Rethinking Higher Education Innovation Ecosystems in Latin America and Europe

- Lessons from the EMBRACE Project -

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Editors: Vera Ferro-Lebres
Inês Barbedo
Luís Pais

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Concept and Reasoning of Innovation Ecosystems

Inês Barbedo[1], Vera Ferro-Lebres[2], Luís Pais[2]

[1] Transdisciplinary Research Center in Education and Development (CITeD) Instituto Politécnico de Bragança, Portugal

[2] CIMO, LA SusTEC, Instituto Politécnico de Bragança, Portugal

I. Evolution of the Innovation Ecosystem Concept

The concept of innovation ecosystems represents a fundamental shift in how scholars, policymakers, and practitioners understand the processes through which innovations emerge and develop within complex networks of interconnected actors, institutions, and resources. The intellectual origins of this concept can be traced to systems theory and organizational ecology, drawing inspiration from natural ecosystem models to explain economic and technological phenomena [1]. The transition from linear models of innovation, which viewed knowledge production and commercialization as sequential stages, to more sophisticated systemic conceptualizations reflects growing recognition that innovation rarely occurs in isolation but rather emerges through co-creation and dynamic interactions among multiple stakeholders operating within specific organizational, institutional, and technological contexts [2].

Over the past two decades, the frequency of references to innovation ecosystems has increased exponentially across academic literature, policy documents, and business discourse [3]. This proliferation reflects both the genuine clarifying power of the concept and its adaptability to describe diverse phenomena, ranging from corporate innovation strategies to regional development initiatives. However, this extensive adoption has also introduced considerable conceptual heterogeneity, as different scholars and practitioners have applied the ecosystem framework to variably overlapping phenomena under different nomenclatures, including business ecosystems, technology ecosystems, platform ecosystems, entrepreneurial ecosystems, and knowledge ecosystems [4]. Understanding these distinctions and their theoretical underpinnings is essential for establishing a coherent framework for analyzing innovation processes in higher education contexts.

A. Defining Innovation Ecosystems

The term "innovation ecosystem" does not yet have an universal definition consensual for all experts, leading some scholars to emphasize the need for greater conceptual rigor [5]. Despite this lack of scientific definition, most academics agree on several core characteristics for innovation ecosystems. It can be conceptualized as a diverse and evolving set of actors, activities, tools, methodologies, institutions, and relations. Including complementary and alternative elements, that are important for the innovative performance of an actor or population of actors [5]. More broadly, innovation ecosystems are described as open, dynamic, non-hierarchical environments consisting of organizations, people, and institutions that interact in creating, using, and diffusing innovations [3].

A key distinctive feature of innovation ecosystems is their emphasis on the collective co-creation of system-level outputs that extend beyond the contributions of any individual participant. This methodology of work represents the primary basis for distinguishing innovation ecosystems from other conceptual frameworks such as supply chains, clusters, or networks [4]. The outputs, participant interdependence, and nonhierarchical governance structures characterize innovation ecosystems and set them apart from more traditional organizational arrangements. We should also emphasize that innovation ecosystems are not predetermined or static entities but rather emerge through complex adaptive processes where actors continuously adjust their strategies, relationships, and resource allocations in response to environmental changes and feedback from other participants [4].

B. Theoretical Foundations and Frameworks

Understanding innovation ecosystems requires engagement with several complementary theoretical perspectives that collectively illuminate different aspects of ecosystem dynamics. Systems thinking provides foundational insights into how multiple interconnected components interact to produce

emergent properties that cannot be explained by examining individual elements [6]. This perspective is particularly valuable for understanding how innovations emerge from complex interactions among heterogeneous actors operating under conditions of uncertainty and limited rationality. The application of complex adaptive systems theory to innovation ecosystems reveals that these environments are characterized by nonlinear dynamics, where small changes can produce disproportionate effects, and similar initial conditions do not necessarily lead to predictable outcomes [7].

Evolutionary economics offers another crucial theoretical foundation, emphasizing how innovation ecosystems change over time through processes of variation, selection, and retention [8]. This approach highlights that innovation is not a deterministic process but rather involves co-experimentation and co-learning, with successful innovations becoming incorporated into institutional structures and practices, and others perceived as stages of learning. Network theory contributes additional insights into the structural characteristics of innovation ecosystems, focusing on patterns of connection among actors and how information, resources, and ideas flow through these networks [9]. Institutional perspectives emphasize the role of formal and informal rules, norms, and legitimacy structures in shaping how actors interact within ecosystems and how innovations are evaluated and adopted [10]. When integrated, these theoretical frameworks provide a comprehensive understanding of innovation ecosystems as complex, adaptive, evolving systems characterized by heterogeneous actors, emergent properties, and dynamic institutional contexts.

The integration of higher education institutions into innovation ecosystems requires engagement with distinctive theoretical perspectives that illuminate how universities contribute to and are transformed by their participation in broader innovation networks. Higher education institutional theory emphasizes how universities balance multiple and sometimes conflicting missions, such as advancing knowledge through research, educating students, serving community needs, and contributing to economic development, within evolving institutional contexts and stakeholder expectations [11]. This theoretical perspective highlights that universities do not approach innovation ecosystems from neutral positions but rather bring distinctive organizational cultures, incentive structures, reward systems, and governance arrangements that shape how they engage with ecosystem partners. The concept of the university's "third mission", engagement with external constituencies and contribution to economic and social development beyond traditional research and teaching functions, provides a theoretical framework for understanding universities' evolving roles within innovation ecosystems [12]. This third mission encompasses technology valorization, entrepreneurship support, consulting relationships with industry, and community engagement around innovation-relevant challenges. Understanding how universities operationalize this expanded mission while maintaining commitment to fundamental research and excellent education remains a central concern for higher education scholars and institutional leaders.

Engagement theory and community-engaged learning provide additional theoretical resources for understanding how universities contribute to innovation ecosystems through participatory approaches that involve students, researchers, professors, and external stakeholders representatives in collaborative problem-solving and innovation activities [13]. These theoretical frameworks emphasize that learning and innovation are enhanced when participants from different backgrounds and expertise areas work together on real life problems, engage in future oriented, design thinking and iterative experimentation, and maintain focus on both process learning and concrete innovation outcomes. Future Oriented co-creation frameworks increasingly inform how universities structure innovation activities, emphasizing empathy for end-users, rapid prototyping and experimentation, and iterative refinement based on user feedback [14]. These approaches represent a significant evolution from traditional university research models emphasizing disciplinary specialization and peer-review processes, instead emphasizing cross-disciplinary collaboration, rapid iteration, and user-centered problem definition. The integration of design thinking into university-based innovation ecosystems reflects broader recognition that effective innovation requires not only scientific and technical sophistication but also deep understanding of user needs and willingness to experiment with novel solutions and implementation approaches.

Co-creation represents a transformative methodology for innovation that fundamentally reconceptualizes the roles of different ecosystem actors from unidirectional knowledge transfer to collaborative knowledge creation and valorization. Service-dominant logic, originating in marketing and management theory but increasingly applied to innovation contexts, provides theoretical foundations for understanding co-creation as a fundamental characteristic of all value creation processes [2]. According to this perspective, value is not created by producers and transferred to consumers, but rather emerges through interactive processes in which diverse actors contribute resources, knowledge, and skills to collaboratively produce worth. In innovation ecosystems, co-creation means that universities do not unilaterally generate innovations that other actors subsequently adopt, but rather that innovations emerge through interactive

processes involving universities, industry partners, government actors, and communities who jointly define challenges, contribute diverse perspectives and expertise, and collaboratively develop and refine innovative solutions [15]. This shift from linear knowledge transfer models to co-creation frameworks represents a fundamental reconceptualization of innovation processes and has profound implications for how innovation ecosystems should be organized, governed, and supported, and for the role of higher education institutions on these ecosystems.

Co-creation processes within innovation ecosystems generate multiple forms of value beyond the specific innovations produced. Actors participating in genuine co-creation develop deeper mutual understanding, build relationships based on trust and reciprocity, and accumulate shared knowledge about how to work effectively across organizational and sectoral boundaries [9]. These relational assets and capabilities facilitate future collaborations and enhance the overall innovation productivity of the ecosystem. Research on collaborative innovation reveals that when ecosystem actors engage in co-creation involving genuine power sharing and mutual influence over innovation direction, rather than nominal participation or token consultation, innovation outcomes are substantially enhanced, and benefits are more equitably distributed among participants [10]. Co-creation methodologies typically emphasize iterative engagement, where diverse stakeholders contribute input throughout innovation processes rather than only at initial challenge definition or final implementation stages. Living labs and collaborative ecosystem approaches have emerged as higher education mechanisms for operationalizing co-creation within innovation contexts, creating structured environments where heterogeneous stakeholders interact intensively to jointly develop and test innovative solutions in real-world settings [16]. These approaches emphasize that sustainable innovation addressing complex social and environmental challenges requires sustained collaboration among diverse actors who bring different forms of expertise, perspective, and stakeholder accountability.

The integration of higher education institutional capabilities with co-creation methodologies creates particularly powerful approaches for innovation ecosystem development. Universities bring distinctive resources to co-creation processes: research expertise enabling rigorous understanding of challenges and evaluation of proposed solutions; educational capabilities enabling development of human capital and diffusion of innovation knowledge; and convening power enabling assembly of diverse stakeholders around shared innovation challenges [11]. However, realizing these contributions requires that universities adapt their institutional structures and practices to facilitate genuine collaboration rather than expert-driven knowledge transfer. This adaptation involves creating institutional spaces and mechanisms specifically designed for co-creation: innovation hubs, problem-solving workshops, and multidisciplinary research centers; where researchers, professors, students, community partners, and industry actors interact intensively around shared challenges [14]. Successful university-based co-creation requires incentive structures and reward systems that explicitly value collaboration and innovation engagement alongside traditional measures of research productivity, ensuring that participation in co-creation does not disadvantage academic careers [12].

Community collaborative learning ecosystems represent an emerging institutional model through which universities operationalize co-creation approaches on substantial scales, creating environments where social innovation emerges through extended collaboration among students, professors, researchers, community members, and institutional partners [13]. These ecosystems emphasize that sustainable innovation addressing social challenges requires intentional longitudinal engagement, continuous dialogue among stakeholders, and attention to how innovation processes and outcomes affect diverse community members [17]. Research on these collaborative innovation and learning ecosystems reveals that the most significant impacts emerge when universities commit to studying and documenting the longitudinal effects of their engagement, enabling continuous learning and refinement of approaches. Furthermore, achieving sustainable community-involved innovation requires simultaneous attention to institutional structures, epistemological frameworks (how knowledge is defined and validated), and ethical practices, alongside disrupting entrenched institutional patterns while building new approaches grounded in genuine partnership and mutual respect [13]. The integration of co-creation methodologies with higher education's distinctive capabilities and resources creates the foundation for innovation ecosystems that generate not only technological and commercial innovations but also contribute substantially to addressing social challenges and building more inclusive and equitable development pathways.

C. Key Actors and Stakeholders in Innovation Ecosystems

Innovation ecosystems encompass diverse profiles of people who fulfill distinct but interrelated roles in the innovation process. Higher education and research institutions serve as primary knowledge co-creation centers and often function as anchors that attract other ecosystem participants and legitimize innovation

activities [18]. These institutions contribute not only through formal research capacity and outputs but also through the development of human capital, the provision of skilled workforce, and their role as platforms for collaboration among different actors. Enterprises and business organizations, ranging from small startups to large multinational corporations, translate innovations into marketable products and services, bearing the primary responsibility for commercialization and value extraction [19]. Government entities and public sector organizations establish policy frameworks, provide funding, and create conditions conducive to innovation; in some contexts, they also serve as important users and adopters of innovations [19].

Civil society organizations, communities, and citizens increasingly recognize their roles as innovation participants, bringing diverse perspectives, articulating social needs, and contributing to the definition of innovation priorities and evaluation criteria [15]. The quality of interactions among these different but complementary actors fundamentally shapes ecosystem effectiveness. Research on successful innovation ecosystems reveals that trust-building, reciprocal relationships, and shared understanding of innovation objectives facilitate more productive collaborations [9]. Moreover, the diversity of ecosystem participants—encompassing different organizational types, sectoral backgrounds, and institutional logics—both enriches the innovation process through varied perspectives and creates coordination challenges that require effective governance mechanisms.

D. Ecosystem Resources, Regulation and Governance

The productivity and competitiveness of innovation ecosystems depend critically on the availability and effective mobilization of diverse resources and assets. Human capital represents perhaps the most fundamental resource, encompassing scientific expertise, entrepreneurial capabilities, technical skills, and creative potential that ecosystem participants bring to innovation processes [20]. The availability of doctoral-level researchers, experienced entrepreneurs, and skilled technicians substantially influences ecosystem capacity to generate and implement innovations. Educational institutions play a crucial role in developing human capital through advanced degree programs, continuous professional development, and informal knowledge networks that facilitate talent attraction and retention [19].

Financial resources and access to appropriate funding mechanisms constitute another critical asset for ecosystem development. Innovation ecosystems require capital at different stages and scales, from seed funding for exploratory research, to venture capital for scaling promising technologies, to public funding for fundamental and applied research with uncertain commercial applications [21]. The diversity and accessibility of funding sources significantly influence the types of innovations pursued and the actors who can participate effectively in ecosystem activities. Physical and digital infrastructure, including labs, maker spaces, cutting edge technologies, and collaborative work environments, enable ecosystem participants to conduct their work efficiently and interact productively [20]. Equally important are knowledge and intellectual assets, involving both scientific knowledge as well as tacit knowledge embedded in communities of practice and professional networks [18].

Institutional and regulatory environments provide foundational governance structures that shape innovation ecosystems across their succession stages, from emergence through expansion to maturity. Transformative governance frameworks must establish policy arrangements that orchestrate the balanced presence of five key ecosystem features: diversity, connectivity, polycentricity, redundancy, and directionality. These governance structures clarify roles and responsibilities among public, private, and academic actors, reducing transaction costs and facilitating more effective coordination of innovation activities. By managing these five features, policy frameworks influence how diverse agents interconnect within ecosystems and determine the extent to which market participants can self-organize while maintaining alignment toward societal objectives. Effective governance must navigate inherent tensions: fostering diversity among ecosystem participants while ensuring connectivity that enables learning and knowledge exchange; establishing polycentricity with multiple centers of decision-making while maintaining redundant functions that enhance resilience; and balancing adaptive market-driven mechanisms with directional governance that guides ecosystems toward desired societal outcomes rather than allowing path dependency driven by incumbent interests [22].

Trust and social capital constitute critical institutional resources that reduce uncertainty in ecosystem interactions and facilitate the formation of productive relationships among previously unacquainted parties [9]. Trust emerges from reputation systems, demonstrated competence, shared values, and positive past interactions. In ecosystems with weak institutions and limited trust, transaction costs rise substantially, and many potentially productive collaborations fail to materialize. Enabling infrastructure, encompassing digital platforms for knowledge exchange, standardized procedures for technology valorization, and administrative systems that facilitate multi-institutional collaboration, significantly influences ecosystem efficiency. The effectiveness of innovation ecosystems thus depends not solely on the presence of high-

quality actors and abundant resources but fundamentally on the institutional arrangements that coordinate their interactions and establish frameworks for resolving disputes, sharing benefits, and managing collective action problems [5,10].

