes alone account for a significant portion of the total 2,224 projects. In contrast, programmes such as MS, ML, and MM contributed the fewest projects.

Table 3. Distribution of BT and MT projects by degree

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	GA (Energy Engineering)	97	4,4	4,4	4,4
	GB (Biomedical Engineering)	86	3,9	3,9	8,2
	GC (Eco-technology in Industrial Processes Engineering)	67	3,0	3,0	11,2
	GD (Industrial Design and Product Development Engineering)	242	10,9	10,9	22,1
	GE (Industrial Electronics Engineering)	151	6,8	6,8	28,9
	GJ (Mechatronics Engineering)	192	8,6	8,6	37,5
	GM (Mechanical Engineering)	348	15,6	15,6	53,2
	GO (Engineering in Industrial Organizations)	225	10,1	10,1	63,3
	MD (Strategic Design of Products and Services)	62	2,8	2,8	66,1
	MG (Energy and Power Electronics)	83	3,7	3,7	69,8
	MH (Industrial Engineering)	265	11,9	11,9	81,7
	MIP (Business Innovation and Project Management)	98	4,4	4,4	86,2
	ML (Supply chain, Manufacturing and Logistics Management)	30	1,3	1,3	87,5
	MM (Biomedical Technologies)	57	2,6	2,6	90,1
	MN (Data Analysis, Cybersecurity and Cloud Computing)	64	2,9	2,9	92,9
	MR (Robotics and Control Systems)	135	6,1	6,1	99,0
	MS (Smart Energy Systems)	22	1,0	1,0	100,0
	Total	2224	100,0	100,0	

4.1.3 Which provinces have the highest concentration of projects?

The distribution of projects by province (Table 4) reveals a strong concentration in Gipuzkoa, which accounts for 82.5% of all projects. Bizkaia follows with 12.5%, while Araba contributes only 5% of the total. This indicates a significant geographic imbalance, with Gipuzkoa being the dominant location for project development.

Table 4. Distribution of BT and MT projects by province

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	ARABA	111	5,0	5,0	5,0
	BIZKAIA	279	12,5	12,5	17,5
	GIPUZKOA	1834	82,5	82,5	100,0
	Total	2224	100,0	100,0	

4.1.4 To what extent is the concentration of projects driven by regional business density?

To examine the relationship between the type of project (BT/MT) and its geographic distribution across provinces (Araba/Bizkaia/Gipuzkoa), a Pearson correlation analysis was conducted (Table 5). The results indicate a statistically significant, although very weak, positive correlation between the variables ($r = 0.046$, $p = 0.030$). These findings were further validated by a Spearman's rho non-parametric test ($r_s = 0.045$, $p = 0.033$), confirming that while a geographical pattern exists, it explains only a small fraction of the total variance (Table 7). This suggests that project placement is likely driven by a more complex set of factors beyond mere provincial business density, such as specific industry specialisations or academic degree requirements.

Table 5. Pearson correlation analysis

		BT1_MT2	*PROVINCE_123*
BT1_MT2	Pearson Correlation	1	,046*
	Sig. (2-tailed)		,030
	N	2224	2224
PROVINCE_123	Pearson Correlation	,046*	1
	Sig. (2-tailed)	,030	
	N	2224	2224

*. Correlation is significant at the 0.05 level (2-tailed).

Table 6. Spearman's correlation analysis

			BT1_MT2	PROVINCE_123
Spearman's rho	BT1_MT2	Correlation Coefficient	1,000	,045*
		Sig. (2-tailed)	.	,033
		N	2224	2224
	PROVINCE_123	Correlation Coefficient	,045*	1,000
		Sig. (2-tailed)	,033	.
		N	2224	2224

*. Correlation is significant at the 0.05 level (2-tailed).

4.1.5 What percentage of projects are aligned with S3 areas?

58.7% of the projects are aligned with the strategic areas of S3, while 41.3% are not (Table 7). This indicates that most of the final projects developed over the past years are connected to the smart specialisation priorities of the Basque Country. The high level of alignment suggests a strong integration between academic work and regional innovation strategies, which may reflect institutional efforts to promote collaboration with key sectors and enhance the relevance of student projects.

Table 7. Distribution of BT and MT projects by S3 alignment

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	NO	918	41,3	41,3	41,3
	YES	1306	58,7	58,7	100,0
	Total	2224	100,0	100,0	

4.1.6 With which strategic area are S3 projects aligned?

The dataset reveals that, out of a total of 2,224 projects, approximately 59% (1,306 projects) are explicitly aligned with one or more S3 areas (Table 8). The most prominent sector is Smart Manufacturing, accounting for 35.7% of all projects, indicating a strong regional emphasis on advanced industrial technologies. Other notable sectors include Bio/Health (7.8%), Bio & Smart Manufacturing (6.2%), and Energy & Smart Manufacturing (4.2%), reflecting a growing interest in cross-sectoral innovation. A significant portion of projects (41.3%) falls under the "Valid" category, which may represent initiatives that are relevant but not yet categorised into specific S3 sectors.

