



## From Anticipated to Emergent Risks: Lessons Learned from Designing a Joint Master's Programme in Low-Carbon Structural Engineering

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### Abstract

*The development of joint and integrated master's programmes within international consortia involves complex academic, institutional, and regulatory challenges. This paper reflects on risk assessment and risk materialisation within the Low Carbon Structures (LowCarb-S) project, an Erasmus Mundus Design Measures action aimed at developing a future joint master's degree in sustainable structural engineering across six European universities. During the proposal phase, a structured risk analysis was conducted to anticipate challenges related to curriculum harmonisation, alignment of learning outcomes, accreditation procedures, institutional engagement, and governance. Although these risks were formally identified and mitigation strategies proposed, the programme development phase revealed notable discrepancies between anticipated and actual risks. Several challenges evolved differently than expected, and additional risks emerged. Key emergent risks included divergent national accreditation cultures, varying interpretations of sustainability and low-carbon competencies, differences in institutional readiness for joint degrees, and difficulties in translating strategic educational objectives into coherent and assessable curricula. Moreover, interdisciplinary integration—central to the programme's ambition—introduced a level of complexity that was underestimated at proposal stage. By contrasting projected and real risks, this paper highlights the limitations of conventional proposal-stage risk assessments and emphasises the need for adaptive and process-oriented risk management throughout joint programme design. The findings provide practical insights for academic leaders and project coordinators involved in Erasmus Mundus initiatives, European University alliances, and the development of innovative, sustainability-oriented engineering programmes.*

**Keywords:** Joint degree, Erasmus Mundus, curriculum development, risk assessment, low-carbon structures, higher education

### 1. Introduction

As the transition toward a greener and more digital society accelerates, the construction sector faces increasing pressure to balance sustainability, competitiveness, and innovation. The European Union has set ambitious targets through initiatives such as the European Green Deal [1] and the Fit for 55 package [2], aiming for climate neutrality by 2050 and significant reductions in CO<sub>2</sub> emissions. Complementary measures, including the Net-Zero Industry Act [3] and the Carbon Border Adjustment Mechanism [4], seek to support industrial transformation while maintaining fair competition. These



policies are driving a shift toward low-carbon materials, improved energy efficiency, life cycle-based design approaches in construction, and industry initiatives such as CEMBUREAU's Net Zero Roadmap [5].

At the same time, the EU's digital strategy highlights the need to enhance digital skills and increase the adoption of advanced technologies such as artificial intelligence. Despite their potential, uptake remains limited, with only 54% of adults possessing basic digital skills [6,7] and a relatively low adoption of AI in enterprises, particularly in the construction sector [8]. Alongside the green and digital transitions, education plays a critical role in supporting innovation and competitiveness. However, disparities persist in participation and attainment levels, with only 47% of European adults engaged in learning activities [9] and 23% attaining tertiary education degrees [10]. EU policy frameworks, including the European Pillar of Social Rights Action Plan [11], aim to address these gaps, although differences across fields remain evident [12].

In response to these interconnected challenges, the Low Carbon Structures Joint Master's Degree (Acronym LowCarb-S) is being developed as an interdisciplinary programme bringing together six European universities. The development of the programme is funded by the European Union through the Erasmus Mundus Design Measures (EMDM) financial scheme. The programme integrates sustainability, digitalization, and AI-driven design within a flexible, modular structure that enhances accessibility while maintaining academic rigor.

The development of joint and double degree programmes has been widely recognised in the literature as a key instrument for advancing internationalisation and institutional cooperation in higher education. However, previous studies consistently highlight that such programmes are inherently complex and often affected by structural, legal, and organisational challenges that extend beyond purely academic design. Evidence shows that difficulties related to accreditation, recognition of qualifications, funding sustainability, and curriculum integration are among the most frequently reported obstacles in transnational programme development [13,14].

Moreover, research conducted at European level indicates that joint programmes operate within highly heterogeneous institutional and regulatory environments, where differences in national systems and institutional practices significantly influence implementation processes and outcomes [15,16]. These findings suggest that the success of joint master's programmes depends not only on academic excellence, but also on the ability to manage institutional diversity and coordination complexity.