The governance of innovation ecosystems has emerged as a critical area of research and practice, as effective coordination among heterogeneous actors with divergent interests and objectives requires sophisticated governance approaches. Different governance models reflect varying distributions of authority, decision-making mechanisms, and coordination approaches [10]. Hierarchical governance models, where a central authority establishes rules and coordinates activities, offer clear accountability and consistency but may limit flexibility and innovation by constraining participants' autonomy. Non-hierarchical or network governance models emphasize self-organization and emergent coordination but require strong social capital and shared commitment to common objectives to overcome free-rider problems and ensure effective collective action.

A key governance function that has attracted substantial scholarly attention is orchestration—the deliberate shaping of ecosystem development through the strategic interventions of particular actors, often anchor organizations or government bodies [10]. Effective orchestration can accelerate ecosystem emergence by recruiting key participants, establishing shared vision and objectives, and building necessary infrastructure. However, orchestration requires careful balance to avoid stifling the emergent properties and adaptive capacity that characterize successful innovation ecosystems. Multi-level governance approaches recognize that innovation ecosystems operate simultaneously at local, regional, national, and international scales, requiring coordination mechanisms that bridge these different levels [7]. Successful ecosystems often employ hybrid governance approaches that combine elements of hierarchy, networks, and markets, with different governance mechanisms applied to different ecosystem functions.

E. European Innovation Ecosystems: Characteristics and Development

European innovation ecosystems represent some of the most developed globally, characterized by substantial research competitive investment, sophisticated governance arrangements, and deep institutional integration across multiple sectors and countries. The European Union's innovation policy framework, encompassing the European Research Area, Horizon Europe research program and other relevant policy documents, establishes comprehensive support mechanisms for innovation ecosystem development [23]. These policy frameworks emphasize research excellence, innovation commercialization, and international collaboration, with particular attention to emerging areas such as artificial intelligence, digital transformation, and sustainability. European ecosystems benefit from well-developed infrastructure, highly educated workforces, and established processes for technology transfer and venture development.

Regional variation within European innovation ecosystems remains substantial, with Nordic countries, Switzerland, and regions like Catalonia and Bavaria demonstrating particular innovation intensity and ecosystem sophistication [4]. These leading ecosystems combine strong university research capabilities with supportive government policies, active venture capital markets, and substantial corporate research and development investments. However, significant disparities exist between leading innovation regions and other areas, with substantial differences in research capacity, funding availability, and entrepreneurial activity. European innovation policy increasingly emphasizes cohesion and inclusive innovation, seeking to strengthen innovation capacity across regions and sectors to reduce geographic disparities and ensure that innovation benefits are widely distributed. The European approach to innovation ecosystems reflects emphasis on systematic coordination, inter-regional collaboration, and integration of social and environmental considerations alongside economic innovation objectives.

F. Latin American Innovation Ecosystems: Context and Challenges

Latin American innovation ecosystems operate within distinctive institutional, economic, and social contexts that shape their development patterns and influence appropriate policy interventions [24]. While several Latin American countries have developed increasingly sophisticated innovation ecosystems, most face significant resource constraints, institutional capacity gaps, and fragmented research and development activities compared to leading global innovation regions [25]. Funding limitations restrict research and development investments, limiting the scale of innovation activities and constraining the diversity of innovation pursuits. Many universities in regions of the globe with lower developmented economies lack adequate research infrastructure, and faculty often must conduct research activities with minimal institutional support, reducing research productivity and innovation capacity [26].

Despite these challenges, Latin American innovation ecosystems possess distinctive strengths and opportunities. The region's significant biodiversity, natural resource endowments, and development

challenges create opportunities for regionally contextual innovation addressing local needs in areas such as agriculture, health, and sustainable resource management [27]. The presence of substantial diaspora populations and increasing international scientific collaboration create potential for technology transfer and knowledge exchange with leading global innovation centers. Entrepreneurship remains vibrant across the region, with innovative approaches to meeting local needs and creating employment, though much entrepreneurship remains opportunity-driven survival activity rather than innovation-driven growth businesses [28]. Increasingly, Latin American governments have prioritized innovation policy and established institutional mechanisms for supporting innovation ecosystems, though funding and implementation capacity often lag policy ambitions [29].

G. Comparative Analysis: Europe and Latin America

Comparative examination of European and Latin American innovation ecosystems reveals both significant differences and potential for mutual learning and collaboration. Resource and funding gaps represent one fundamental difference, with European innovation ecosystems typically benefiting from substantially higher research and development investment per capita, both from public and private sources [27]. This funding disparity constrains the scale of innovation activities and limits the diversity of innovation pursued in Latin American ecosystems. Institutional maturity and integration differ substantially, with European ecosystems characterized by deeply embedded relationships among universities, industry, and government, while Latin American ecosystems typically feature more fragmented and less routinized interactions [24]. European regulatory and policy frameworks supporting innovation have typically been developed and refined over extended periods, while many Latin American policy frameworks remain relatively recent and their implementation often faces capacity constraints.

However, important similarities and complementarities also exist. Both regions value innovation as a driver of economic development and competitiveness, and both have invested in creating institutional mechanisms and policy frameworks supporting innovation [23]. Scientific collaboration between European and Latin American researchers has expanded substantially, creating bridges between innovation ecosystems and opportunities for knowledge exchange [30]. Latin American innovation ecosystems increasingly demonstrate distinctive approaches to innovation emphasizing social inclusion, community participation, and locally contextual solutions, which complement European approaches emphasizing technological sophistication and systematic commercialization [15]. Strategic positioning of both regions within global innovation networks and complementary strengths in different innovation domains suggest significant potential for mutually beneficial collaboration and knowledge transfer.

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Mission-oriented HAMK Innovation Ecosystem

Marja Laurikainen[1], Essi Ryymin[2], Milla Mäkinen [3], Kirsi Vesterinen [4]
[1]Häme University of Applied Sciences, School of Professional Teacher Education, HAMK Global
[2] Häme University of Applied Sciences, Unit for Research and Development of Higher Education Pedagogy
[3] Häme University of Applied Sciences, HAMK Edu research unit
[4] Häme University of Applied Sciences, HAMK Bio research unit

Abstract

This chapter describes the main characteristics of the mission-oriented innovation ecosystem at HAMK, where collaboration between all stakeholders is based on shared values and aligning strategies, aiming not only towards economic growth but providing solutions for societal challenges. In Finnish universities of applied sciences, the foundation for the ecosystem building is their legal purpose as drivers for economic and societal development in their operating regions. At HAMK, the innovation ecosystem is an intertwined network of educational and research activities that connect students, teachers, researchers, and various types of external stakeholders. The solution-driven applied research and the Design-Based Education framework bring the authentic challenges and conditions of the world of work close to the higher education setting, and the living labs for iterative prototyping link education, research and world of work, enabling solving of complex, often poorly defined "wicked" problems. The Innovation unit at HAMK coordinates the RDI activities and connects initiatives in research and education with the needs of the companies and employers, as well as combines different activities related to entrepreneurship and start-up support under one umbrella providing also specific services such as IPR and law issues for students and staff to boost knowledge transfer and innovation.

Keywords: Mission-oriented Innovation Ecosystem, Design-Based Education, Living Labs, Co-creation, Knowledge Transfer

II. INSTITUTIONAL OVERVIEW

Overview of Häme University of Applied Sciences (HAMK)

Häme University of Applied Sciences (hereafter referred to as HAMK) is a multidisciplinary university with ca. 800 staff and an annual turnover of ca. 73M€. HAMK has four schools: School of Professional Teacher Education, School of Biotechnology and Natural Resources, School of Business, Design and Technology, and School of Health and Social Services, with appr. 10000 students in 36 bachelor-level degrees programs (15 in English) and in 14 master-level degree programs (3 in English). Measured by the amount of research and development conducted, HAMK is among the top universities of applied sciences in Finland with a RDI portfolio valued more than 15 M€ in three research ecosystems: *SmartBio* for developing responsible raw material production and the circular economy with industry, *SmartBuild* with solutions for sustainable construction and the built environment, and *SmartEdu* for developing competences, new creative learning and knowledge management skills, modernizing learning solutions, and creating new opportunities for learning, for example through virtual solutions, gamification and analytics. HAMK is also one of the five universities of applied sciences that are authorized by the Finnish government to provide teacher education. HAMK School of Professional Teacher Education (SPTE) grants pedagogical qualifications through consecutive teacher education programs to teachers from various educational levels and fields of study. With over 65 years' experience, SPTE conducts high-level teacher education and research and development in education and manages national and international projects to transform education. [1]

HAMK is actively engaged in various global networks in education and research in different professional fields, having extensive experience in collaborating with several international funding institutions (IFIs), and governmental and educational organizations; EMBRACE project led by HAMK being one example. HAMK is also a member of the EU Regional University Network (RUN-EU), that brings together eight European higher education institutions from seven countries. RUN-EU aims to jointly develop cutting-edge teaching, learning and research to meet the future competence needs of the surrounding world. HAMK's responsibility in the network is to design and implement pedagogical capacitation programs for

the faculties in each university, including digital pedagogy, distance learning and the use of digital tools in higher education. [2]

In the EMBRACE project, HAMK is the Coordinator and responsible for the overall implementation, deliverables and results of the project. HAMK also lead the professional development program for a selected group of teachers from the partner institutions on digital tools and pedagogy, and active methodologies.

The profile of the Finnish Universities of Applied Sciences as drivers of regional economic development

In Finland, the Universities of Applied Sciences (UAS) are multidisciplinary and regional higher education institutions that highlight close connection to the world of work and regional development. The Universities of Applied Sciences Act (932/2014) states the mission of UASes as:

> *"The mission of universities of applied sciences is to provide higher education for professional expert tasks and duties based on the requirements of the world of work and its development and on the premises of academic research and academic and artistic education and to support the professional growth of students.*
>
> *The mission of universities of applied sciences is also to carry out applied research, development and innovation activities and artistic activities that serve education in universities of applied sciences, promote industry, business and regional development and regenerate the industrial structure of the region. In carrying out their mission, universities of applied sciences shall provide opportunities for continuous learning. (1368/2018)".* [3]

Therefore, development of Innovation Ecosystem within and around a university of applied sciences is at the core of its operations. At HAMK, the ecosystem has evolved to its current form (see section II) over the past few decades alongside the development phases of the institution. However, the ecosystem is a constantly changing network of people, organizations, activities, and resources; thus, the need for continuous development is evident.

III. DESCRIPTION OF THE INNOVATION ECOSYSTEM

Mission-oriented HAMK Innovation Ecosystem for public value

Higher Education Institutions (HEI) today serve three core roles in innovation ecosystems. First, they act as knowledge engines, generating new scientific and technological insights and enabling their transfer to practice. Second, they function as educational engines, preparing students with the skills and mindsets required for innovative and uncertain workplaces [4]. Third, they increasingly become ecosystem orchestrators, convening cross-sectoral networks, facilitating living-labs and innovation platforms, and embedding authentic contexts to student learning [5].

As described above, a distinctive strength of universities of applied sciences (UAS) lies in their applied orientation and regional embeddedness. The purpose of UASes is to "act as an Innovation Ecosystem" providing the region with skillful workforce and developing the world of work through applied research and new solutions to companies' challenges. The legislation and the governmental policing are directing the UASes profiles and the way they are organizing their operations aligned with their purpose in the educational system.

When discussing about innovation, the contemporary discourse increasingly frames it not as a linear pipeline from research to productization but as a dynamic ecosystem involving multiple interacting actors – companies, universities, governments, and civil society. This means that higher education institutions (HEIs) are no longer isolated knowledge factories but central nodes that co-produce value through convening, prototyping, and capability building [4, 6]. This shift is particularly salient in mission-oriented innovation systems, where the goal is not merely economic growth but tackling societal challenges such as climate change, ageing population, or digital inclusion, and where HEIs must adopt governance, partnerships and value-sharing arrangements consistent with these missions, and ensure reciprocity and societal accountability in their partnerships [7, 8, 6, 9].

At HAMK, the Innovation Ecosystem is steered by the institutional strategy [10] and the core values, such as sustainability, production of practical and meaningful results that are useful and impactful, and that promote the vitality, well-being and sustainability of the society – HAMK aims to be a bold and creative reformer. Furthermore, at HAMK, the mission-oriented ecosystem is based on the selection of the areas of research, development and innovation activities emphasizing both the strengths of the institution and the challenges of the world of work and society regionally, nationally, and globally. In addition, educational programs and processes provide students with relevant competences to tackle these societal challenges in an ethical and impactful manner, and students are prepared for the evolving future careers through authentic learning and co-creation modes that enable inclusive citizen/user engagement and ensure legitimacy and adoption [11]. Moreover, the ecosystem partners embed public-value reciprocity (shared data, open use rights for public sector, affordable adoption for NGOs). By embedding mission-orientation, HAMK ensures that its ecosystem is not merely transactional but transformative, delivering both student learning and social impact.

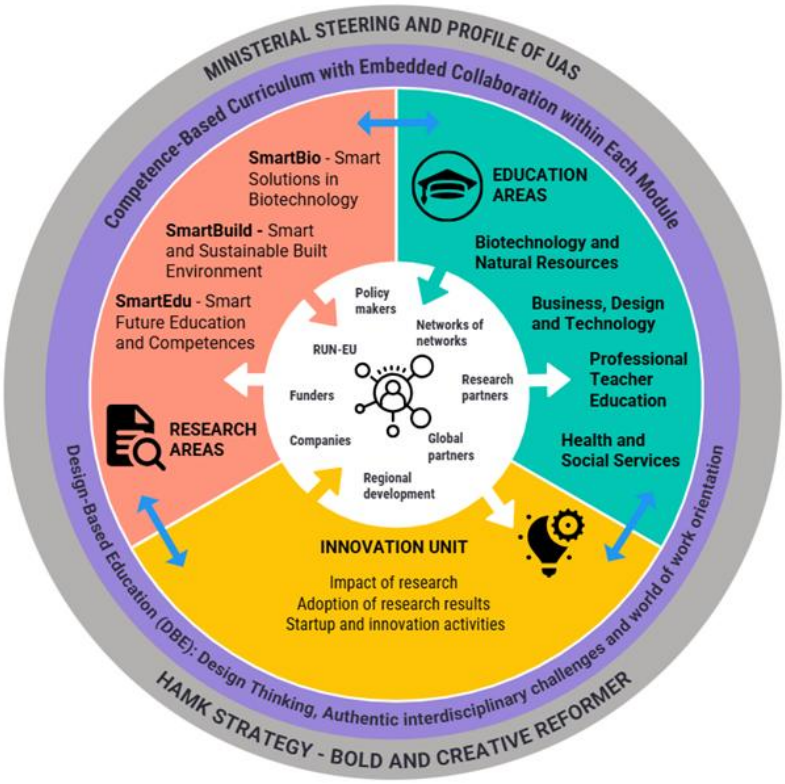

Figure 1. Draft illustration of the HAMK Innovation Ecosystem [12]

Figure 1 above illustrates the HAMK Innovation Ecosystem, where the mission-orientation is created through the purpose of a UAS and the HAMK strategy and values, as described above. The educational choices – the competence-based curriculum and the Design-Based Education model – steer the operations of HAMK within the innovation ecosystem both internally and externally with various types of stakeholders. The core tasks of HEI, education and research form two axes of the ecosystem; however, both being intertwined with each other, feeding ideas and inputs to each other, connecting people and resources, and supporting the implementation of both activities. Furthermore, the stakeholders provide their versatile challenges for both education and research, and in some cases, this requires also seeking external funding opportunities. The newly established HAMK Innovation Unit coordinates innovation activities in and between both education and research, and it connects different types of support activities and mechanisms within the innovation ecosystem. These three aspects: education, research, and innovation unit are described in more detail below.