Table 8. Distribution of BT and MT projects by S3 area

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid		918	41,3	41,3	41,3
	Bio & SM	137	6,2	6,2	47,4
	Bio/Health	173	7,8	7,8	55,2
	Energy	82	3,7	3,7	58,9
	Energy & Bio	15	,7	,7	59,6
	Energy & Bio & SM	12	,5	,5	60,1
	Energy & SM	93	4,2	4,2	64,3
	Smart Manufacturing	794	35,7	35,7	100,0
	Total	2224	100,0	100,0	

4.1.7 Are S3 strategic areas driven by company activity?

To evaluate the strategic alignment between regional innovation priorities and industrial reality, a Chi-square test of independence was performed between the S3 Strategic Areas and the companies' CNAE sectors (N = 1,301). The analysis revealed a highly significant association between the variables ($\chi^2 = 1449.11$, df = 714, $p < .001$). The strength of this relationship, measured by Cramer's V (.431), indicates a robust moderate-to-strong association, suggesting that project distribution is not random but closely follows the specialised domains of the Basque Country's industrial fabric (Table 9). These results provide empirical evidence that the student projects are effectively clustered within specific S3 axes according to the specialised activity of the host companies, confirming a high degree of practical alignment with the regional Smart Specialisation Strategy.

Table 9. Chi-square test of S3 strategic areas versus company activity

	Cases					
	Valid		*Missing*		*Total*	
	N	*Percent*	*N*	*Percent*	*N*	*Percent*
RIS3_StrategicAreas * CNAE2009	1301	58,5%	923	41,5%	2224	100,0%

Chi-Square Tests

	Value	*df*	*Asymptotic Significance (2-sided)*
Pearson Chi-Square	1449,107[a]	714	<,001
Likelihood Ratio	1107,025	714	<,001
Linear-by-Linear Association	,878	1	,349
N of Valid Cases	1301		

a. 791 cells (94,2%) have expected count less than 5. The minimum expected count is ,01.

Symmetric Measures

		Value	*Approximate Significance*
Nominal by Nominal	Phi	1,055	<,001
	Cramer's V	,431	<,001
N of Valid Cases		1301	

4.2 Research questions

Building on the descriptive analysis, this section presents the core research questions that guide the inferential analysis of student mobility projects within the framework of the Basque Country's Smart Specialisation Strategy. The aim is to examine whether specific characteristics of academic engagement (such as project type, academic programme, geographic location, and period) are significantly associated with S3 alignment. The following questions structure this inquiry: (RQ1) Which student mobility activity (BT or MT) is more closely related to S3 projects? (RQ2) Is there an association between the type of student mobility activity (BT or MT) and alignment with S3 strategic areas? (RQ3) Do the provinces of Gipuzkoa, Bizkaia, and Araba differ in the proportion of projects aligned with RIS3 areas? (RQ4) Are there significant differences in the number of S3-aligned projects across different academic years? and (RQ5) Is there a significant relationship between the type of university degree and the S3 strategic areas in which graduates are positioned?

4.2.1 RQ1. Which student mobility activity - Bachelor's thesis (BT) or Master's thesis (MT) - is more closely related to RIS3 projects?

An independent samples t-test was conducted to examine whether the proportion of S3-aligned projects differed between undergraduate (BT) and master's (MT) programmes. The results revealed a statistically significant difference between the two groups, $t(2222) = 6.692$, $p < .001$. BT projects had a higher proportion of RIS3 alignment ($M = 0.64$, $SD = 0.48$) compared to MT projects ($M = 0.50$, $SD = 0.50$). The mean difference was 0.144, with a 95% confidence interval ranging from

0.102 to 0.186. The effect size, measured by Cohen's d, was 0.488, indicating a moderate practical significance (Table 10). These findings suggest that undergraduate programmes are more likely to produce S3-related projects than master's programmes.

Table 10. t-test analysis for RQ1

	BT_MT	*N*	*Mean*	*Std. Deviation*	*Std. Error Mean*
S3_Yes1No0	BT	1408	,64	,480	,013
	MT	816	,50	,500	,018

Independent Samples Test

		t-test for Equality of Means							
		t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				One-Sided p	Two-Sided p			Lower	Upper
S3_Yes1No0	Equal variances assumed	6,692	2222	<,001	<,001	,144	,021	,102	,186
	Equal variances not assumed	6,620	1645,847	<,001	<,001	,144	,022	,101	,186

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
S3_Yes1No0	Cohen's d	,488	,294	,208	,381
	Hedges' correction	,488	,294	,208	,381
	Glass's delta	,500	,287	,200	,374

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control (i.e., the second) group.

4.2.2 RQ2. Is there an association between the type of student mobility activity (BT or MT) and alignment with S3 strategic areas?