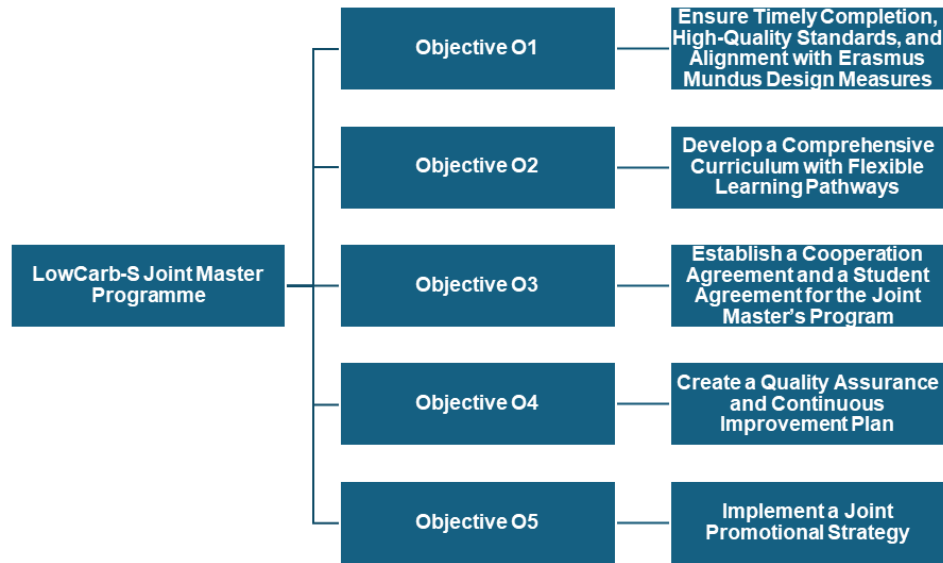
This paper examines the gap between anticipated and actual risks in the development of the Low Carbon Structures (LowCarb-S) joint master's programme. Beyond a descriptive comparison, it aims to provide a critical reflection on the limitations of proposal-stage risk assessment in complex, multi-institutional academic projects. The paper argues that risk in such contexts is not primarily technical, but emerges from institutional diversity, governance complexity, and uneven partner engagement. By analysing how initially identified risks evolved and how new risks emerged during implementation, the study contributes to a more process-oriented understanding of risk management in joint programme design. While not aiming for statistical generalisation, the study offers practical and conceptual insights for academic leaders and project coordinators involved in Erasmus Mundus initiatives, European University alliances, and the development of interdisciplinary, sustainability-oriented programmes.

This study adopts a qualitative case-study approach based on the implementation of the LowCarb-S project. The analysis is grounded in the comparison between proposal-stage risk assessment and mid-term implementation dynamics, using internal project documentation, coordination meetings, and progress monitoring activities as primary sources of evidence.

## **2. Description of the Low Carbon Structures (LowCarb-S) Joint Master's Programme**

The Low Carbon Structures (LowCarb-S) Joint Master's Degree is an interdisciplinary initiative developed by a consortium of six European universities: Technical University of Cluj-Napoca (TUCN), Cyprus University of Technology (CUT), Riga Technical University (RTU), University of Cassino and Southern Lazio (UNICAS), Technological University Dublin (TUD), and University of Montenegro (UoM). Each institution contributes complementary expertise in sustainable construction, structural engineering, digitalization, and artificial intelligence, supported by specialized laboratories and research facilities. It is designed to respond to the growing need for engineers capable of addressing climate change challenges through low-carbon design, life cycle optimisation, and the integration of digital tools such as AI-driven modelling.

The project is guided by several core objectives in alignment with Erasmus Mundus Design Measures requirements. Figure 1 details the objectives of the LowCarb-S project:



**Fig. 1.** LowCarb-S Core Objectives

The achievement of these objectives may be affected by a range of risks, including institutional, regulatory, and operational challenges, which can influence both the implementation process and the overall outcomes of the programme.

### 3. Risks in the Proposal Phase vs. the Development Phase at the Mid-point Implementation Period

During the proposal phase, a structured risk assessment was conducted to identify potential challenges that could affect the achievement of the project objectives and to define appropriate mitigation measures, which is presented in Table 1. The risks were classified as having either high or medium impact on the implementation of the project proposal.