Education design: Challenge-driven work-integrated learning at ecosystem scale

The theory and practice of challenge-based learning (CBL) suggest that students learn best when engaged in real-world, external partner-driven problems rather than hypothetical cases. Research emphasizes three conditions for effectiveness: (1) joint problem-framing with the partner; (2) iterative prototyping and feedback loops in a real-life setting; and (3) facilitative pedagogy that shifts the role of faculty toward coach and networker [12]. At HAMK, this translates into companies, NGOs, and other employers supplying real authentic problems for student teams to co-define, develop deliverables, and deploy/prototype in a living-lab context, while faculty and partner staff are co-mentoring. The outcomes are formally assessed not only for academic learning but in real-life settings for partner-value and potential continuation of the collaboration. The challenge-based learning is incorporated into each module of each educational program at HAMK; thus, all students are exposed to learning that introduces the authentic challenges and conditions of the world of work. This scale model ensures that the learning ecosystem is aligned with the world of work, and that student effort leads to potential service contracts, pilots or prototypes that matter.

Within innovation ecosystem, the idea of living labs – open, real-life testbeds where users, companies, public agencies and academia co-create solutions – has gained traction [13]. Such labs concretely link education, research and world of work, enabling students to engage in complex, often poorly defined "wicked" problems in situ [11, 14]. At HAMK, the implemented Design-Based Education model [15, 16], see more detailed HAMK DBE model description in section IV, establishes a learning process that facilitates the idea of living labs, and iterative prototyping of solutions takes place in HAMK Design Factory workshops, and other labs.

Knowledge transfer through applied research and development

One essential element in Innovation Ecosystem is cross-border knowledge generation and transfer, which can be interpreted as a process where various actors can benefit from either explicit or tacit knowledge, held collectively or individually by other actors, making the ecosystem sustainable through mutual benefit [17]. Within the ecosystem, knowledge can transfer from universities to other organizations, across competitors, and between populations of organizations [16, 18, 19, 20]. However, Meng et al. (2019) [21] points out universities' learning from industry; this reverse knowledge flow is a prevalent modality as academics learn from industry practitioners to generate new ideas with higher potential to be commercialized and to finalize their innovations in accordance with market demands [22, 23]. The knowledge transfer can have many mechanisms, such as:

- Formal collaborations: Joint RDI projects, licensing agreements, and academic–industry partnerships.
- Informal exchanges: Networking events, mentorship, and communities of practice.
- Digital platforms: Facilitate rapid and scalable knowledge sharing through symbiotic models (e.g., reciprocal benefit structures).
- Contests and open innovation challenges: Catalyze cross-border knowledge transfer and foster creativity. [24, 25]

At HAMK, all the above-mentioned knowledge transfer mechanisms are in use; however, the joint RDI projects, usually funded by an external funding agency and implemented with local, national, and international strategic partners, ensure operational funding from the educational institution's perspective and therefore create sustainability. As stated in the institutional description, HAMK has three transdisciplinary research ecosystems where high-level applied research expertise is combined with the needs of a changing world: *SmartBio, SmartBuild*, and *SmartEdu*. HAMK seeks innovative solutions in partnership with businesses, industry, the public and third sectors, and other research and education organizations by utilizing top quality research environments such as laboratories and virtual environments, as well as fields, greenhouses and forests. The applied research and development projects involve researchers as well as teachers (and sometimes also students) from the educational programs together with the partners from the world of work and society. In 2024, HAMK's volume of research activities was approximately 15 M€, and its ambitious goal is to double the amount by 2030. Therefore, HAMK has done a lot of work in systematizing its internal support services related to applying funding from various sources, programs, and agencies locally, nationally and internationally, as well as implementing the projects. Currently, there is also development taking place to systematize research collaboration practices with external stakeholders and to identify strategic partners (companies and other organizations) within all three research ecosystems.

Latest developments with Artificial Intelligence bring new possibilities, and AI-based innovation ecosystems can optimize their roles to support sustainable innovation and ecosystem resilience. In addition, AI technology innovations can drive profound transformations in various industries' business models. The effective use of AI tools and creation of such an ecosystem can empower companies [26]. Moreover, AI can have significant impact on data-driven decision-making processes, such as open innovation capabilities, human-AI collaboration, data governance and security, real-time analytics, and ecosystem collaboration, and thus, creating a data-centric, and more interconnected innovation ecosystem [27].

For the past years, HAMK has had a stronger and wider portfolio of RDI projects dealing with digitalization and the use of AI. With these projects, both HAMK and its external partners have developed their expertise in digital solutions and AI tools, and their applications in different industries. HAMK utilizes its own business intelligence tools, various types of tools for data analysis, and AI solutions for different organizational and educational processes. These tools (and others) can be used for enhancing the operations of the innovation ecosystem as well. However, it is also important to notice here the risks of AI and highlight that the RDI activities at HAMK are built on the principles of responsible science, which include impact, ethics, and openness, and the transparency principles for business cooperation.

Innovation Unit for coordination, impact evaluation, and start-up support

The recent support mechanism for the innovation ecosystem at HAMK, is the establishment of an *Innovation Unit* that will provide overall coordination of all RDI activities in institutional level, and evaluate their impact on HAMK itself, its external partners, and the region. The unit systematizes the integration of education, such as DBE projects, and research activities, and supports the further development of ideas and inventions generated either in educational or research processes. The aim of the unit is to provide the necessary pre-conditions and (infra)structure for the RDI activities, as well as to contribute to long-term planning, which includes strategies for the three research ecosystems as well as for the educational programs, including tools and pedagogical support to increase innovation capacity building. Furthermore, the new unit will collect all education, entrepreneurship, and business service offerings related to the start-up support and activities of both HAMK students and staff. The support services of the unit include contractual and IPR advice, lawyer services, seed funding for innovation and start-ups, internal invention processes, mentoring program, and various types of innovation events, pitching opportunities and competitions.

To speed up the innovation, HAMK is also establishing its own Living Lab concept, which will be hosted by the innovation unit. The European Network of Living Labs' definition of living labs is the most prominent in research "*user-centred open innovation ecosystems*" that integrate research and innovation through co-creation in real-world environments [28, 29]. HAMK has recognized that Living Lab would be an attractive and efficient way of reinforcing start-ups and new business creation in the region and combining the services from HAMK but also from the regional business support organizations. HAMK Living Lab aims to boost business vitality of the region by attracting various stakeholders to connect and co-create in a low-threshold way. The Living Lab will work as a dynamic testbed and communications platform for new innovative concepts, formats, and projects aiming at a commercial outcome. It also provides the businesses with an easy access gateway to see and feel the research and innovation capabilities of HAMK.

Through its activities and by connecting various support services in institutional level, the Innovation Unit will foster and maximize the opportunities related to innovation ecosystems, such as:

- *Accelerated Innovation*: Knowledge transfer enables faster development of new technologies and business models, especially when supported by digital tools and Industry 4.0 technologies.
- *Cross-sectoral Synergies*: Collaboration across industries and academia fosters multidisciplinary solutions to complex challenges like sustainability and digital transformation.
- *Global Competitiveness*: Efficient ecosystems can transform knowledge into technology, driving economic growth and positioning regions as innovation leaders.
- *Inclusive Innovation*: Open innovation contests and platforms democratize participation, allowing SMEs and individuals to contribute. [25, 30, 31]

The Innovation Unit will also address potential challenges brought up by research on innovation ecosystems or identified otherwise through internal risk evaluation processes, and seek solutions to address them in a systematic manner at the institutional level:

- *Fragmentation of Ecosystem*: Lack of cohesion among actors leads to misalignment of goals and underutilization of research insights.
- *Trust and Cultural Barriers*: Differences in organizational culture and intellectual property concerns hinder open knowledge sharing.
- *Unequal Benefit Distribution*: Imbalanced allocation of benefits discourages collaboration and may lead to monopolization of knowledge.
- *Resource Constraints*: Building relational infrastructure and sustaining partnerships require significant time and investment.
- *Digital Divide*: While digital platforms enhance connectivity, disparities in technological capabilities can limit participation. [24, 32, 33, 34]

In sum, an innovation ecosystem where students solve authentic problems demands a coherent architecture integrating challenge-based pedagogy, partner-engagement infrastructure, and mission-oriented governance. Research indicates that such ecosystems, when properly configured, enhance student readiness, regional innovation capacity, and societal impact [4, 5]. HAMK Innovation Ecosystem is a research-grounded framework that bridges the world of work, external partners across sectors, and the higher-education mission of applied research and learning through *Design-Based Education model*, described in more detail in section IV.

IV. HAMK innovation ecosystem in practice: developing strategy with local stakeholders

The creation of transformational innovation ecosystems requires proactive and systemic internal and external work. At HAMK, the innovation ecosystem consists of three main stakeholder types: partner organizations (companies, non-profit organizations, public organizations), funders (public and private, national and international), and HAMK itself. Two core questions in the creation and facilitation of the partnerships between the organizations are: 1) what the vision, values, objectives are, as well as operational planning and budgeting cycles of the organizations, and 2) how to build and actively facilitate trans-organizational connections between them.

The foundation for this ecosystem work is formed by institutional strategy. At HAMK, the strategy highlights strengthening cooperation with the private sector and thus directs towards partnership building. Further, the strategy points out quantitative and qualitative indicators for the collaboration, e.g. both research volume and corporate funding should double by 2030, which lay the basis for the work, starting from finding partners that share HAMK's vision, values, objectives, as well as operational and budgeting cycles to make concrete plans with them (see Figure 2 below).

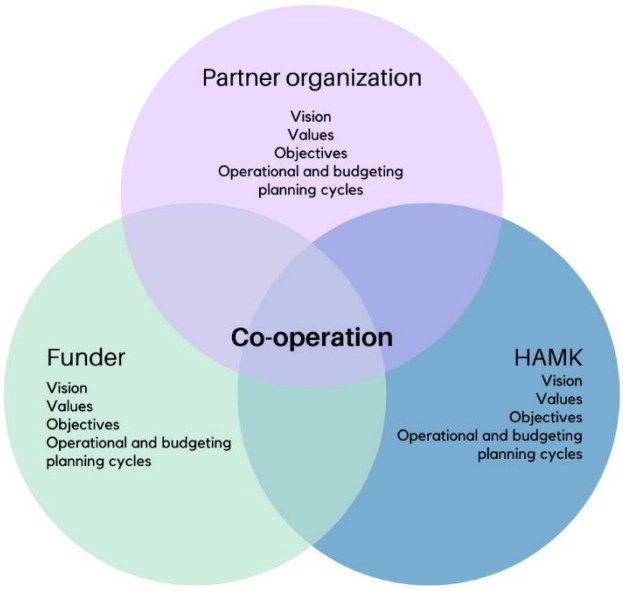

Figure 2. The foundations of ecosystem building at HAMK

The partnerships with the private sector can take many forms. These include agile, fast, and customized services as well as deeper, long-term, customer-oriented services – and everything in between. In practice, for example student internships, Bachelor and Master thesis, and design projects can be considered as "fast track" to cooperation, whereas research and innovation projects require deeper, long-term partnerships. Different types of sold products and development projects align somewhere between these two extremes. The starting point for a partnership with private sector is the company's own need for change (Figure 3). To recognize these required changes, HAMK needs to have dynamic and diverse relationship with the local private sector.

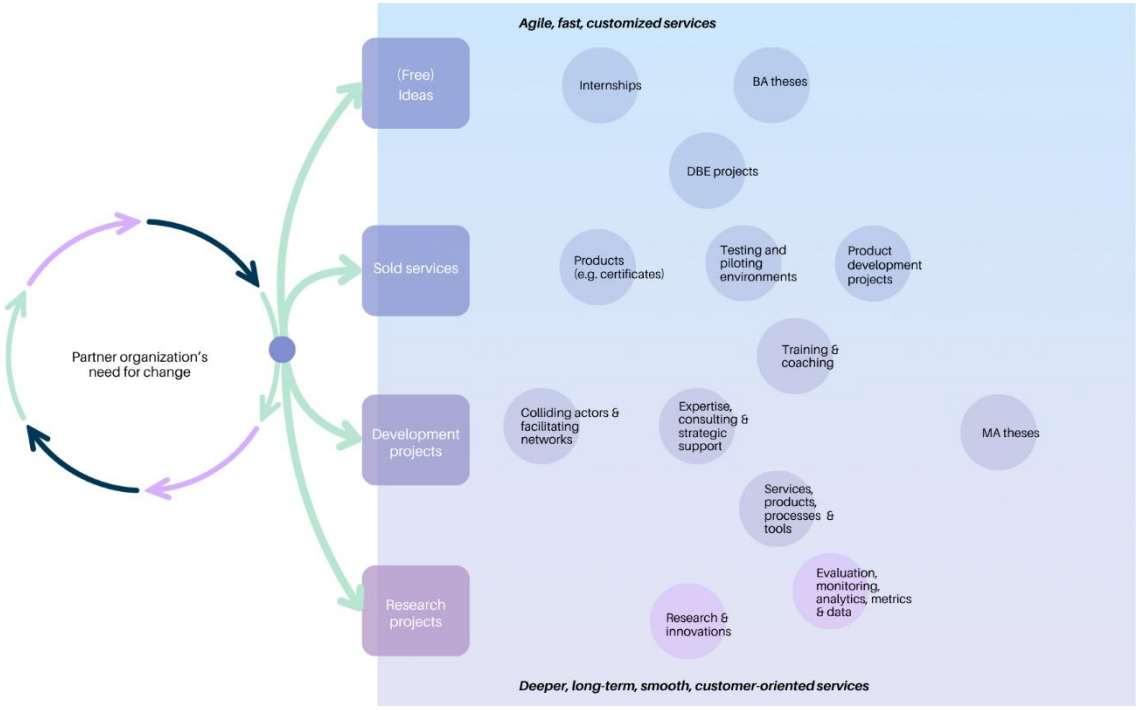

Figure 3. HAMK's forms of partnerships with private sector

When dynamic relationships within the ecosystem are in place, the HEI can take its place as an innovation generator. At HAMK, the need to consider the institution as an innovation generator has been recognized, and it requires both internal and external services. The internal services include different types of support for students, researchers, and teachers for ideation and innovation, protection and commercialization, networking, and market needs mapping. The required external services include stakeholders' and partners' needs' mapping, connecting people, and building partnerships for project application and implementation. To create these services, the HEI needs formal support structures, such as clear partnership management roles, functioning customer relationship management (CRM) systems, and sales expertise. When the HEI claims its place as an innovation generator, new companies, products, services, and processes can be created (Figure 4).