A Chi-square test was conducted to examine the relationship between the type of student mobility activity (BT or MT) and the S3 strategic sectors in which these projects are developed. The results revealed a statistically significant association between thesis type and S3 sector (χ^2 = 122.317, df = 6, p < 0.001), indicating that the distribution of BT and MT projects is not uniform across sectors (Table 11). Specifically, BT projects are more prevalent in sectors such as Smart Manufacturing and Bio/Health, while MT projects are more concentrated in Energy-related areas.

Table 11. Chi-square test for RQ2

			S3_SECTOR								Total
				Bio & SM	Bio/Health	Energy	Energy & Bio	Energy & Bio & SM	Energy & SM	Smart Manufacturing	
BT_MT	BT	Count	507	101	49	52	3	12	79	605	1408
		% within S3_SECTOR	55,2%	73,7%	28,3%	63,4%	20,0%	100,0%	84,9%	76,2%	63,3%
	MT	Count	411	36	124	30	12	0	14	189	816
		% within S3_SECTOR	44,8%	26,3%	71,7%	36,6%	80,0%	0,0%	15,1%	23,8%	36,7%
Total		Count	918	137	173	82	15	12	93	794	2224
		% within S3_SECTOR	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	217,940[a]	7	<,001
Likelihood Ratio	224,030	7	<,001
N of Valid Cases	2224		

a. 1 cells (6,3%) have expected count less than 5. The minimum expected count is 4,40.

4.2.3 RQ3. Do the provinces of Gipuzkoa, Bizkaia, and Araba differ in the proportion of projects aligned with S3 areas?

A Chi-square test of independence was conducted to examine whether the proportion of S3-aligned projects differed significantly across provinces. The results showed no statistically significant association between province and S3 alignment ($\chi^2 = 1.67$, $p = 0.434$) (Table 12). This indicates that, although Gipuzkoa hosts most projects in absolute terms, the relative proportion of S3-aligned projects is similar across Araba, Bizkaia, and Gipuzkoa. Therefore, RIS3 alignment appears to be consistent across geographic location.

Table 12. Chi-square test for RQ3

			S3_YesNo		*Total*
			NO	*YES*	
PROVINCE	ARABA	Count	50	61	111
		% within S3_YesNo	5,4%	4,7%	5,0%
	BIZKAIA	Count	107	172	279
		% within S3_YesNo	11,7%	13,2%	12,5%
	GIPUZKOA	Count	761	1073	1834
		% within S3_YesNo	82,9%	82,2%	82,5%
Total		Count	918	1306	2224
		% within S3_YesNo	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1,671[a]	2	,434
Likelihood Ratio	1,673	2	,433
N of Valid Cases	2224		

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 45,82.

4.2.4 RQ4. Are there significant differences in the number of S3-aligned projects across different academic years?

A one-way ANOVA was conducted to examine whether the proportion of S3-aligned projects varied significantly across the period 2020-2024 (Table 13). The descriptive statistics showed a slight decrease in S3 alignment over time, with the highest proportion in 2020 (M = 0.62) and the lowest in 2023 and 2024 (M = 0.57). However, the ANOVA results indicated no statistically significant differences between years, F (4, 2219) = 0.874, p = .479. The effect size was negligible ($\eta^2 = 0.002$), suggesting that the year of the project had minimal influence on S3 alignment. Therefore, we conclude that the proportion of S3-related projects remained relatively stable over the five-year period.

Table 13. One-way ANOVA for RQ4

S3_Yes1No0

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
2020	403	,62	,485	,024	,58	,67	0	1
2021	420	,59	,493	,024	,54	,63	0	1
2022	446	,59	,492	,023	,55	,64	0	1
2023	479	,57	,495	,023	,53	,62	0	1
2024	476	,57	,496	,023	,52	,61	0	1
Total	2224	,59	,492	,010	,57	,61	0	1

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
S3_Yes1No0	Based on Mean	3,961	4	2219	,003
	Based on Median	,874	4	2219	,479
	Based on Median and with adjusted df	,874	4	2218,490	,479
	Based on trimmed mean	3,961	4	2219	,003

ANOVA

S3_Yes1No0

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,848	4	,212	,874	,479
Within Groups	538,229	2219	,243		
Total	539,077	2223			

ANOVA Effect Sizes[a,b]

		Point Estimate	95% Confidence Interval	
			Lower	Upper
S3_Yes1No0	Eta-squared	,002	,000	,005
	Epsilon-squared	,000	-,002	,003
	Omega-squared Fixed-effect	,000	-,002	,003
	Omega-squared Random-effect	,000	,000	,001

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.
b. Negative but less biased estimates are retained, not rounded to zero.

4.2.5 RQ5. Is there a significant relationship between the type of university degree and the S3 strategic areas in which graduates are positioned?

The analysis indicates a statistically significant relationship between the type of university degree and the S3 strategic areas in which graduates are positioned (Table 14), as evidenced by the Pearson chi-square value of 1404.224 (df = 96, p < .001). This indicates that the distribution of graduates across strategic areas is not random but varies meaningfully depending on their degree.