**Table 1.** Risks in the proposal phase with corrective measures

Risk No	Description	Proposed risk-mitigation measures	Affected Objectives
R1	Differences in academic structures, credit recognition policies, and institutional priorities may hinder the development of a cohesive joint master's programme. Risk: High impact.	1. Establish a structured governance and coordination framework early in the project. 2. Conduct regular consortium meetings to align expectations and resolve conflicts. 3. Ensure adherence to European Higher Education Area (EHEA) qualification frameworks for uniformity across institutions.	O1, O2, O3, O4
R2	Lengthy administrative processes in partner institutions may delay curriculum validation and approval. Risk: Medium impact.	1. Develop a pre-accreditation compliance checklist to anticipate and address approval challenges. 2. Establish clear responsibilities for each partner in securing internal approvals.	O1, O3, O4
R3	Designing an interdisciplinary programme that integrates expertise from multiple universities while ensuring academic coherence can be complex. Risk: High impact.	1. Define common learning outcomes based on partner expertise and industry needs. 2. Ensure flexibility through modular course structures that accommodate different institutional requirements.	O2
R4	A lack of engagement from industry partners and external stakeholders may reduce the programme's practical relevance. Risk: Medium impact.	1. Establish advisory boards with representatives from industry and research institutions. 2. Align curriculum with industry needs through consultations and workshops. 3. Incorporate practical case studies and industry-driven challenges into course design.	O2, O5



R5	Without an effective dissemination strategy, the proposed master's programme may struggle to attract strong institutional and student interest. Risk: High impact.	1. Develop a strategic marketing plan that highlights the programme's unique value. 2. Address existing university networks, Erasmus+ platforms, and academic conferences to promote the initiative.	O5
R6	Unforeseen financial limitations or bureaucratic hurdles could impact the project's ability to finalize the programme design. Risk: Medium impact.	1. Establish a detailed and transparent financial management plan with contingency funds.	O1, O3, O5
R7	The joint master's programme may not secure sufficient funding or institutional commitment for future implementation. Risk: High impact.	1. Secure institutional commitments from partners regarding future resource allocation. 2. Search potential funding sources, including Erasmus Mundus Joint Master (EMJM) funding.	O3, O5

At the mid-point of project implementation, the development of the LowCarb-S programme reveals a mixed progress pattern, with discrepancies between planned and actual achievements, thus confirming the relevance of several risks identified during the proposal phase.

On the academic side, several key steps have been completed. The overall programme structure has been agreed (four semesters, 120 ECTS), alongside a decentralized accreditation approach, whereby each partner will pursue national accreditation in line with domestic regulations. Additionally, stakeholder engagement has been initiated through the design of questionnaires targeting employers and employees, focusing on sustainability, green practices in construction, and digitalization needs. Final learning outcomes have also been defined, and the consortium has initiated the process of aligning existing courses within each institution to these outcomes—an essential step given the constraints related to future Erasmus Mundus Joint Master (EMJM) applications.

However, progress has been slower than initially planned in several areas. The curriculum development process, while conceptually advanced, has been affected by institutional differences and varying interpretations of legal and procedural constraints. This situation directly reflects Risk R1 (differences in institutional frameworks) and Risk R3 (complexity of interdisciplinary curriculum design), while also highlighting additional layers of legal sensitivity not fully anticipated at proposal stage.

Furthermore, limited progress has been recorded in the development of joint governance instruments, such as joint policies and agreements, primarily due to time constraints among responsible partners. This aligns with Risk R2 (administrative delays) and Risk R6 (organizational and resource-related constraints), demonstrating how competing institutional priorities can impact coordination efforts.

In contrast, dissemination activities have progressed effectively. The consortium has successfully developed a visual identity, communication templates, social media presence, a dedicated website and promotional materials for the first project onsite event. Furthermore, the project was already presented in an international conference and more scientific disseminations are ongoing, in accordance with the project proposal. These outcomes indicate that mitigation measures associated with Risk R5 (dissemination and visibility) have been successfully implemented.

Regarding partnership formalization, although partner agreements have been drafted to regulate financial distribution—given that the Technical University of Cluj-Napoca (TUCN) acts as the main beneficiary—only partial signature completion has been achieved to date, with the agreement finalized by the University of Montenegro (UoM), Cyprus University of Technology (CUT), and University of Cassino and Southern Lazio (UNICAS). This situation reflects elements of Risk R7 (insufficient institutional commitment) and highlights delays in formal engagement across the consortium.

Overall, the current stage of implementation demonstrates that while strategic academic components are advancing, operational, legal, and institutional factors are generating delays and reshaping the initially anticipated risk landscape. These findings demonstrate the need of adaptive and continuous risk management beyond the proposal phase.

Table 2 presents the risks identified in the project proposal and the updated corrective measures required to bring the project back on track.