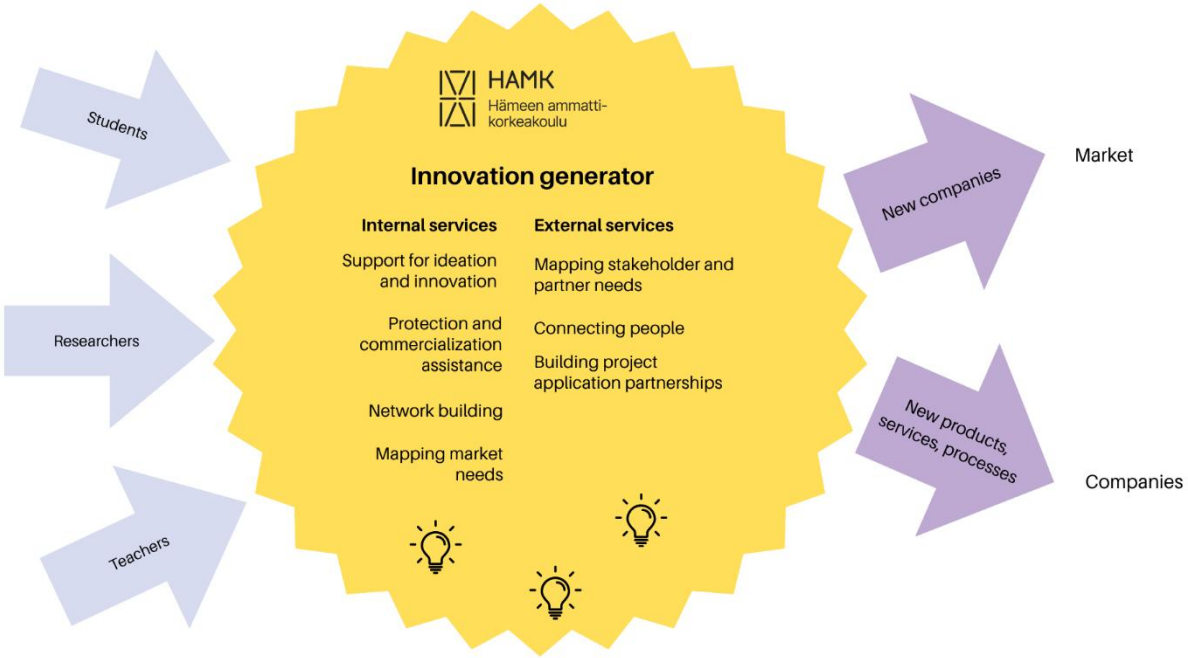

Figure 4. HAMK's vision as an innovation generator

V. CASE STUDY: Putting a partnership-based educational framework into practice at HAMK

HAMK applies an innovation-driven pedagogical framework, Design-Based Education (DBE)[35], in all its degree programs. The DBE framework is one of the foundations for putting HAMK's ecosystem into practice. DBE learning is based on close co-operation with HAMK's external partners, who give students authentic challenges to innovate on. HAMK's DBE framework is based on eight dimensions (see Figure 5 below): 1. design thinking, 2. authentic challenges and working life orientation, 3. sustainable development and responsibility, 4. learning through development and teamwork, 5. student agency, 6. well-being skills, 7. research-based approach, innovation competencies and transformative approach and 8. multidisciplinarity and multidisciplinary cooperation.

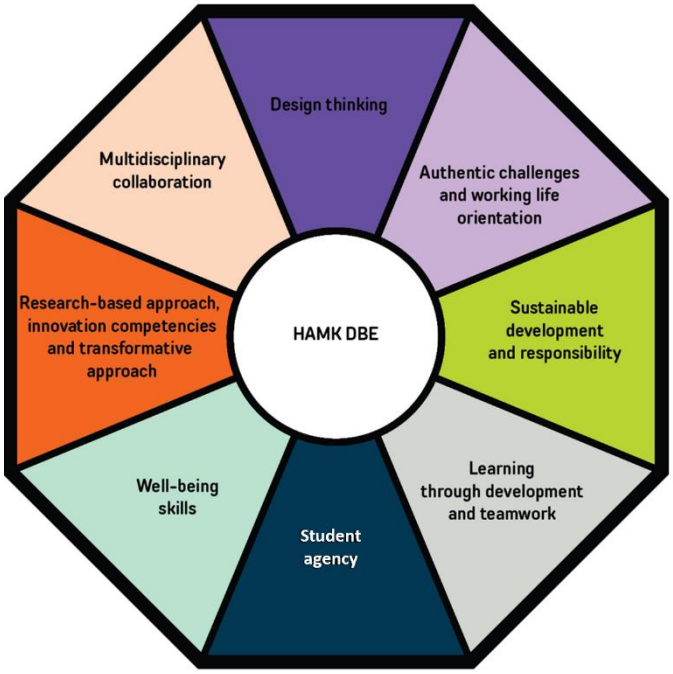

Figure 5. The dimensions of Design Based Education at HAMK

Implementing the DBE framework at HAMK is not merely a change in the pedagogical mindset and tools, but in the way the whole institution builds connections to its external partners within the innovation ecosystem. With the DBE framework, teachers and students become both active partnership-builders with HAMK's stakeholders and co-creators of new ideas and innovations.

At HAMK, introducing a new pedagogical framework has required the establishment of new internal structures for the degree programs to support teachers in the application of the DBE model. The educational units have, for example, formed DBE management groups and provided pedagogical tools, training, and mentorship support for teachers. In parallel, implementing DBE has meant a new way of learning for many students. HAMK is developing DBE orientations, DBE days, and DBE communication materials to support students in understanding what studying under the DBE model means. Moreover, HAMK is developing a strategy to increase the understanding of the local stakeholders of their role as DBE partners. The implementation of the new pedagogical framework within the institution becomes also an ecosystem building opportunity. DBE provides various ways of collaboration possibilities within the ecosystem, such as co-creative short term innovation projects (length varying from one day to eight weeks), multidisciplinary innovative thesis and research, development, and innovation practices.

As a case example of DBE implementation at HAMK, the first-year business students experienced DBE in practice in September 2025, in cooperation with the RUN InnoBoost project funded by EIT Higher Education Initiative [36]. The aim of the RUN InnoBoost is to strengthen the innovation capabilities of students and staff at RUN-EU network [2] and to support start-up activities. In the case example of the DBE implementation, the business students worked during one intensive week on a new beverage product suitable for the GOSH brand of a Finnish company, Maku Brewing, which is a microbrewery founded in 2014. Over the past years, the brewery has expanded its product portfolio to include mixed non-alcoholic drinks with the aim of attracting a new, younger consumer base to its products.

The students' DBE week was based on the *Design Sprint model*, a systematic co-creation process, which was originally created by former Google Ventures design partner Jake Knapp. The model has been tested and adopted in several contexts, including higher education institutions, where it can be used for increasing students' knowledge on innovation and creating links between a higher education institution and their surrounding ecosystem. In this case, it was used during the DBE week to help students to understand the challenge and the customers, to create ideas and prototypes for the new products, and to test the product ideas. At its best, DBE implementations can offer new ways of collaboration that "make the partners smile", as the Maku Brewery commented. This particular case resulted in an interdisciplinary collaboration in beverage prototyping with lecturers from business, biotechnology, and food technology. The topic was interesting and motivating for the students, since they were a potential target group for the new product.

One of the most significant challenges of DBE implementation is to match the timetables of very different types of ecosystem partners: companies and higher education institutions. The second challenge from the study planning perspective is to connect the teaching cycles with the needs and schedules of the ecosystem partners, as well as to identify open challenges that create a platform for both students' learning and company's innovation. However, at best, collaboration with the world of work within the DBE framework can strengthen the links within the ecosystem and boost its innovativeness by bringing together new people for the co-creation of novel ideas, processes, products and services that can strengthen regional economy. In the case of Maku Brewery, new concepts innovated by the students will be put into practice during 2026.

VI. LESSONS LEARNED

Building an effective innovation ecosystem requires clear mission-orientation, strategic alignment, shared values, as well as ongoing negotiation, flexibility, and open-mindedness among all stakeholders. Both university-to-industry and industry-to-university flows should be supported, with mutual benefit and guiding principles. The HAMK ecosystem is guided by institutional strategies and core values such as sustainability, societal impact, and practical results. This alignment ensures that research, education, and innovation activities are mutually reinforcing and addressing real-world challenges. Moreover, embedding challenge-based learning and authentic, partner-driven problems into curricula enhances student readiness and ecosystem relevance. However, implementing new pedagogical frameworks like Design-Based

Education requires internal structures, management groups, training, and communication between and between all stakeholders. Further, functioning innovation infrastructure enables suitable conditions where living labs and iterative prototyping environments foster co-creation between students, faculty, and external partners. These labs serve as open, real-life testbeds for solving complex, "wicked" problems, linking education, research, and industry in a dynamic ecosystem.

It is essential that innovation activities are coordinated by a specified unit with clear responsibilities. At HAMK, there is a dedicated innovation unit that coordinates RDI activities, evaluates impact, and provides support for start-ups and entrepreneurship. This centralization helps systematize internal and external services, including legal/IPR advice, mentoring, funding, and innovation events, accelerating innovation and business creation. The unit also ensures that there is the best fit between HAMK's and its partners' missions, and budgeting and operational planning cycles as well as flexible cooperation models ranging from internships to long-term research projects. Furthermore, the innovation unit can systematically address typical challenges related to ecosystems such as fragmentation of activities, trust and cultural barriers, unequal benefit distribution, resource constraints, and digital divide. Systematic risk evaluation and targeted solutions (e.g., clear partnership management, CRM systems, inclusive innovation platforms) are needed to overcome these barriers.

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Sustainable Ecosystem through Co-creation Models and Community of Practice

Inês Barbedo[1], Vera Ferro-Lebres[2], Luís Pais[2]

[1] Transdisciplinary Research Center in Education and Development (CITeD) Instituto Politécnico de Bragança, Portugal

[2] CIMO, LA SusTEC, Instituto Politécnico de Bragança, Portugal

I. INSTITUTIONAL OVERVIEW

The Instituto Politécnico de Bragança(IPB) is located in the northest of Portugal, Trás os Montes region, near the border with Spain. The region has 107,473 inhabitants (2023) and a low population density of 19 inhabitants/km² [3] and is known for its rural profile, aging population, and strong agricultural sector. In economic terms, the manufacturing and service sectors stand out.

Instituto Politécnico de Bragança was created on 28 January of 1983 to promote higher education, teacher training, and applied research in the region. Correntlly is composed by 6 schools, divided in three campus: School of Technology and Management(ESTiG), School of Health(ESSa), School of Agriculture(ESA), School of Education(ESE) in Campus de Santa Apolónia, Bragança; School of Public Management, Communication and Tourism(EsACT) in Campus do Cruzeiro, Mirandela; and the youngest school the School of Hospitality and Wellness(EHB), since 2023 in Chaves, in the region of Alto Tâmega.
The Strategic Positioning of IPB since the beginning is:
1. Research: Doctoral training and R&D units.
2. Internationalization: A multinational and multicultural academic community.
3. Co-creation: An active agent in regional development.
IPB has around 400 teachers, around 90% with PhD, distributed for the 6 schools, with more than 10000 students, where 36% atudents are non-Portuguese, from 68 differente nationalities. Is also integrated by more than six research centers: Moutain Research Center (CIMO), Research Centre in Digitalization and Intelligent Robotics (CeDRI), Transdisciplinary Research Center in Education and Development (CITeD), Applied Management Research Unit(UNIAG), Research Center for Active Living and Wellbeing(liveWELL), Sustainable Construction Research Group (GICoS), one Associated lab SusTEC- Associate Laboratory for Sustainability and Technology in Moutain Regions, and two collaborative labs, MORE – mountains of research and AQUAVALOR- Center for the Valorization and Transfer of Water Technology.

Doctoral training and Research and Development (R&D) units at the IPB play a critical role in promoting applied research, technology transfer, and regional development. IPB emphasizes a strong link between teaching, applied research, and innovation, with a focus on sustainable development, particularly within the context of mountain regions.

Internationalization acts as a catalyst for the dynamics of our educational ecosystem. The mobility and international alliances enrich the academic environment and research capacity, promoting a constant flow of knowledge and perspectives.

Co-creation acts as a powerful agent of regional development by fostering collaborative, bottom-up innovation that brings together public, private, and civil society actors to address complex, localized challenges.

I. DESCRIPTION OF THE INNOVATION ECOSYSTEM

An ecosystem is a dynamic, non-linear system, constantly changing and adapting. Learning ecosystem is a standard analytical framework in education used to model the non-linear interactions between individuals (agents) and their environments. This approach treats relationships, resources, and systemic processes not as static elements, but as a complex web of interdependent actors. By applying this framework, educators can better analyze how specific components influence the behavior and evolution of the system as a whole[2].

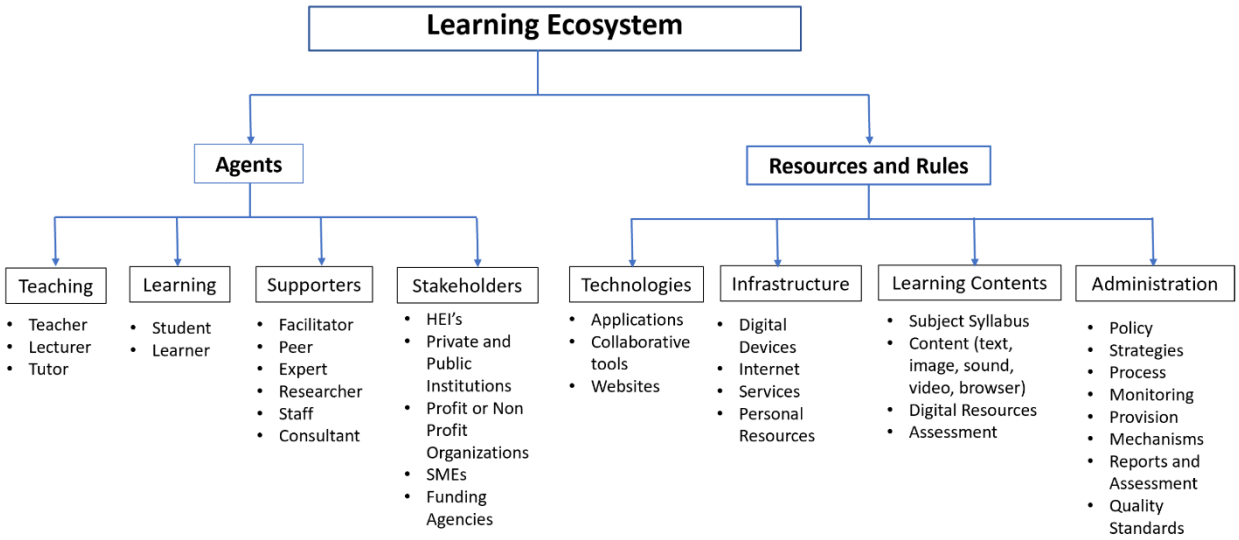

Figure 1: Components of an ecosystem (adapted from [1])

Learning ecosystems are emerging as a practice of uniting diverse stakeholders in collective learning for mutually beneficial outcomes, in response to the clear need for societal transformation toward viable futures. The strategic alliance between academic institutions and industry is recognized as a critical mechanism for accelerating innovation by facilitating the bidirectional flow of intellectual capital and technical expertise [4]. Innovation now depends on emerging collaborative relationships. By leveraging new dynamics and trajectories, the Quadruple Helix model provides a framework for understanding these connections. Crucially, the learning processes driven by science and industry are essential for firms to navigate the structural complexity and uncertainty inherent in the modern socioeconomic landscape.

Consider that the mission of the Portuguese HEI is divided in three main activities: education, research and the world of work, the production and dissemination of knowledge, the promotion of social mobility, and connection with the job market, that will integrate the graduated students in the world of work (Figure 2).