Graduates with degree GA are predominantly positioned in the "Energy & Bio" and "Smart Manufacturing" areas, while degree GB graduates are mainly found in "Energy" and "Energy & SM". Degrees such as GD and GM show strong representation in the "Energy" area, whereas GE and

MH are more evenly distributed across multiple strategic areas, including "Bio/Health" and "Bio & SM". These patterns suggest that certain degrees are more aligned with specific S3 priorities, highlighting the importance of academic background in shaping graduates' strategic positioning within innovation ecosystems.

Table 14. Chi-square test for RQ5

			S3_StrategicAreas							*Total*
			Bio & SM	Bio/Health	Energy	Energy & Bio	Energy & Bio & SM	Energy & SM	Smart Manufacturing	
DEGREE	GA	Count	5	1	22	0	56	0	8	92
		% within S3_StrategicAreas	6,1%	0,6%	2,8%	0,0%	60,2%	0,0%	66,7%	7,0%
	GB	Count	0	0	23	0	0	62	1	86
		% within S3_StrategicAreas	0,0%	0,0%	2,9%	0,0%	0,0%	45,3%	8,3%	6,6%
	GC	Count	0	0	54	0	3	8	2	67
		% within S3_StrategicAreas	0,0%	0,0%	6,8%	0,0%	3,2%	5,8%	16,7%	5,1%
	GD	Count	0	0	218	0	9	14	1	242
		% within S3_StrategicAreas	0,0%	0,0%	27,5%	0,0%	9,7%	10,2%	8,3%	18,5%
	GE	Count	15	23	30	3	2	4	0	77
		% within S3_StrategicAreas	18,3%	13,3%	3,8%	20,0%	2,2%	2,9%	0,0%	5,9%
	GJ	Count	14	10	56	0	3	4	0	87
		% within S3_StrategicAreas	17,1%	5,8%	7,1%	0,0%	3,2%	2,9%	0,0%	6,7%
	GM	Count	16	11	109	0	6	8	0	150
		% within S3_StrategicAreas	19,5%	6,4%	13,7%	0,0%	6,5%	5,8%	0,0%	11,5%
	GO	Count	2	4	93	0	0	1	0	100
		% within S3_StrategicAreas	2,4%	2,3%	11,7%	0,0%	0,0%	0,7%	0,0%	7,7%
	MD	Count	1	4	17	0	0	1	0	23
		% within S3_StrategicAreas	1,2%	2,3%	2,1%	0,0%	0,0%	0,7%	0,0%	1,8%
	MG	Count	8	12	2	3	2	0	0	27
		% within S3_StrategicAreas	9,8%	6,9%	0,3%	20,0%	2,2%	0,0%	0,0%	2,1%
	MH	Count	9	35	91	4	11	16	0	166
		% within S3_StrategicAreas	11,0%	20,2%	11,5%	26,7%	11,8%	11,7%	0,0%	12,7%
	MIP	Count	0	10	28	1	0	3	0	42
		% within S3_StrategicAreas	0,0%	5,8%	3,5%	6,7%	0,0%	2,2%	0,0%	3,2%
	ML	Count	0	0	7	0	0	1	0	8
		% within S3_StrategicAreas	0,0%	0,0%	0,9%	0,0%	0,0%	0,7%	0,0%	0,6%
	MM	Count	0	26	4	1	0	7	0	38
		% within S3_StrategicAreas	0,0%	15,0%	0,5%	6,7%	0,0%	5,1%	0,0%	2,9%
	MN	Count	0	13	17	0	0	4	0	34
		% within S3_StrategicAreas	0,0%	7,5%	2,1%	0,0%	0,0%	2,9%	0,0%	2,6%
	MR	Count	7	20	21	2	1	4	0	55
		% within S3_StrategicAreas	8,5%	11,6%	2,6%	13,3%	1,1%	2,9%	0,0%	4,2%

			S3_StrategicAreas							*Total*
			Bio & SM	Bio/Health	Energy	Energy & Bio	Energy & Bio & SM	Energy & SM	Smart Manufacturing	
	MS	Count	5	4	2	1	0	0	0	12
		% within S3_StrategicAreas	6,1%	2,3%	0,3%	6,7%	0,0%	0,0%	0,0%	0,9%
Total		Count	82	173	794	15	93	137	12	1306
		% within S3_StrategicAreas	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1404,224[a]	96	<,001
Likelihood Ratio	1010,267	96	<,001
N of Valid Cases	1306		

a. 66 cells (55,5%) have expected count less than 5. The minimum expected count is ,07.