**Table 2.** Risks in the proposal phase encountered in the development phase and updated corrective measures at mid-point project

Risk No	Encountered (Yes/No)	Updated corrective measures adopted at the project mid-point
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R1	Yes	Organize targeted bilateral meetings to clarify legal constraints; define a minimum common framework accepted by all partners; use external guidance (EHEA/EMJM examples) to standardize interpretations.
R2	Yes	Set internal deadlines with clear responsibilities per partner; introduce periodic progress monitoring; escalate delays within the consortium management structure.
R3	Yes	Continue structured mapping of existing courses to agreed learning outcomes; organize dedicated curriculum workshops.
R4	Partially	Finalize and distribute questionnaires; actively involve industry representatives through advisory boards and upcoming events (e.g. Midpoint and endpoint project physical meetings); integrate feedback into curriculum design.
R5	No (well managed)	Continue dissemination efforts; maintain active online presence; leverage upcoming physical meetings and networks to increase visibility and attract stakeholders.
R6	Yes	Reallocate tasks or provide support to overloaded partners; prioritize critical deliverables (joint policies); introduce shorter, more frequent coordination meetings focused on specific outputs.
R7	Yes	Follow up individually with partners; clarify financial and legal implications; set firm deadlines for signature; consider interim agreements if needed to ensure continuity.

The analysis of the current risk landscape indicates that most of the risks identified during the proposal phase have materialised, particularly those related to institutional diversity, administrative complexity, and coordination constraints. However, beyond simple validation of initial assumptions, the findings reveal that risks in joint programme development are not static events, but dynamic processes shaped by institutional behaviour and interaction patterns within the consortium.

A clear differentiation emerges between risks that are structural (e.g., differences in legal frameworks and accreditation procedures), operational (e.g., delays in curriculum alignment and governance development), and behavioural (e.g., uneven partner engagement and limited availability of key contributors). Among these, behavioural and governance-related risks (R2, R6, R7) have had the most significant cascading effects, directly impacting the achievement of core programme objectives, particularly O2 (programme design), O3 (institutional integration and accreditation), and O5 (long-term sustainability).

In contrast, risks associated with more autonomous and less interdependent activities, such as dissemination (R5), have been effectively mitigated, confirming that tasks with lower dependency on multi-actor coordination are more resilient to implementation constraints. This distinction suggests that the main limitation of the proposal-stage risk assessment was not the identification of individual risks, but the underestimation of their interdependency and amplification effects within a complex consortium environment.

These findings highlight the need to move from a static, compliance-oriented risk assessment approach toward a dynamic and adaptive model, in which risks are continuously monitored, reinterpreted, and managed in relation to evolving institutional realities.

#### 4. Lessons Learned

Table 3 proposes a structured framework of implementation-stage risks (revised risks RR) suitable for Erasmus Mundus Design Measures new applications, along with the reasons why the specific risk was underestimated in the proposal phase of the LowCarb-S project.

**Table 3.** Revised Risks (RR) that should be included in an Erasmus Mundus Design Measures project proposal

Risk No	Description (Emergent Risk)	Proposed mitigation measures	Why it was underestimated in proposal phase of the LowCarb-S
RR1	Divergent legal interpretations and risk-averse institutional cultures (e.g., regarding surveys, data use, or joint procedures) delay decision-making.	Engage legal departments early; develop shared legal guidelines/templates; use previously approved Erasmus Mundus examples to reduce uncertainty.	The proposal assumed alignment under common European frameworks (EHEA, Erasmus+), underestimating institutional legal caution and internal compliance layers.
RR2	Variability in institutional readiness for joint degrees (administrative capacity, experience, internal support).	Conduct an initial "readiness assessment"; provide targeted support to less experienced partners; define minimum operational standards.	It was assumed that all partners have similar experience with international joint programmes, while in reality readiness levels differ significantly.



RR3	Difficulty in translating high-level learning outcomes into coherent, compatible curricula based on existing courses.	Introduce iterative curriculum design workshops; allow partial course adaptation; consider hybrid solutions (new + existing courses).	The proposal underestimated the rigidity of existing curricula and the complexity of aligning them across institutions.
RR4	Delays caused by uneven partner engagement and limited time availability for key contributors.	Define clearer accountability mechanisms; introduce milestone-based monitoring; redistribute tasks where delays persist.	The proposal assumed consistent engagement across partners, without fully accounting for workload differences and competing priorities.
RR5	Overestimation of the speed of governance framework development (joint policies, agreements).	Prioritize essential agreements first; use simplified or interim versions; build on existing templates from similar projects.	Governance development was treated as a structured process, without accounting for negotiation complexity and institutional constraints.
RR6	Challenges in aligning expectations regarding programme implementation pathways (national accreditation vs. fully joint accreditation).	Clarify early the preferred implementation model; document agreed pathway; ensure transparency and consensus at consortium level.	The proposal did not fully anticipate strategic differences in how partners envision the final programme structure.
RR7	Underestimation of the complexity introduced by interdisciplinary integration (technical + digital + sustainability domains).	Define clear thematic pillars; assign interdisciplinary coordinators; ensure balance between depth and integration.	Interdisciplinarity was considered an added value, but its operational complexity in curriculum design was underestimated.