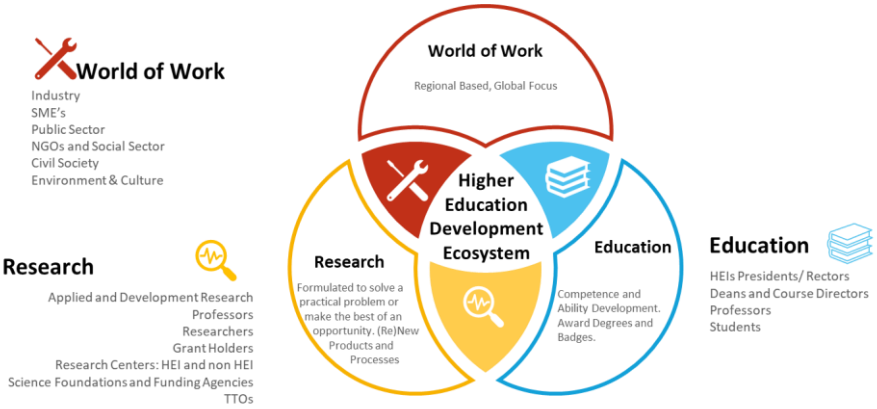

Figure 2: The three main categories of HEI's Activity

In the world of work we think regionaly but with global focus. We can identify strategic stakeholders like industry, SME's, public sector, NGOs and social sector, representing the external environment where skills and innovations are applied. By the academic offer and recognition, the education focus on competence and ability development. The research contributes to knowledge and technologies development creating solutions for practical problems or make the best of an opportunity.

Combining research designed based on challenges offered by the field of work, by collaborative and cofounded projects there is an effective transfer of technology and knowledge that is transformed into products, services, and processes, accelerating innovation, and also the promotion of intra and entreprenership.

Intersecting of the world of work and education is a collaborative clustering for impact and innovation of a Higher Education offer with and for all, for example througt Open Campus Learning Opportunities (Practical Classes in stakeholder facilities; Field Trips); Student assignments; Internships; Co-creation and Innovation Challenges; Entrepreneurship; Lifelong Learning or learning on the job, solving societal challenges in the region based on its purpose and resources. Thus, "Talent in the region" is enhanced by matchmaking and monitoring regional stakeholder Field of Work and labor market behaviors.

Promoting education focusing on research methodology, research skills and competences; data science; and science-based practice, results in research with higher impact through innovative research questions emerging from education experiences, leading to (re)newed knowledge products and industrial and commercial products. Thus higher technology readiness levels (TRL) and technology transfer for education, through Student Thesis; Scientific Internships; Innovation and Research Based Curriculum.

In the union of the tree main activities, workd of work, education and research, through Future Oriented Learning communities of professors, students, lecturers, researchers, entrepreneurs, employees, employers, citizens and governments, working together on regional and global development, by cross setorial future oriented challenges, the Higher Education Development Ecosystem from IPB.

To empower the Higher Education Development Ecosystem strategic plane of IPB includes a set of inictiatives

- Curriculum flexibility, through the introduction of an elective unit (Unidade Livre) in course plans where students must choose a curricular unit outside the mandatory curriculum of their course, allowing the student to personalize their academic path.
- Formative innovation (IF) offering a range of units not integrated into the course curricula, unlike the elective unit that is part of the mandatory credits to complete the course), these units function as a parallel and voluntary learning ecosystem that allows the student to build a unique profile. As social and technological change accelerates, higher education must continuously adapt by providing new learning opportunities that address emerging societal challenges. This includes applying active methodologies, offering real-world learning experiences based on complex problems, and fostering close collaboration with research centers. Non-integrated units serve as a key tool for exploring emerging and transdisciplinary themes while simultaneously strengthening technical competencies. They are designed to stimulate the development of transversal skills and support a smoother transition of graduates into the job market.
- Entrepreneurship, employability, training innovation platfrom that organize and promote activities like job fairs, fostering direct contact with companies, and promoting the transfer of technology and knowledge**.**
- Innovative ideas competition to enhanceTechnologic and Creative entrepreneurship**.**
- Financial support for Regional Development (PRR), thereby reinforcing its strategic capacity to advance innovative educational initiatives, strengthen academic and research infrastructures, and contribute in a sustained manner to the socio economic development of the region.

II. FROM AN ECOSYSTEM CONCEPT INTO DAILY ACTIVITY: CO-CREATION MODELS

To move from a high-level ecosystem concept into daily activity, organizations shift from passive networking to active co-creation models. This transition requires embedding collaborative habits into the actual workflow of employees and partners.

Co-creation within the higher education (HE) ecosystem influences multiple dimensions, including academic practices, curriculum development, institutional leadership, and stakeholder engagement. It fosters collaboration among academics, students, external stakeholders, and institutional leaders, which can enhance both academic and non-academic activities across the university environment[14]. This collaborative process supports inclusive and equitable participation, shaping future university policies and practices in areas such as curriculum design, pedagogic methods, assessment, sustainability, and wellbeing.

At IPB, within the academic and international ecosystem, the A3ES- Agência de Avaliação e Acreditação do Ensino Superior, the official Portuguese agency responsible for evaluating and accrediting higher-education institutions and degree programs, ensures the quality of universities and polytechnics in Portugal and publishes accreditation results publicly. A3ES plays a fundamental role in ensuring a culture of quality and continuous curriculum improvement. The mission of A3ES is to contribute to improving the quality of Portuguese higher education, through the assessment and accreditation of higher education institutions and their study programmes, and to ensure the integration of Portugal in the European quality assurance system of higher education. This mission aligns closely with IPB's strategic commitment to excellence, transparency, and international recognition. Furthermore, student mobility is considered an integral part of academic training, enriching learning through intercultural experiences, global competencies, and exposure to diverse educational environments. Likewise, staff mobility is fully embedded in professional development strategies, supporting pedagogical innovation, scientific collaboration, and the strengthening of international networks.

The development of dual degree programmes represents another strategic pillar with a strong impact on the institution. These programmes enhance IPB's international attractiveness, deepen global partnerships, and offer students distinctive academic pathways aligned with European standards of quality and recognition.

Co-creation also benefits from structured approaches like Large Scale Interventions (LSI), which emphasize shared leadership and responsibility through stakeholder steering committees. This approach facilitates whole-system engagement, fostering ownership and accountability for change within institutions and society. Ensuring adequate resources and supporting stakeholder participation, especially for those contributing voluntarily, are critical for effective co-creation processes and systemic impact [15]. Within this framework, the STARS EU Alliance reinforces collaborative innovation through dedicated work packages focused on sharing and discussing active learning methodologies and pedagogical innovation. This aligns closely with the broader role of internationalization, which is articulated in the institution's Erasmus Policy Declaration and embedded in its strategic vision. The internationalization strategy serves multiple functions, including enhancing training, expanding opportunities for internships, promoting international mobility, strengthening strategic alliances, and fostering diversity across the academic community. Together, these dimensions contribute to a dynamic and globally connected ecosystem that supports institutional transformation and enriches the educational experience.

Co-creation strategies for enhancing research and development (R&D) in higher education emphasize collaborative frameworks that integrate multiple stakeholders, including industry, universities, and research institutes. Such collaboration fosters open innovation, which can lead to the development of new products, processes, services, and business models. Effective governance and management of these collaborative projects are crucial, with insights drawn from real-life examples that highlight how project consortia and governance boards can implement and monitor initiatives to achieve greater impact [16].

Teacher training and capacity-building initiatives further reinforce this co-creation ecosystem. Programmes such as *WE – Working and Envisioning* more detailed in next section of this paper, ERASMUS-funded collaborations, in POCH (Programa Operacional Capital Humano) refers to the Human Capital Operational Programme co-creation projects with external partners, and multidisciplinary teacher-training activities that bring together diverse actors to jointly design innovative solutions. Such collaboration fosters open innovation, enabling the development of new products, processes, services, and business models. Coursera-based digital upskilling, and the internal peer-to-peer programme developed during the pandemic contribute to pedagogical innovation and professional development. Blended Intensive Programmes (BIPs) for teachers and staff—focusing on pedagogical innovation, creativity for inclusion, and equality, equity, diversity, and inclusion (EEDI) in STEAM—strengthen institutional capacity and promote collaborative learning across borders.

Community engagement and inclusive practices also play a vital role in sustaining a culture of co-creation. Initiatives such as *Compromisso Cívico*, the *Mentoring Academy*, *IPB Volunteering*, and the *Inter-Religious Space* demonstrate how students and staff collaborate to build supportive and inclusive communities. Flexible learning pathways, including *Unidades Livres* and *IF* and the accreditation of alternative learning experiences, further expand access and validate diverse forms of knowledge, reinforcing the institution's commitment to openness, diversity, and lifelong learning.

Within this broader ecosystem, the International Conference on Co-Creation Processes in Higher Education (IN2COP) serves as a platform for reflection, knowledge exchange, and the dissemination of insights emerging from co-creation practices. The event showcases concrete outputs from teacher-training programmes, student innovation challenges, and international mobility projects, strengthening a global learning community committed to navigating the evolving landscape of higher education. Through workshops, thematic panels, and presentations of initiatives such as the Mentoring Academy, Civic Commitment programmes, volunteering networks, and inclusive spaces like the Inter-Religious Room, IN2COP fosters a multidisciplinary and multicultural environment capable of addressing contemporary and future societal challenges.

Together, these interconnected initiatives create a dynamic and globally engaged ecosystem where co-creation, innovation, internationalization, and community involvement converge to shape the future of higher education.

III. CASE STUDY: WE WORKING AND ENVISIONING COMMUNITY OF PRACTICE

WE-Working & Envisioning, Community of Practice, is a vibrant and inclusive group of professors-facilitators within a broader Ecosystem. Since its inception in 2017, WE has served as a dynamic platform for professors-facilitators, to come together and tackle complex challenges facing the future.

At its core, WE embraces the philosophy of a community of practice, viewing learning as a collaborative social experience that thrives on regular interaction and collective problem-solving.

WE Community of Practice (WE) actively seeks to expand its reach by inviting practitioners from other institutions, facilitating cross-institutional collaboration, and enriching the collective knowledge base. The WE has Weekly Meetings, to serve as a platform for members to share insights, experiences, and best practices, fostering a

culture of sharing knowledge; to provide opportunities for members to support each other, offer guidance, and create solutions collectively; to follow-up sessions ensure progress is tracked, accountability is maintained, and actions are taken to address any issues or challenges. The regular meetings are essential for fostering collaboration and maintaining momentum within the WE Community of Practice, because of Sharing, Caring, Supporting, Creating, Follow-Up)

The teaching and learning activities are focused on:

- **Future Co-Creation Challenges for Students with External Stakeholders:** Co-creation challenges provide students with practical opportunities to apply their knowledge and skills in real-world scenarios, fostering innovation and creativity.
- **Teacher Training:** Providing teacher training aligns with the mission to enhance education through innovation. Equipping educators with the necessary skills, knowledge, and resources can better support students in their co-creation challenges and foster a culture of innovation within their institutions.
- **Innovation Workshops for Stakeholders:** External stakeholders are periodically invited to engage in 1-day workshops fostering the topic of innovation and future oriented challenges for private, public and social entities. Usually, the main outcome of these workshops are a set of needs and opportunities for new challenge-based learning batch and *where the younger generation of students co-create new solutions.*

WE conduct a non integrated curricular unit called Challenge Based Inovation , offered every semester. WE activities are guided by a set of fundamental values, including innovation, critical thinking, and a focus on solving complex, future-oriented challenges. Co-creation projects at IPB, as Challenge Based Inovation is an example, play a key role in regional development, promoting collaboration between teachers, students of diverse nationalities and cultures, and local partners. Through challenge based learning(CBL) and other active learning methodologies, and multidisciplinary, this is a cross-sectoral and inter-university knowledge co-creation model, combining a physical with a virtual platform that will facilitate the transfer of research results back to education and will engage to regional development. Applying CBL, this unit offers a wide range of potential benefits. It aligns closely with several characteristics of future, including the emphasis on authentic, active learning; the provision of choice in problem-solving approaches and learning pathways; and the development of multidisciplinary teamwork and decision-making skills[5]. CBL also responds to many students' desire for a stronger sense of purpose in their studies. Moreover, it can be viewed as an evolution of design-based education—supporting 'learning through' rather than merely 'learning to' design [6] Furthermore, facing a global world with constantly and rapidly changing technological development, it is essential to provide higher education students with the skills and tools to face the future. In this way, we propose working on innovation and creativity skills, promoting responses to rapid changes and adaptation to uncertainty.

The process followed in the Challenge Based Innovation has a set of steps, nominated

Preparation:

The Facilitator Community of Practice and Teacher Community collaborated with regional stakeholders to identify needs and design the future oriented challenges, defining the context and a question. Having the context is identified an ideal location for an immersive week to accelerate innovation.

Kick-Off:

Is a full day face to face session where multidisciplinary and multicultural teams are build. The challenge is introduced to each team, and the teams work on the preparation for research and benchmarking.

Multidisciplinary and multicultural teams are increasingly prevalent in various sectors due to globalization, requiring effective management of diverse cultural, disciplinary, and generational backgrounds to achieve optimal performance. Such teams face specific challenges, including cross-cultural communication barriers that can hinder workforce management and team performance. Identifying and addressing these barriers is essential, as efficiency in interpersonal and intercultural communication directly impacts team success in multicultural organizations [7].
At Challenge Based Innovation, WE team uses this approach, that underscores the importance of early team-building efforts to navigate the complexities of diverse team compositions. Higher education settings also provide insights into multidisciplinary and multicultural team dynamics. Studies show that knowledge transfer and sharing among peers from diverse disciplines and cultures occur effectively through case-based and problem-based learning activities. These collaborative approaches expose teams to authentic, complex problems, equipping members with skills necessary for global competitiveness [8].

Teamwork:
In a hybrid, blended format, each team work with a facilitator, conduct research and benchmarking on the challenge and co-create solutions.
Design thinking is also used in CBL processes, that serve as a structured ideation and innovation tool that enhances student engagement and solution development by emphasizing creativity, stakeholder involvement, and iterative problem-solving. This integration supports the educational goal of linking learning with real-world challenges through a creative and systematic approach .It facilitates co-creation of solutions by guiding students through stages that emphasize understanding the challenge deeply and collaboratively generating innovative responses [9].

Immersive and intensive week:
The face-to-face, one-week intensive will immerse participants in the region, putting in practice context-based learning, engaging the teams in Future Design and Speculative Design processes, developing prototypes, validate them with clients or end users, and conclude with a final pitch.

This fase of the process, Immersive and Intensive week, is used the educational Context-based learning approach that integrates real-world contexts into the teaching and learning process to enhance students' understanding and application of concepts. It is grounded in constructivist learning theory, emphasizing the connection between theoretical knowledge and practical situations. This approach aims to make learning more relevant and meaningful by situating content within contexts familiar or significant to learners[10]. Intensive courses in context-based learning benefit from practical, structured approaches that help learners and instructors engage with relevant contextual issues. Context-based learning emphasizes the integration of real-life or relevant contexts to enhance the learning process, which can be particularly significant in intensive courses where time constraints demand efficient and effective learning strategies. This approach

supports personalized and adaptive learning by considering the learner's current knowledge, motivation, goals, and available time, which are critical factors in intensive learning environments where learners must quickly assimilate and apply new information[11].