5 Discussion

5.1 Research contributions

This study makes several important contributions to understanding how academic projects align with regional innovation strategies. First, it offers a comprehensive, data-driven overview of the distribution and evolution of bachelor's and master's theses over five years, highlighting the growing contribution of undergraduate education to regional innovation. Second, it provides empirical evidence linking academic programmes, geographic location, and S3 alignment, revealing patterns that can inform institutional planning and policy decisions. Third, it identifies key sectors (particularly Smart Manufacturing) as areas of strong student engagement, while also signalling underexplored domains that may require targeted institutional support. Finally, through robust statistical analysis, the study demonstrates how educational level, programme type, and regional context shape the thematic orientation of student projects, offering a framework for aligning academic output with strategic regional priorities.

Beyond this general contribution, the study generates insights for each of the triple helix actors: academia, industry, and government.

5.1.1 Contributions to academia

The findings show how structured student mobility serves as an effective mechanism for aligning academic work with regional innovation strategies. Analysis of more than 2,200 projects highlights the strong role of undergraduate education in driving innovation, particularly in Smart Manufacturing. The results underscore the importance of embedding regional priorities into curricula and project design, offering a reference model for institutions seeking to enhance their societal impact through education-driven university-industry collaboration. The study also enriches the entrepreneurial university literature by illustrating how dual education and final-year projects help bridge theoretical and practical knowledge.

5.1.2 Contributions to industry

For industry, the research shows the tangible value of collaborating with universities through thesis projects. The high alignment of BT with S3 sectors (especially Smart Manufacturing) demonstrates how companies can use academic collaborations to address real challenges and foster innovation. Student mobility also enhances employability and knowledge transfer, positioning it as a strategic tool for talent acquisition and organisational learning. By engaging in dual education and hosting final-year projects, companies contribute to regional development while gaining access to new ideas, prototypes, and process improvements.

5.1.3 Contributions to government

From a policy standpoint, the findings provide actionable evidence on how student mobility and university-industry collaboration support S3. The consistent alignment of academic projects with regional priorities across provinces and years indicates that structured educational initiatives can act as powerful instruments of place-based innovation. The study highlights the need for policies that reduce geographic disparities and encourage engagement in underrepresented sectors. Governments can use these results to design incentives, funding schemes, and governance models that strengthen universities' roles as active agents in regional innovation ecosystems.

5.2 Limitations and future research directions

Given the growing number of undergraduate theses and their stronger alignment with RIS3 strategic areas, future research could investigate the factors driving this engagement. Exploring pedagogical approaches, institutional incentives, or curriculum structures that promote RIS3-related project development at the undergraduate level may offer insights for increasing participation at master's level.

Another promising avenue involves examining the geographic concentration of projects in Gipuzkoa. Although current data show no significant differences in RIS3 alignment across provinces, understanding local dynamics - such as industry presence, university partnerships, and student demographics - could inform strategies to achieve a more balanced distribution of projects across the Basque Country.

The strong representation of Smart Manufacturing suggests potential saturation or institutional bias. Future studies could assess whether this dominance reflects genuine innovation potential or limited diversification. Investigating underrepresented sectors such as Energy & Bio or Bio & Smart Manufacturing could help broaden the strategic focus and create new opportunities for interdisciplinary innovation.

Given the observed association between academic programmes and S3 sectors, further research could map competences and learning outcomes to strategic priorities, supporting the design of educational pathways more closely aligned with regional innovation needs and enhancing the impact of student projects.

Finally, methodological improvements should be considered. Limitations in the present analysis (such as low expected counts in some tests) indicate that future research would benefit from larger datasets, longitudinal tracking of project outcomes, and qualitative approaches that capture student and faculty perspectives on S3 alignment and project development.

5.3 Practical implications

The findings of this study offer valuable insights for academic institutions, policymakers, and regional innovation stakeholders. The strong alignment of undergraduate theses with S3 strategic areas indicates that bachelor's programmes are effectively incorporating regional innovation priorities into their curricula. This underscores the potential of undergraduate education as a driver of innovation and highlights the importance of strengthening support structures for final-year projects, such as mentorship, industry collaboration, and targeted funding.

The predominance of certain programmes (e.g., GM, MH, GD, GO) in project output and S3 alignment suggests these disciplines can serve as strategic anchors for institutional planning. Universities may use these patterns to identify best practices and extend them to programmes with lower engagement. Additionally, the high concentration of projects in Gipuzkoa points to possible regional disparities in academic-industry collaboration, encouraging policymakers to promote more balanced participation through incentives in underrepresented provinces such as Araba and Bizkaia.

The strong focus on Smart Manufacturing carries notable implications for regional development. While this aligns with existing industrial strengths, it raises questions about possible underutilisation of other S3 sectors. Institutions and regional authorities could explore ways to build interest and capacity in emerging or less represented fields, fostering a more diversified innovation ecosystem.

Finally, the significant associations between thesis type, academic programme, and S3 sector indicate that more deliberate alignment between educational pathways and strategic priorities is both feasible and advantageous. This could inform curriculum design, career guidance, and industry partnerships. Nevertheless, limitations (such as reliance on quantitative data, lack of longitudinal tracking, and small sample sizes in some categories) highlight the need for more robust, mixed-methods research to support evidence-based decision-making.