Table 3 contains a set of structural and emergent risks that are typical for Erasmus Mundus Design Measures projects, but which are often underrepresented or underestimated in the initial proposal phase. A common pattern across all identified risks is the gap between assumed institutional homogeneity and the actual heterogeneity of consortium partners in terms of legal interpretation, administrative capacity, and operational readiness.

First, RR1 and RR2 emphasize that institutional diversity is not only administrative but also cultural and legal. While Erasmus+ frameworks assume a shared European baseline, the implementation reality of the LowCarb-S project shows that internal compliance layers, legal caution, and differing interpretations of regulations can significantly slow down decision-making. Variability in readiness for joint degrees demonstrates that partner institutions operate at different maturity levels, requiring differentiated support strategies rather than uniform assumptions.

The findings of this study are consistent with previous research on joint and transnational degree programmes. Earlier studies have identified similar patterns, including difficulties in curriculum integration, administrative complexity, and the need for sustained institutional commitment [13,14,15]. These aspects are often underestimated at proposal stage, despite being repeatedly highlighted in European-level analyses of joint programme development.

RR3 and RR7 reflect curricular and academic integration challenges in the LowCarb-S project, particularly in interdisciplinary programmes. The transformation of high-level learning outcomes into coherent curricula is constrained by existing national requirements, which are often rigid and not easily adaptable. Interdisciplinary integration further amplifies this complexity, as it requires not only content alignment but also conceptual coherence across domains that traditionally operate separately. These difficulties align with previous studies showing that curriculum integration across institutions is one of the most complex aspects of joint programme design. This complexity is further amplified in interdisciplinary programmes, where alignment must occur not only across institutions but also across distinct academic domains [17].

RR4 and RR5 shift the focus toward governance and consortium dynamics, highlighting that project delays are frequently driven by uneven partner engagement and the optimistic assumptions regarding the speed of institutional alignment. For LowCarb-S, governance frameworks and formal agreements require significantly more time due to negotiation processes, competing institutional priorities, and differing strategic interpretations of the programme structure. These findings are similar to prior research, which underline that successful implementation of joint programmes depends heavily on sustained institutional commitment and effective coordination among partners. Without clear accountability mechanisms and active participation, delays and misalignments become systemic rather than isolated issues [14,16].



Finally, RR6 illustrates a critical strategic risk related to divergent expectations regarding the final programme architecture, particularly in relation to accreditation pathways. This type of misalignment is not operational but strategic, and it can affect the entire design logic of the programme if not addressed early and explicitly.

Overall, the table highlights that the main underestimated dimension in the proposal phase of the LowCarb-S project was not technical feasibility, but rather organizational complexity and behavioural variability across partners. The proposed mitigation measures consistently point toward earlier alignment, incremental design approaches, and stronger governance enforcement mechanisms, suggesting a shift from assumption-based planning to iterative and evidence-based consortium management. The complexity of international collaboration environments, including intercultural interactions and diverse academic practices, has been recognised as a defining characteristic of Erasmus Mundus programmes. These environments generate both opportunities for learning and additional layers of coordination challenges, particularly in relation to communication, expectations, and collaborative work dynamics [18].

## 5. Conclusions

In conclusion, the risk analysis and implementation challenges demonstrate that the success of Erasmus Mundus Design Measures projects depends less on the conceptual robustness of the initial proposal and more on the capacity to manage institutional diversity, align expectations, and respond to evolving constraints. The findings on the LowCarb-S project implementation show that the most critical risks are not technical, but organisational—emerging from governance complexity, legal heterogeneity, and uneven partner engagement.

The study further highlights that proposal-stage risk assessments of the LowCarb-S project underestimated not only the likelihood of certain risks, but also their systemic nature and interdependencies. As a result, risks related to coordination, decision-making, and institutional alignment can ultimately affect the achievement of core programme objectives if not actively managed during implementation. The findings should be interpreted in the context of a single case study and are not intended for statistical generalisation.

However, future initiatives should move toward more realistic, adaptive, and process-oriented approaches, anticipating uneven participation and embedding governance mechanisms capable of maintaining progress under such conditions. Ultimately, building resilient joint programmes requires a shift from static planning to continuous alignment, active coordination, and iterative risk management.

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