In intensive courses, context-based learning can facilitate problem-solving skills by situating learning activities within meaningful scenarios, such as simulations or project designs, which help students construct a complete problem-solving process. This method has been shown to improve students' abilities to analyze questions, develop solutions, and apply feedback, which are essential skills in condensed learning formats where active engagement and immediate application are necessary [12].

Context-based learning offers pedagogical advantages for intensive courses by promoting engagement, problem-solving, and knowledge transfer, but its success depends on thoughtful design and support structures tailored to the intensive learning context.

During the intensive and immersive, the teams are asked to use speculative design. Seculative design has been extensively integrated into multidisciplinary research, shifting the focus from pragmatic problem-solving to critical problem-finding. This perspective enables the development of future-oriented alternatives that open space for new modes of thinking. By embracing uncertainty and examining multiple potential trajectories, speculative design proves especially valuable for addressing complex, ambiguous, or long-term challenges, extending and complementing the capacities of traditional design approaches. Originally conceived as a critical mindset rather than a rigid formal methodology, the practice emerged as a counter-discourse to the uncritical acceleration of technological progress and market-driven design. Consequently, speculative design has matured into a versatile framework adopted across diverse sectors—including human–computer interaction, urban planning, healthcare, and public policy—continually recalibrating its approach to address evolving systemic challenges and new contexts [13].

Refinement and Reporting:
In a hybrid, blended format, each team including facilitator work to focus on evolving and elevating their work while preparing the a Package that includes the report, one-pager, and an improved prototype.

Post Activities:
The process concludes with a 360^{o} assessment and a meeting with the external stakeholder from each challenge, followed by a continuity plan that may include thesis development, internships, research, development and innovation (RDI) projects with the research centers. The Facilitator and Teacher Community of Practice does a periodic follow-up, and ongoing improvement initiatives, start think and prearing the future.

IV. LESSONS LEARNED

Portugal's higher-education evolution shows that research excellence emerges when doctoral training and R&D units are strategically integrated, and the Instituto Politécnico

de Bragança is a clear example of this trajectory. Over the past decade, IPB strengthened its research profile by expanding doctoral collaborations, consolidating applied research centers, and fostering interdisciplinary teams that respond to regional and national priorities. The institution learned that sustained investment in human capital, international partnerships, and competitive funding mechanisms transforms a polytechnic into a research-active institution capable of producing knowledge with real societal impact.

At the same time, IPB demonstrated that internationalization can become a defining institutional identity. Today, it hosts one of the most multinational and multicultural academic communities in Portugal, attracting students and staff from more than 90 countries. This diversity reshaped teaching practices, broadened research networks, and positioned IPB as a global reference among polytechnics. The lesson learned is that international openness not only compensates for demographic decline but also enriches the academic environment, strengthens institutional resilience, and enhances global visibility.

Finally, IPB's experience shows that co-creation with regional stakeholders is essential for sustainable territorial development. Deeply embedded in the Northeast of Portugal, IPB collaborates with municipalities, companies, cultural institutions, and social organizations to address local challenges and stimulate innovation. Through applied research, technology transfer, and community-based projects, the institution acts as a catalyst for entrepreneurship and regional transformation. The key insight is that higher-education institutions thrive when they position themselves as active agents in their territories, co-creating solutions that generate economic, social, and cultural value.

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Sinergia UTP

Ricardo Agudelo[1], Ruth Martin[2], Jorge Rojas[3,4]
[1]Embrace Manager
[2] Embrace Manager
[3] Embrace Expert

Abstract
This study examines the innovation ecosystem of the Technological University of Pereira (UTP) and its strategic framework for university-business articulation through the EMBRACE project. The research addresses the critical imperative to align academic capabilities with regional productive demands, focusing specifically on digital transformation and the strategic application of Artificial Intelligence (AI).
The UTP operationalizes its model through the Computer and Educational Resources office (CRIE), utilizing a strategy that involves two primary actions: the launch of "SinergIA," an initiative dedicated to ethical AI training and competency development, and the establishment of the annual "Inspira" event to foster high-level co-creation among stakeholders.
Central to the investigation was a pilot case study conducted with postgraduate students from the Master's in Management of Human and Organizational Development. These students were tasked with applying AI tools (e.g., sentiment analysis) to address real-world organizational challenges within their workplaces. This practical deployment served as a living laboratory, seamlessly integrating academic consulting with experiential learning.
This active implementation model effectively facilitates knowledge transfer, strengthens graduate competencies in the strategic use of AI, generates shared value by providing companies with actionable insights, and robustly enhances the relationship between academia and industry..

Keywords: Co-creation, digital transformation, Innovation ecosystem, Sinergía.

V. INSTITUTIONAL OVERVIEW

The Technological University of Pereira (UTP) is a Colombian public (state) university, subject to inspection and surveillance through Law 1740 of 2014 and Law 30 of 1992 of the Ministry of Education of Colombia. It has (according to the electronic bulletin of indicators published in 2014) with 17,613 students in undergraduate programs and 1,265 in postgraduate programs, studying during the day, at night and during special hours. The U.T.P.
It is located in the village “La Julita” located in the southeast of the city of Pereira, within the Metropolitan Area of Central West, with a population of 710,000 inhabitants, it is located in a privileged location in the city, and with a very pleasant climate. between 16° and 25°, since it is located in a very humid area surrounded by primary and secondary forests at an altitude of 1560 m above sea level. n. m. [1]
The Technological University of Pereira has High Quality Accreditation according to Resolution No. 2550 June 30, 2005 through which this distinction is granted to the first University in the region to be recognized for its excellence; which makes it one of the 10 best universities in the country, one of the 100 best in Latin America. Bureau Veritas awarded the certificates in quality management ISO9001: 2000 and in public management NTC GP 1000: 2000 in the administrative processes that support teaching, research and extension. The Superintendency of Industry and Commerce of Colombia granted this university an accreditation to the product certification body of this university, which allows it to issue a quality seal for products and batches of products.

A. CRIE

The Center for Computer and Educational Resources (CRIE) of the Technological University of Pereira is a cross-cutting unit that articulates technology, pedagogical innovation, and the digital transformation of academic and institutional processes. Its purpose is to strengthen the university's educational ecosystem

by developing technological solutions, managing digital platforms, training faculty in ICT skills, and implementing strategies that promote quality, accessibility, and innovation in teaching. As a self-sustaining center, the CRIE operates under a project-based approach, offering services and programs that drive the integration of disruptive technologies into educational, research, and university management processes. [2]

Within the framework of the EMBRACE project, the CRIE takes on a strategic role as the central node for articulation between the university, the productive sector, and the academic community. Drawing on its experience in digital transformation and pedagogical and technological support, it leads the coordination of initiatives that promote university–business cooperation, the participation of students in collaborative projects, and the dissemination of innovative best practices.

VI. DESCRIPTION OF THE INNOVATION ECOSYSTEM

The Technological University of Pereira (UTP) has developed various innovation ecosystems that seek to connect the academic community with the regional productive fabric. Within the EMBRACE project framework, the Center for Computer and Educational Resources (CRIE) is intended to become the articulating node of these ecosystems through two interdependent components:

a. Research and Training in Disruptive Technologies.

The CRIE leads the "SinergIA" initiative, which empowers faculty and students in the ethical and strategic use of artificial intelligence (AI). The strategy articulates knowledge and experiences from universities in Finland, Portugal, Brazil, and Colombia to position AI as a key ally in teaching-learning processes. Its objectives include: strengthening technology skills, fostering educational innovation, and especially, reinforcing the articulation between academia, entrepreneurship, and the productive sector. This perspective aligns with the EMBRACE focus, which aims for the UTP to train talent capable of applying disruptive technologies (AI, Industry 4.0, fintech) in work and business environments. [3]. The strategy also materializes through a trilogy of MOOCs focused on improving the digital and pedagogical competencies of higher education teachers, based on the European Framework for the Digital Competence of Educators (DigCompEdu), ensuring the relevance of the skills required for integration with the labor market and educational transformation. [4]

b. Annual "Inspira" Event.

The plan is to hold an annual meeting that brings together innovation ecosystem stakeholders to analyze their progress, needs, and strategies, and to deepen their relationship with the business sector. The event will seek to showcase ongoing initiatives, present applied research projects, and foster co-creation with the productive sector. The UTP's experience in organizing fairs and congresses demonstrates the relevance of this type of space..

A. Relationships between the UTP Ecosystems and Business/Industry

Barranqueros UTP Entrepreneurship Ecosystem.

Conceived as a support model for entrepreneurs in the university community, it offers two routes: an academic route (for undergraduate students interested in exploring entrepreneurship) and a support route (for students, graduates, faculty, and staff with initiatives at different stages).

Since 2019, the ecosystem has supported sustainable business and social projects. It is financed by contributions from graduates, allied companies, and donors to strengthen mentorship, training, and prototyping. With over 150 hours of mentoring and 40 training events annually, it facilitates access to markets and technologies, demonstrating the close link with the private sector. Participation in fairs like Expocamello 2024 evidences this articulation: the UTP showcased 12 Barranqueros initiatives in categories such as food, fashion, health, and technology.

The entrepreneurs expanded their network of contacts, acquired new clients, and successfully commercialized their products. Additionally, the university provided institutional stands (Botanical Garden, Planetarium, Gastronomic Laboratory, CIDT) to bring its offerings closer to the community. [5]

Technological Management, Innovation and Entrepreneurship (Vice-Rectorate for Research).

This Vice-Rectorate manages the university's knowledge assets by formulating strategies for technological management, innovation, and entrepreneurship that consolidate scientific capabilities and strengthen ties with society. To achieve this, it works permanently and collaboratively with researchers, companies, and other ecosystem agents to exchange knowledge according to the environment's needs.
It develops applied R&D projects, prepares, and commercializes research results through licensing or the creation of spin-offs. The unit offers patent and software portfolios that seek to showcase the technological offer and connect R&D&i demand at a regional, national, and international level. This approach makes it easier for companies to identify available technologies and establish agreements with the university. [6]

Center for Innovation and Technological Development (CIDT).
Recognized by the Ministry of Science, the CIDT mobilizes, articulates, and enhances the capabilities and knowledge services of the State, companies, and society to incentivize innovation supported by applied research, technological development, and technology-based entrepreneurship. It promotes the social appropriation of knowledge through spaces for collaboration and synergy among researchers, companies, and society. Its leadership is evident in events like the "Innovation Thursdays" (Jueves de la Innovación), created jointly with the Pereira Chamber of Commerce. This networking space, supported by the Ministry of Commerce, the Investor Angels Network, and the Node Network, articulates the regional ICT ecosystem and is considered a national model.
The CIDT organizes forums on disruptive technologies; for example, the "Fintech: Industry 4.0" event brought together entrepreneurs, businesspeople, SMEs, and authorities to learn about use cases of financial technologies and Industry 4.0 verticals. Entities such as Colombia Fintech, the CEmprende entrepreneurship program, and technology companies participated, demonstrating how the CIDT connects academia and business. [7]

Risaralda Network of Innovation, Science, and Technology Nodes.
This network, coordinated by the UTP, has been consolidated over 15 years as a strategy to connect the business sector, the State, academia, and civil society. It functions as the articulating axis of the department's Science, Technology, and Innovation (STI) ecosystem, with synergies with organizations such as Sociedad en Movimiento, the Regional Competitiveness Commission, the Trust Network, and the Departmental Entrepreneurship Network.
It is composed of nine sectoral nodes, of which the Industry 4.0/ICT Node is led by the CIDT and Quinoa Labs., with support from the UTP Planning Office, and is developing a digital platform that will serve as a bridge for articulation between nodes, companies, and citizens. [8]

Articulation with Companies through Events and Dialogues.
The UTP promotes direct meetings with the business sector. In July 2025, the Alumni Association, the Faculty of Applied Mechanics, and the Regional Competitiveness Commission held a strategic breakfast with regional businesspeople and employers to strengthen formative practices and the university–business linkage. The objective was to create a space for dialogue with strategic partners, identify opportunities for collaborative work, and promote joint actions that improve academic relevance and the social impact of education. [9]

The Mayor's Office of Pereira also recognizes the UTP as a central actor in the innovation ecosystem. In June 2025, the city presented its "Specialized Route for Technology Entrepreneurship 4.0," an intensive training and support program developed in partnership with the Technological University of Pereira and aimed at entrepreneurs in different phases. The route is supported by academia, companies, and the public sector to create a favorable environment where technology ventures can grow and project themselves towards internationalization. [10]

B. Relevance of Disruptive Technologies

Disruptive technologies (AI, Industry 4.0, Fintech, among others) are the common thread between the two EMBRACE scenarios and the institutional strategy of the UTP. The CRIE, through SinergIA, works on the ethical and strategic integration of artificial intelligence into university education. The CIDT promotes initiatives focused on Industry 4.0, blockchain, and Fintech so that entrepreneurs and companies can learn

about the opportunities of these technologies. The events of the Barranqueros ecosystem and the Node Network allow projects born in academia to articulate with companies and approach global markets. Consequently, EMBRACE will use these resources to drive an annual "Inspira" event that analyzes the progress and needs of the ecosystem and to strengthen research and training in disruptive technologies, ensuring that the UTP and the region are positioned in the global economy based on innovation..

VII. CASE STUDY

Use of Artificial Intelligence in Organizational Processes with Students of the Master's in Management in Human and Organizational Development

Within the framework of designing the university-business relationship model (WP4), a pilot experience was developed with students of the Master's in Management in Human and Organizational Development at the Technological University of Pereira (UTP). The purpose was to explore how artificial intelligence (AI) can strengthen both academic and organizational processes in which the students are directly involved within their companies.

A. Methodology

The activity was structured as a pilot elective course articulated by the CRIE, involving different ecosystem actors:

- Postgraduate Students: Each applied AI tools to analyze specific problems within their organizations.
- Master's Faculty: Through interviews and co-creation sessions, they identified how AI could support pedagogical, evaluative, and research processes.

The methodological approach combined three fundamental components:

- Experiential learning: Direct application of knowledge in real business contexts.
- Academic consulting: Personalized advice to students during implementation.
- Exploratory interviews: Collection of perceptions and suggestions from participating faculty..

B. Practical Applications and Results

Students implemented artificial intelligence tools in various areas of their companies, highlighting the following uses:

- Sentiment analysis: Applied to surveys and internal communications to evaluate employee perceptions and satisfaction levels.
- Optimization of organizational processes: Identification of bottlenecks and formulation of improvement proposals based on predictive analysis.
- Strengthening of degree theses: Use of AI for bibliographic review, academic writing, and automated data analysis.
- Improvement of organizational climate: Design of cultural and labor intervention strategies through simulations and analysis of communication patterns.

C. Case Impact

- In Companies: Practical inputs were generated that contributed to decision-making, the improvement of internal processes, and human talent management.
- In Students: Competencies in the strategic use of artificial intelligence were strengthened, connecting their training with their immediate work environment.
- In Faculty: Opportunities were identified to integrate AI into teaching, support for research projects, and the evaluation of learning outcomes.
- In the University: A replicable model of university-business articulation, mediated by emerging technologies, was consolidated, generating shared value and positioning the UTP as a regional benchmark in applied innovation.

VIII. LESSONS LEARNED

The cross-cutting nature of artificial intelligence allows for a simultaneous impact on organizational management and formative processes, where students act as bridges between the university and organizations, facilitating the transfer of knowledge and innovation.