6 Conclusions

This study provides evidence of the evolving role of universities in regional innovation ecosystems, particularly through education-driven collaboration. The analysis of 2,224 BT and MT theses from 2020 to 2024 reveals a clear upward trend in BT projects, which consistently outnumbered MTs, indicating a growing engagement of undergraduate students in final project activities. This trend aligns with the literature on entrepreneurial universities and the increasing relevance of work-integrated learning at the undergraduate level (Galan-Muros & Davey, 2017; Rampersad, 2015).

The strong alignment of BT projects with S3 priorities (especially in Smart Manufacturing) reinforces the strategic role of universities in supporting regional development through talent development and knowledge transfer (Aranguren & Magro, 2022; Burbridge & Morrison, 2021). Statistical analyses confirm that BTs are significantly more likely to be aligned with S3 sectors than MTs, with Smart Manufacturing and Bio/Health as dominant areas for BTs, while MTs are more prevalent in Energy-related sectors. This sectoral distribution reflects both institutional strengths and potential biases, as noted in critiques of S3 (Hassink & Gong, 2021).

Despite the geographic concentration of projects in Gipuzkoa (82.5%), alignment with S3 priorities remains consistent across provinces, suggesting effective regional integration and governance flexibility (Morgan et al., 2020). The prominence of programmes such as GM, MH, GD, and GO in project output further highlights the importance of curricular structure and institutional emphasis in shaping engagement with strategic innovation areas.

However, the underrepresentation of emerging sectors like Energy & Bio and Bio & Smart Manufacturing points to opportunities for diversification. The significant relationship between academic programmes and S3 sectors (although statistical interpretation is limited) suggests that aligning educational pathways with regional priorities could enhance the impact of university-industry collaboration. These findings underscore the need for adaptive policy mechanisms, continuous monitoring, and targeted support to ensure inclusive and balanced innovation across sectors and academic levels.

References

Agrawal, A., & Henderson, R. (2002). Putting patents in context: Exploring knowledge transfer from MIT. *Management Science, 48*(1), 44–60. https://doi.org/10.1287/mnsc.48.1.44.14279

Alunurm, R., Rõigas, K., & Varblane, U. (2020). The relative significance of higher education–industry cooperation barriers for different firms. *Industry and Higher Education, 34*(6), 377–390. https://doi.org/10.1177/0950422220909737

Ankrah, S., & Al-Tabbaa, O. (2015). Universities–industry collaboration: A systematic review. *Scandinavian Journal of Management, 31*(3), 387–408. https://doi.org/10.1016/j.scaman.2015.02.003

Arancegui, M. N. (2015). Las estrategias territoriales para la transformación productiva: Reflexión desde el caso del País Vasco [Territorial strategies for productive transformation: Reflections from the case of the Basque Country]. *ICADE. Revista de la Facultad de Derecho*, 96, 75–104.

Aranguren, M. J., & Magro, E. (2022). How can universities contribute to regional competitiveness policy-making? *Competitiveness Review, 30*(2), 101–117. https://doi.org/10.1108/CR-11-2018-0071

Aranguren, M. J., Navarro, M., & Wilson, J. R. (2015). From plan to process: Exploring the leadership implications of RIS3. *Orkestra Working Paper Series in Territorial Competitiveness*, 1, 1–30.

Aranguren, M. J., & Wilson, J. R. (2013). What can experience with clusters teach us about fostering regional smart specialisation? *Ekonomiaz: Revista Vasca de Economía*, 83, 126–145.

Bekkers, R., & Freitas, I. M. B. (2008). Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter? *Research Policy, 37*(10), 1837–1853. https://doi.org/10.1016/j.respol.2008.07.007

Bozeman, B., Fay, D., & Slade, C. P. (2013). Research collaboration in universities and academic entrepreneurship: The-state-of-the-art. *The Journal of Technology Transfer, 38*(1), 1–67. https://doi.org/10.1007/s10961-012-9281-8

Breschi, S., & Lissoni, F. (2001). Localised knowledge spillovers vs. innovative milieux: Knowledge "tacitness" reconsidered. *Papers in Regional Science, 80*(3), 255–273. https://doi.org/10.1111/j.1435-5597.2001.tb01799.x

Burbridge, M., & Morrison, G. M. (2021). A systematic literature review of partnership development at the university–industry–government nexus. *Sustainability, 13*(24), 13780. https://doi.org/10.3390/su132413780

Calza, E., Goedhuys, M., & Trifković, N. (2019). Drivers of productivity in Vietnamese SMEs: The role of management standards and innovation. *Economics of Innovation and New Technology, 28*(1), 23–44. https://doi.org/10.1080/10438599.2018.1423765

Clauss, T., & Kesting, T. (2017). How businesses should govern knowledge-intensive collaborations with universities: An empirical investigation of university professors. *Industrial Marketing Management*, 62, 185–198. https://doi.org/10.1016/j.indmarman.2016.09.001

Davey, T., Baaken, T., Galán-Muros, V., & Meerman, A. (2011). *Study on the cooperation between higher education institutions and public and private organisations in Europe*. European Commission.