Co-creation among faculty, students, and companies enhances curricular relevance and opens new lines of institutional cooperation by using this type of "living laboratory" to incorporate disruptive technologies into the university-business relationship model promoted by the UTP.

It was established that piloting the MOOCs is essential for continuous improvement. The qualitative feedback—generally positive regarding language use and content depth—provides direct and valuable input for iteratively refining instructional design.

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Interdisciplinarity in action - the experience of Federal University of ABC's learning Ecosystem

Allan Moreira Xavier[1], Carla Lopes Rodriguez[2], Carolina Correa de Carvalho[3] , Denise Consonni[3], Geovane Oliveira de Sousa[3], João Ricardo Sato[2], Julio Francisco Blumetti Faco[3], Paula Ayako Tiba[2],

[1] Centro de Ciências Naturais e Humanas (CCNH/UFABC)
[2] Centro de Matemática Computação e Cognição (CMCC/UFABC)
[3] Centro de Engenharia, Modelagem e Ciências Sociais Aplicadas (CECS /UFABC)

Abstract

Within the EMBRACE project (Education Modernization Brazil, Colombia, Europe, the new era of digital higher education cooperation), the contribution of the Federal University of ABC (UFABC) in Work Package 4 (WP4) was to prototype a learning ecosystem, named ENLACE (Engagement, Networking, Learning, Agency, Collaboration, Empowerment) that could reduce the gap between academic knowledge and professional practice, while strengthening regional economic and social development, in the greater ABC region, São Paulo, Brazil. The UFABC Learning Ecosystem Experience involved four integrated roles: Students (Protagonists); Facilitators (Mediators); External Actors (Challenge Mobilizers/Supervisors); and the university itself, as the system host and also one of the challenge-proposers. The system was structured in six progressive main activities, combining synchronous and asynchronous moments: Mapping Relations; Individual Skill Recognition; Pitch Construction; Ecosystem Match; Ideation and Prospecting of Approaches; Final Proposal Presentation and Evaluation. The entire experience was sustained by a robust digital infrastructure centred on UFABC's Moodle platform. The experience successfully validated an innovative, replicable, multiactor and interdisciplinary collaborative model, significantly reducing the gap between academic knowledge and the world of work. A core lesson learned is the effectiveness of placing students as protagonists in addressing real challenges provided by external partners (private companies, startups, and public bodies). Despite some practical operational difficulties faced on the fist-run process, the overall outcome was regarded as a transformative experience, reinforcing the commitment of all actors to the continuity and sustainable growth of the collaborative network.

Keywords: Learning Ecosystem; UFABC; EMBRACE Project; Interdisciplinarity.

• FEDERAL UNIVERSITY OF ABC OVERVIEW

The Federal University of ABC (UFABC) was established in 2005 and subsequently amended in 2015, coinciding with a period of expansion in higher education in Brazil. This development was a response to historical demands from the working class of the Greater ABC region of São Paulo for a free, high-quality public university. This region's distinctive features, including the presence of substantial industrial complexes, a high degree of urbanization, and natural reserves dedicated to environmental preservation, have contributed to its emergence as a significant contributor to the global economy. Concurrently, the region is confronted with substantial social challenges and issues related to the organization of the metropolitan area, thereby establishing it as a nexus for the articulation of these complex agendas. Consequently, the institution was established with the objective of achieving recognition as a leading authority on the national and international levels. This initiative is driven by the institution's commitment to addressing regional demands through its research and training initiatives. These initiatives are meticulously designed to cultivate professionals of the utmost caliber. The university's substantial regional presence is substantiated by the considerable proportion of enrolled students hailing from cities in the ABC region.

Admission to UFABC's interdisciplinary courses is through the Unified Selection System (SiSU). Since the university's inception in 2006, prior to the implementation of the Quota Law [1], 50% of the places available for annual selection were already reserved for public school students.

This university has pioneered a novel model of higher education in Brazil, characterized by interdisciplinary bachelor's degrees. The Bachelor's Degree in Science and Technology (BCT) was the inaugural course of its kind at UFABC, and it is defined, according to the Guiding References [2], as an undergraduate training program culminating in a diploma, with a focus on interdisciplinarity, dialogue between areas of knowledge, and curricular flexibility. By prioritizing interdisciplinary arrangements in its curricular structure that consider the correlations between the

sociocultural and environmental reality in which it is inserted, the BCT Pedagogical Project emphasizes, in turn, the importance of a comprehensive education in the sciences, including the historical view of our civilization and privileging the capacity for social insertion in the broad sense. The mandatory curricular units are designed to reorganize knowledge into six interdisciplinary structural axes, converging various areas of knowledge. The mandatory disciplines are developed along the following axes [3]: The structure of matter; energy; transformation processes; representation and simulation; information and communication; and the humanities. The academic organization into Centers, without the classic departments and chairs, is another institutional choice that aims to encourage the formation of interdisciplinary research groups and student participation in activities in this area from the moment they enter the University.

In 2006, UFABC and BCT initiated their operations in Santo André as part of a multi-campus university proposal. Subsequently, in February 2010, they commenced the delivery of courses in São Bernardo do Campo. Notably, they have maintained a unified approach to the planning, delivery, and execution of courses across both campuses, despite the distinct external evaluation processes employed at each institution. Beginning in 2010, the Bachelor of Science and Humanities (BCH) program was initiated, thereby expanding the university's activities into other fields of knowledge, consistently in an interdisciplinary manner. Beginning in 2020, UFABC initiated the provision of interdisciplinary teacher training courses, designated as LIs, within the domains of Natural and Exact Sciences (LCNE) and Humanities (LCH). This initiative was undertaken with the objective of ensuring a sufficient supply of teachers across the greater ABCDMaior region.

In addition to interdisciplinary entry-level training courses (BIs and LIs), UFABC offers specific training courses of a professional nature, which are guaranteed to students who have completed interdisciplinary entry-level courses. Each of the entry courses grants access to a specific series of training courses. Consequently, UFABC organizes student training, commencing from a more intricate and interdisciplinary epistemological level and progressing to more pragmatic and disciplinary levels.

Students are granted autonomy in selecting and delineating their academic trajectory, which is to be accomplished within the stipulated deadlines established by the courses' pedagogical initiatives. This autonomy is ensured by the delineation of academic units at UFABC, which are categorized as mandatory, limited-choice, and free-choice. The UFABC curriculum does not adhere to the conventional prerequisite model. Instead, the institution's annual catalog offers recommendations for fundamental knowledge, emphasizing the importance of understanding and engagement with the specific curricular unit. The absence of prerequisites enables students to exercise autonomy during enrollment. Limited-option courses must be selected from a set of subjects that are predominantly part of the compulsory curriculum in specific training programs. This ensures that there is no sequentiality in the training of UFABC students (i.e., students do not enter and complete an interdisciplinary course only after beginning their specific disciplinary training). However, there is complementarity in the relationship between interdisciplinary and disciplinary courses, highlighting the university's understanding that interdisciplinarity cannot exist without disciplinary appropriation.

These characteristics position UFABC as an innovative entity within the Brazilian higher education landscape. However, this distinction does not exempt it from the challenges that are characteristic of the contemporary higher education environment. Among these challenges, high rates of attrition, the intricacies of implementing the pedagogical initiative, and the paucity of interinstitutional mobility are particularly salient issues that threaten the continued vibrancy and innovation of this pedagogical endeavor.

● DESCRIPTION OF THE UFABC INNOVATION ECOSYSTEM

The initial mapping of UFABC's learning ecosystem, elaborated by the UFABC EMBRACE team in November 2024 at Colombia kick off, shows a highly interconnected structure where institutional, academic, and societal actors converge to support innovation, practical learning, and collaborative knowledge production, as shown in Figure 1. Internal agents—students, professors, staff, research hubs, study centers, and key institutional offices—interact with external partners such as companies, government bodies, non-governmental organizations (NGOs), consortia, and student-led organizations. Strengthened by funding agencies and professional programs, this emerging ecosystem provides the core conditions for linking academic training with societal needs, fostering interdisciplinary collaboration, and co-creating solutions with regional impact .

Figure 1 - Mapping of UFABC's learning ecosystem: featuring the UFABC logo at its center, the figure represents, in colored and interconnected circles, the actors participating and the collaborative actions between them.

Based on this initial mapping, the UFABC EMBRACE team designed the UFABC Learning Ecosystem Experience, aimed at developing an innovative learning ecosystem model that strengthens interactions between UFABC and the world of work across the ABC region and Greater São Paulo. The primary goal of this ecosystem is to reduce the gap between academic knowledge and professional practice, thereby contributing to more solid and sustainable regional economic and social development. The experience was deliberately organized to create structured opportunities for collaboration and promote joint learning among diverse actors. This co-creation model aimed to solidify a sustainable, interdisciplinary, and collaborative learning ecosystem.

The collaboration involved four central, integrated roles:

- Students (Protagonists): Undergraduate and postgraduate students from UFABC were the protagonists, applying theoretical knowledge in real contexts to analyze challenges and elaborate solution proposals. They developed technical and transversal competencies, such as systems thinking, creative problem-solving, and collaborative work. A total of 60 students participated.
- Facilitators (Mediators): Composed of UFABC faculty and administrative staff, they acted as process mediators, providing orientation, articulating dialogues between actors, and encouraging critical reflection. There were 14 facilitators involved.
- External Actors (Challenge Mobilizers/Supervisors): These representatives from private companies, startups, and public bodies presented real challenges (scenario-problems) to the student groups. They participated actively through meetings, feedback, and proposal evaluations, ensuring the developed proposals were feasible, relevant, and aligned with organizational demands. Six external entities, represented by 10 professionals, participated.
- The university itself integrated the ecosystem as one of the organizations, bringing an internal institutional challenge focused on strengthening its partnerships with the world of work. Beyond being the academic host, UFABC also appeared as one of the challenge-owners, reflecting on its own relationship with the world of work and seeking ways to strengthen institutional partnerships and strategies for digital and pedagogical transformation.

The result was not a simple triad of students, teachers and companies, but a richer constellation of roles: each actor group had specific responsibilities, deadlines, communication tools, and expected contributions at each stage of the ecosystem.

- **THE CO-CREATION METHODOLOGY AND JOURNEY**

The experience utilized active and asynchronous methodologies, including Design Thinking, discussion forums, and online questionnaires, all designed to foster student protagonism and collaboration. The process was supported by a dedicated Virtual Learning Environment (AVA) on UFABC's Moodle platform, which served as a central, interactive, and collaborative digital ecosystem.

The journey of co-creation was structured in six progressive main activities, combining synchronous and asynchronous moments:

- **Activity 1.** Mapping Relations: Participants responded to specific questionnaires to map experiences, needs, challenges and expectations regarding the university–world of work interaction. This diagnostic phase identified existing gaps and opportunities serving multiple purposes: i) to identify gaps and opportunities in existing university–industry or public sector collaboration; ii) to clarify what each actor hoped to gain from the experience; iii) to generate a set of scenario-problems that would later anchor the co-creation process. At the same time, participants familiarized themselves with the Moodle Virtual Learning Environment (VLE) that would function as the digital backbone of the ecosystem.
- **Activity 2.** Individual Skill Recognition (InnoCard): Participants reflected on their individual competencies and learning needs based on an Individual Innovation Competence model adapted InnoCard tool. They identified personal strengths and weaknesses across domains such as: personal characteristics (flexibility, motivation, responsibility, self-management); future-orientation and opportunity recognition; creative and cognitive skills; social skills (collaboration, networking, communication); project management, technical skills, leadership; implementation and entrepreneurship; domain-specific knowledge. Students and facilitators reflected on their own innovation competencies, while external professionals focused on competencies relevant to the challenges they intended to bring. Each participant produced a short written reflection and a PDF report, which later assisted in group formation, role division, and the choice of challenges in Activity 4.
- **Activity 3**. Pitch Construction: Participants created a personal or institutional brief pitch (up to 30 seconds or 400–500 characters), using formats such as video, audio, micro-text plus image, or visual collages, to present themselves as potential collaborators, stimulating strategic communication and connection building. The pitch had a clear function within the ecosystem: i) to articulate who the participant was (personal, educational, and professional dimensions); ii) to highlight competencies, values, interests, and aspirations; iii) to position each person as a potential collaborator in a network linking university, society, and the world of work. The activity was supported by a guided script, focusing on three pillars: 1. Personal, identity, motivations, stories; 2. Educational, learning experiences, academic interests; 3. Professional or Institutional, projects, organizational roles, and contribution to society. All pitches were shared to all participants on Padlet walls, organized by an actor group (students, facilitators, external professionals). This public layer was critical: it made people visible as potential partners before any formal group was formed.
- **Activity 4.** Ecosystem Match: This marked the beginning of practical application. Here, the ecosystem moved from individual reflection to collective action: students formed autonomously, based on mutual interests, competencies, and availability, multidisciplinary groups (3 to 5 members), and selected a real challenge proposed by the external actors. Groups were then designated to a specific chosen challenge, and they contacted the external representatives to validate their understanding of the problem. This step cemented the base for solution co-creation. Groups explored the menu of real challenges submitted by the partner organizations (municipalities, hospital, industrial company, startups, and UFABC); Each group indicated up to three preferred challenges; Facilitators indicated their priorities and were later assigned to challenges, with two facilitators per challenge; Groups contacted external representatives via email to validate their understanding of the chosen problem. This stage required courage and responsibility, as highlighted in an inspirational text shared with participants: choosing a problem meant choosing which reality to engage with, whose expectations to manage, and which constraints to accept. It was also the moment when the ecosystem solidified, as groups, challenges, and mediators were aligned around concrete tasks and deadlines.
- **Activity 5.** Ideation and Prospecting of Approaches: Groups used Design Thinking methodologies to transform knowledge into concrete, innovative, and potential solutions for the selected real challenges. They explored the challenge in depth, using empathy, field information (when available), and previous mappings; generated a wide range of ideas through brainstorming and creative tools; clustered ideas by affinity and selected the most promising options; began to sketch prototypes, such as conceptual models, process maps, narratives, infographics, or early versions of solution frameworks. Groups were encouraged to embrace responsible audacity: not perfection, but the courage to propose new perspectives and discard even good ideas in favour of better ones. Prototypes were documented in shared digital spaces, with evidence of brainstorming, top ideas, justifications for their choice, and any feedback from facilitators or organizations. Facilitators, in turn, were asked to: accompany the groups' ideation paths; stimulate the creative use of tools; help in refining and focusing proposals; provide constructive, timely feedback. External organizations were invited, whenever possible, to listen to the emerging proposals and offer short reactions that could help refine the solutions.
- **Activity 6.** Final Proposal Presentation and Evaluation: Students submitted consolidated proposals for the challenges. External actors actively evaluated the final deliveries for clarity, viability, and connection to the real-world problems. This ensured the solutions built were feasible, executable, and sustainable in the long

term. Each group submitted its consolidated proposal in the format requested by the respective organization: written documents for the municipal governments and industrial partner; video presentations (with slides) for the hospital, UFABC, and one startup; a more flexible format for another startup. Regardless of the medium, all final proposals included: clear identification of the group and challenge; contextualization and objectives; detailed proposal and methodology (methods, steps, implementation path); expected results and anticipated challenges; barriers, assumptions, and risk considerations; impact expectations and references. Proposals were shared through a common Padlet wall, allowing all actors to see what had been produced across challenges and institutions. External actors evaluated the proposals against criteria such as clarity, feasibility, and alignment with real organizational needs, submitting their assessments as PDF reports. In parallel, all actor groups completed online evaluation forms reflecting on their experience in the ecosystem: what worked, what did not, what they learned, and what could be improved. At the end, the closing moment was not just an administrative formality: it consolidated a 3D feedback loop from students, from organizations, and from facilitators, enriching the collective understanding of the ecosystem's strengths and limitations and informing its next iterations.