Davey, T., Meerman, A., Galán-Muros, V., Orazbayeva, B., & Baaken, T. (2018). *The state of university-business cooperation in Europe: Final report*. European Commission.

De Man, A. P. (2004). *The network economy: Strategy, structure and management*. Edward Elgar Publishing.

Dima, A. M., Hasegan, S. S., & Luciana, I. (2017). Review on the dimensions of business-university alliances. *Proceedings of the 11th International Conference on Business Excellence, 11*(1), 64–73. https://doi.org/10.1515/picbe-2017-0007

Euskadi, P. (2020). *Estrategia de Especialización Inteligente RIS3*. Gobierno Vasco [RIS3 Smart Specialization Strategy: Basque Government].

Ferreira, H., Marques, C. S., & Farinha, L. (2025). Regional smart specialisation strategies: A systematic literature review. *Journal of the Knowledge Economy*, 1–28. https://doi.org/10.1007/s13132-025-02736-3

Ferretti, M., & Parmentola, A. (2015). Technological learning and innovation systems in developing countries: The example of Dubai. *International Journal of Technoentrepreneurship, 3*(1), 37–59.

Fitjar, R. D., Benneworth, P., & Asheim, B. T. (2019). Towards regional responsible research and innovation? Integrating RRI and RIS3 in European innovation policy. *Science and Public Policy, 46*(5), 772–783. https://doi.org/10.1093/scipol/scz029

Foray, D., David, P. A., & Hall, B. H. (2011). Smart specialisation: From academic idea to political instrument, the surprising destiny of a concept and the difficulties involved in its implementation. *Integration Process in the New Regional and Global Settings*, 269.

Galan-Muros, V., & Davey, T. (2017). Trends, challenges and promising approaches in the relationship between higher education and the employer community. *State of Higher Education 2015-16. OECD Higher Education Programme (IMHE)*, 63–86.

Griniece, E., Panori, A., Kakderi, C., Komninos, A., & Reid, A. (2017). Methodologies for Smart Specialisation Strategies: A view across the EU regions. *International Conference for Entrepreneurship, Innovation, and Regional Development (ICEIRD 2017)*, 321–330.

Gulbrandsen, M., Mowery, D., & Feldman, M. (2011). Introduction to the special section: Heterogeneity and university-industry relations. *Research Policy, 40*(1), 1–5. https://doi.org/10.1016/j.respol.2010.09.007

Hardy, C., Phillips, N., & Lawrence, T. B. (2003). Resources, knowledge and influence: The organizational effects of interorganizational collaboration. *Journal of Management Studies, 40*(2), 321–347. https://doi.org/10.1111/1467-6486.00342

Hassink, R., & Gong, H. (2021). Six critical questions about smart specialization. En *Rethinking Clusters* (pp. 171–187). Springer.

Hewitt-Dundas, N. (2013). The role of proximity in university-business cooperation for innovation. *The Journal of Technology Transfer, 38*(2), 93–115. https://doi.org/10.1007/s10961-011-9229-4

Isaksen, A., & Karlsen, J. (2010). Different modes of innovation and the challenge of connecting universities and industry: Case studies of two regional industries in Norway. *European Planning Studies, 18*(12), 1993–2008. https://doi.org/10.1080/09654313.2010.516523

Kempton, L. (2015). Delivering smart specialization in peripheral regions: The role of Universities. *Regional Studies, Regional Science, 2*(1), 489–496. https://doi.org/10.1080/21681376.2015.1085329

Laukkanen, M. (2003). Exploring academic entrepreneurship: Drivers and tensions of university-based business. *Journal of Small Business and Enterprise Development, 10*(4), 372–382. https://doi.org/10.1108/14626000310504684

Lehmann, E. E., & Menter, M. (2016). University–industry collaboration and regional wealth. *The Journal of Technology Transfer, 41*(6), 1284–1307. https://doi.org/10.1007/s10961-015-9445-4

Lim, J. D. (2006). *Regional innovation system and regional development: Survey and a Korean case*. The International Center for the Study of East Asian Development.

López-Rodríguez, J., Faíña, A., & Manso, G. (2010). Sistemas de innovación regionales: El caso del País Vasco. [Regional Innovation Systems: The Case of the Basque Country] *Revista Galega de Economía*, 19, 1–17.

Mascarenhas, C., Galvão, A.R., Mendes, T., Marques, C.S., & Ferreira, J. (2022). University and Industry Collaboration in the Era of Smart Specialisation: Empirical Research on Sustainable Knowledge Transfer. European Conference on Knowledge Management.

Mascarenhas, C., Galvão, A. R., Mendes, T., Marques, C., & Ferreira, J. J. (2025). How do smart specialization strategies influence university-industry collaboration in cross-border regions? *Review of Managerial Science*, 1–37. https://doi.org/10.1007/s11846-025-00933-7

McCann, P., & Ortega-Argilés, R. (2018). Smart specialization, regional growth and applications to European Union cohesion policy. En *Place-based economic development and the new EU cohesion policy* (pp. 51–62). Routledge.

Mihaylova, L., Papazov, E., & Woolfolk Ruiz, D. E. (2024). The significance of Erasmus+ mobility in business education: An examination of a successful Bulgarian–Mexican collaboration. *Azbuki*.

Morgan, K., Navarro, M., & Valdaliso, J. M. (2020). Economic governance in the Basque country: Balancing continuity and novelty. *Ekonomiaz*, 35, 170–201.

Navarro, M., Aranguren, M. J., & Montero, E. M. (2011). Smart specialisation strategies: The case of the Basque country. *Orkestra Working Paper Series in Territorial Competitiveness*, 7, 1.

O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spinoff performance of US universities. *Research Policy, 34*(7), 994–1009. https://doi.org/10.1016/j.respol.2005.05.011

Panori, A., Komninos, N., Kakderi, C., & Fellnhofer, K. (2017). Smart specialisation strategies: An online platform for strategy design and assessment. *International Conference on Reliability and Statistics in Transportation and Communication*.

Pavlin, S. (2016). Considering university-business cooperation modes from the perspective of enterprises. *European Journal of Education, 51*(1), 25–39. https://doi.org/10.1111/ejed.12163

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., & Sobrero, M. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy, 42*(2), 423–442. https://doi.org/10.1016/j.respol.2012.09.007

Perkmann, M., & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews, 9*(4), 259–280. https://doi.org/10.1111/j.1468-2370.2007.00225.x

Petruzzelli, A. M. (2011). The impact of technological relatedness, prior ties, and geographical distance on university–industry collaborations: A joint-patent analysis. *Technovation, 31*(7), 309–319. https://doi.org/10.1016/j.technovation.2011.01.008

Phan, Phillip H. and Siegel, Donald S. (2006). The Effectiveness of University Technology Transfer: Lessons Learned, Managerial and Policy Implications, and the Road Forward. http://dx.doi.org/10.2139/ssrn.900605

Philpott, K., Dooley, L., O'Reilly, C., & Lupton, G. (2011). The entrepreneurial university: Examining the underlying academic tensions. *Technovation, 31*(4), 161–170. https://doi.org/10.1016/j.technovation.2010.12.003

Plewa, C., Korff, N., Johnson, C., Macpherson, G., Baaken, T., & Rampersad, G. C. (2013). The evolution of university–industry linkages—A framework. *Journal of Engineering and Technology Management, 30*(1), 21–44. https://doi.org/10.1016/j.jengtecman.2012.11.005

Rampersad, G. C. (2015). Developing university-business cooperation through work-integrated learning. *International Journal of Technology Management, 68*(3–4), 203–227. https://doi.org/10.1504/IJTM.2015.069664

Ranga, M., & Etzkowitz, H. (2013). Triple Helix systems: An analytical framework for innovation policy and practice in the knowledge society. *Industry and Higher Education, 27*(4), 237–262. https://doi.org/10.5367/ihe.2013.0165

Rodríguez-Pose, A., Di Cataldo, M., & Rainoldi, A. (2014). *The role of government institutions for smart specialisation and regional development*. European Commission, JRC Science and Policy Reports.

Rodríguez Ochoa, D., Arranz, N., & Fernandez de Arroyabe, M. (2025). Strengthening Smart Specialisation Strategies (S3) Through Network Analysis: Policy Insights from a Decade of Innovation Projects in Aragón. *Economies*, 13(8), 218. https://doi.org/10.3390/economies13080218

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change, 16*(4), 691–791. https://doi.org/10.1093/icc/dtm023

Rudawska, I., & Kowalik, J. (2019). Towards university-business cooperation: Key drivers, barriers and modes. *International Entrepreneurship Review, 5*(2), 91. https://doi.org/10.15678/IER.2019.0502.06

Shane, S. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*. Edward Elgar Publishing.

Siegel, D. S., Waldman, D., & Link, A. (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy, 32*(1), 27–48. https://doi.org/10.1016/S0048-7333(01)00196-2

Stoimenova, B. B. (2019). Regional innovation systems and university competitiveness. *International Journal of Innovation: IJI Journal, 7*(2), 227–235. https://doi.org/10.5585/iji.v7i2.353

Treasury, H. M. (2003). *Lambert review of business–university collaboration: Final report*. HM Treasury.

Wilson, J. R., Aranguren, M. J., & Navarro, M. (2015). *From plan to process: Exploring the leadership implications of RIS3 (2015R01)*. Orkestra-Basque Institute of Competitiveness.