The overall result was the establishment of a foundation for a replicable learning ecosystem model, expanding UFABC's impact and consolidating a space for innovation, engagement, and shared learning among all participants. All three actor groups (students, facilitators, and external actors) recognized the value of connecting academic learning to real challenges and the collective construction of solutions. It expanded UFABC's reach, strengthened relationships with the world of work, and created a space for innovation, engagement, and shared learning among all participants. Most importantly, the experience made visible, sometimes painfully, the real cost of meaningful collaboration: the hours of invisible facilitation, the emotional work of keeping groups together, the risk of losing participants along the way, and the need to constantly balance ambition with feasibility. In doing so, the UFABC Learning Ecosystem Experience delivered not only prototypes and proposals, but also a set of carefully earned insights. These insights are, in themselves, one of the project's most valuable outcomes and a crucial resource for anyone who wishes to design the next generation of Erasmus+ learning ecosystems.

To consolidate this legacy and give the experience a recognizable identity within the institution, the learning ecosystem developed at UFABC was formally named ENLACE[1] – Engagement, Networking, Learning, Agency, Collaboration, and Empowerment. The name reflects its central mission: to create meaningful links (*enlaces*) between students, the university, society, and the world of work through structured, collaborative, and challenge-driven processes. ENLACE emerges as a replicable architecture for academic innovation, capable of articulating multiple actors, integrating active learning methodologies, and sustaining co-creation practices inside and beyond the university. To support its visual communication and strengthen institutional understanding, we propose presenting ENLACE through a diagram that illustrates the Six-Stage Journey of the UFABC Learning Ecosystem Experience. This visual representation can highlight the complete cycle, reinforcing the iterative and systemic nature of the model, Figure 2.

[1] E – Engagement: commitment, participation, and active involvement
N – Networking: interconnection among actors and institutions
L – Learning: individual and collective learning processes
A – Agency: protagonism, empowerment, and initiative of participants
C – Collaboration: co-creation, teamwork, and shared development
E – Empowerment: strengthening capacities for action and innovation

Figure 2 - ENLACE diagram: The figure represents, in circles arranged in a colored hexagonal diagram, the elements that make up the ENLACE ecosystem: Engagement, Networking, Learning, Agency, Collaboration, Empowerment.

The circular—or hexagonal—diagram representing ENLACE inspired and guided the design of the six activities proposed in the Ecosistemas: Mapping Relationships, Recognizing Individual Competencies (InnoCard), Building Presentations and Collaborative Identities (Pitch), Connecting with the Ecosystem and Selecting Challenges, Ideation and Prototyping Approaches, and Submission and Evaluation of the Final Proposal. This visual model reinforces that ENLACE functions as a living ecosystem in which diagnosis, self-reflection, connection, co-creation, ideation, and evaluation are not isolated steps but interdependent components of a continuous architecture of learning, innovation, and institutional collaboration.

• THE DIGITAL BACKBONE: MOODLE AS A LIVING HUB

The entire experience was sustained by a robust digital infrastructure centred on UFABC's Moodle platform. Moodle functioned as (a) the central repository for descriptions, guidelines, and schedules; (b) the space for task submissions and feedback; (c) the gateway to external tools (Padlet, forms, InnoCard, videos); (d) a communication channel for individual messages and collective forums.

The richness of formats was remarkable: texts, photos, videos, audio pitches, collages, infographics, slides, virtual murals, forms, and PDFs circulated as evidence of learning and collaboration. This multi-format nature made the ecosystem inclusive, visually and cognitively vibrant, but also demanded a significant coordination effort.

Two elements were crucial for the success of this digital backbone:

- a Moodle expert inside the EMBRACE UFABC core team, who ensured that the platform was configured and maintained at a professional level;
- a highly tech-savvy coordinator, who guaranteed continuity, solved technical and organizational issues quickly, and refused to let interruptions even when the volume of interactions and uploads peaked.

Without this internal technical and pedagogical expertise, the complexity and intensity of the digital environment would likely have overwhelmed both students and facilitators. More than just a repository of materials, it became the core of the digital learning ecosystem, strengthening the relationship between the university and the world of work and leaving a strategic legacy by fostering a culture of collaborative learning, open innovation, and continuous professional development. It is important to highlight the points that can be improved from the established virtual environment: in this case, exploring tools that can improve communication between the actors, and including elements that promote accessibility.

• CASE STUDY: THE UFABC LEARNING ECOSYSTEM EXPERIENCE

The UFABC Learning Ecosystem Experience was designed as a living laboratory: an attempt to turn an Erasmus+ capacity-building project into a concrete, local bridge between a public university and the world of work in the GreaterABC and São Paulo regions. Within the broader EMBRACE project (Education Modernization Brazil, Colombia, Europe, the new era of digital higher education cooperation), UFABC's contribution in Work Package 4 (WP4) was to prototype a learning ecosystem that could reduce the gap between academic knowledge and professional practice, while strengthening regional economic and social development.

Anchored in the definition of learning ecosystems proposed in [5] as systems that connect teachers, developers, professionals, managers, content, technologies, culture, and strategy to generate real impact, the UFABC team set out to design a living ecosystem rather than a one-off project. The guiding idea was simple but demanding: create structured, replicable opportunities for collaboration that make academic learning visibly useful to real organizations, while supporting students' development of both technical and transversal competencies.

The ecosystem was thus framed as a multi-actor, multi-layered environment, integrating activities, people, tools, and institutions. Its ambition was to become a sustainable, interdisciplinary and collaborative model of co-creation that UFABC could adapt and expand in the future. At its core, the experience was not "just a course", but a structured ecosystem: a deliberately designed environment in which students, facilitators, and external organizations co-created solutions to real challenges. The ecosystem invited participants to move beyond the classroom, into a shared space where different forms of knowledge, institutional cultures, languages, and expectations needed to be negotiated, often asynchronously, often at a distance, and almost always under time pressure.

Despite the quality of the design and the genuine effort by facilitators and external partners, the ecosystem experienced significant student attrition: roughly half of the initial participants did not complete the full two-month journey. This drop-off occurred gradually across the five main milestones in each Activity, even with close monitoring by facilitators, regular reminders and nudges in Moodle, attempts to rescue disengaged groups through targeted messages and support, the real-world appeal of the challenges. All these callings guaranteed the opportunity to finish the proposed learning ecosystem.

The reasons are multifactorial, including workload pressures, competing priorities, the emotional weight of real-world problems, and the demands of self-regulated asynchronous work. However, the experience makes one point very clear: maintaining engagement in long, multi-actor, project-based ecosystems is not automatic and requires deliberate, structural strategies beyond goodwill and enthusiasm.

A second key learning was the overwhelming preference for asynchronous work among students. Very few groups reported synchronous meetings, even though they were encouraged to schedule online sessions when needed. Instead, most collaboration happened through: messages in Moodle; shared documents and slides; exchanges in Padlet and other tools; occasional email threads with facilitators and external actors. Asynchronous flexibility clearly supported inclusion, allowing students with different schedules and responsibilities to participate. But it also introduced challenges:

- communication became fragmented and often slower;
- misunderstandings had to be corrected through multiple written exchanges;
- facilitators needed to monitor scattered interactions across tools and times;
- the feeling of belonging to a group was, at times, weaker.

This translated into a hidden workload for facilitators: instead of the planned two hours per week, many dedicated up to five hours answering questions, reviewing drafts, following up on missing submissions, and providing individualized feedback. Informal feedback from both students and facilitators confirmed that the effort required for deep support in an asynchronous, project-based ecosystem was significantly higher than anticipated.

The multiplicity of formats, including videos, pitches, murals, documents, forms, and prototypes, was both a strength and a source of complexity. On the one hand, it allowed students to express themselves creatively and to experiment with different forms of communication and representation. On the other hand, it increased cognitive load and made it harder to maintain a unified overview of progress.

The analysis of participant feedback shows that InnoCard (Activity 2) played a central role in helping participants to recognize their strengths and challenges in areas such as communication, teamwork, self-management, creativity, and domain-specific knowledge. On the positive side, these insights facilitated group formation and allowed for a more balanced distribution of responsibilities throughout the co-creation journey. As a limitation, the activity also revealed important gaps—particularly in self-management, communication, and leadership—that later contributed to difficulties in coordinating remote group work.

The pitch (Activity 3) also produced mixed outcomes. Among its strengths, the activity enhanced visibility of participants' identities, motivations, and profiles, enabling more informed connections during the match-making process. Additionally, the current ecosystem generated a robust set of materials—videos, texts, and visual narratives—that can now serve as concrete references and models for future iterations, improving the accuracy of early guidance, aligning expectations, and reducing uncertainty for new participants. However, the activity also exposed challenges related to the lack of prior examples, the need for clearer and more structured instructions, and the demand for brief synchronous moments to address doubts.

Evaluations across all actor groups indicate that many of the challenges observed later in the ideation and proposal phases were already visible in Activities 2 and 3, underscoring their strategic importance. Taken together, the results suggest that refining these two activities—now supported by the repository of materials produced within the ecosystem—can enhance early engagement, improve expectation alignment, and strengthen group cohesion throughout the co-creation journey.

The comparative feedback from facilitators, students, and external actors demonstrates a broadly positive perception of UFABC's Learning Ecosystem, while also revealing distinct challenges and expectations across groups. Facilitators and students alike emphasize the value of applying theoretical knowledge to real-world problems, benefiting from interdisciplinary collaboration, and strengthening the connection between the university and external sectors; external actors similarly recognize these advantages, highlighting students' engagement and the relevance of the solutions produced.

Despite these convergences, the groups differ in their perceived challenges: facilitators and students report difficulties related to communication, clarity of initial instructions, time management, and coordination in fully online environments, whereas external actors identify fewer obstacles, typically limited to thematic complexity or limitations in problem definition and available data. Suggestions for improvement converge on the need for clearer guidelines, enhanced communication, more structured support mechanisms, and opportunities for synchronous interaction, while external actors additionally underscore the potential for the ecosystem to inform public policy and institutional innovation. Across all groups, there is strong willingness to continue engaging in collaborative networks, indicating shared recognition of the ecosystem's transformative potential for education and societal impact.

For future editions, some potential refinements emerge:

- clearer minimal viable expectations for each activity, with optional enrichment layers;
- more explicit recommendations on how to manage asynchronous group work;
- micro-milestones with shorter feedback cycles to prevent long periods of silence;
- small, mandatory synchronous checkpoints (for example, brief online meetings at the start, mid-point, and near the end) to re-anchor the groups and reduce attrition.

Despite its challenges, the UFABC Learning Ecosystem Experience succeeded in building the foundations of a replicable model that can be adapted in future cohorts and by other institutions in the EMBRACE network. Some elements proved particularly powerful:

- authentic, multi-sector challenges, bringing universities, public sector, health institutions, industry, and startups into a shared problem-solving arena;
- structured self-knowledge tools, such as InnoCard and pitches, helping participants understand themselves as actors in an innovation ecosystem rather than passive recipients of content;
- deliberate match-making between people and problems, based on interests and competencies;
- a clear, progressive journey from mapping to ideation to final proposals, scaffolded by design-thinking principles;
- a robust, professionally maintained digital environment, essential for sustaining a complex asynchronous ecosystem;
- a 3D feedback architecture, capturing the voices of students, facilitators, and external organizations at the end of the process.

● LESSONS LEARNED

The experience successfully validated an innovative, replicable, and multiactor and interdisciplinary collaborative model, significantly reducing the gap between academic knowledge and the world of work. A core lesson learned is the effectiveness of placing students as protagonists in addressing real challenges provided by external partners (private companies, startups, and public bodies). This collaborative approach proved essential for the development of crucial technical, transversal, and socio-emotional competencies in students, including complex problem-solving, systemic thinking, and teamwork. Furthermore, the model was highly valued by all participants—students, facilitators, and external actors—who recognized its potential for mutual learning, promoting a stronger social role for the university, and generating applied, robust solutions.

However, the experience also highlighted several operational challenges that serve as key lessons for future implementation. The main difficulties revolved around achieving seamless communication and alignment among all actors, especially during the initial phases when information could be dispersed or unclear. Participants also consistently noted the complexity of managing time and deadlines, suggesting the need for more extended periods for activity execution and proposal maturation. Despite the quality of the design and the genuine effort by facilitators and external partners, the ecosystem experienced significant student attrition: roughly half of the initial participants did not complete the full two-month journey. This drop-off occurred gradually across the five main

milestones, even with: close monitoring by facilitators; regular reminders and nudges in Moodle; attempts to rescue disengaged groups through targeted messages and support; the real-world appeal of the challenges. The reasons are multifactorial, including workload pressures, competing priorities, the emotional weight of real-world problems, and the demands of self-regulated asynchronous work. However, the experience makes one point very clear: maintaining engagement in long, multi-actor, project-based ecosystems is not automatic and requires deliberate, structural strategies beyond goodwill and enthusiasm. Recommendations include the importance of centralizing all information on the Moodle platform to reduce redundancy, planning external challenges with greater advance notice to ensure partners are prepared for dialogue, and defining the scope of these challenges with greater objectivity. Despite these practical friction points, the overall outcome was regarded as a transformative experience, reinforcing the commitment of all actors to the continuity and sustainable growth of the collaborative network.

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IFSP Innovation Ecosystem: A Model for Inclusive, Applied, and Sustainable Education

Matos, Jussara Pimenta[1]; Martins, Teresa Helena Buscato[1]
[1]IFSP

Abstract
The EMBRACE project, developed through collaboration between European and Latin American higher education institutions, aims to modernize tertiary education by fostering digital transformation, pedagogical innovation, and inclusive stakeholder engagement. The Federal Institute of São Paulo (IFSP) exemplifies this mission through its INNO-ECO Model—a comprehensive institutional framework that integrates education, research, and social impact within an innovation-driven ecosystem. Anchored in the quadruple helix model, the INNO-ECO framework fosters collaboration among academia, industry, government, and civil society through decentralised governance and co-creation methodologies. This model is structured around five interconnected pillars: education, research, community engagement, internationalisation, and infrastructure. It follows a five-phase operational cycle: mapping, co-design, implementation, monitoring, and dissemination, enabling adaptability and responsiveness to evolving regional and global challenges. Initiatives such as INOVA, Integra, and EMBRAPII partnerships enhance applied research, regional innovation, and inclusive education. Case studies in areas such as renewable energy, digital inclusion, and prison education illustrate the model's impact and scalability. Grounded in critical frameworks like digital competence and anticolonial pedagogy, the INNO-ECO Model reflects IFSP's commitment to inclusive, sustainable education. Aligned with the United Nations Sustainable Development Goals, it positions IFSP as a key actor in educational and social transformation.

Keywords:
Innovation Ecosystem; Educational Innovation; Sustainable Development; Inclusive Governance; Stakeholder Collaboration.

I. INSTITUTIONAL OVERVIEW

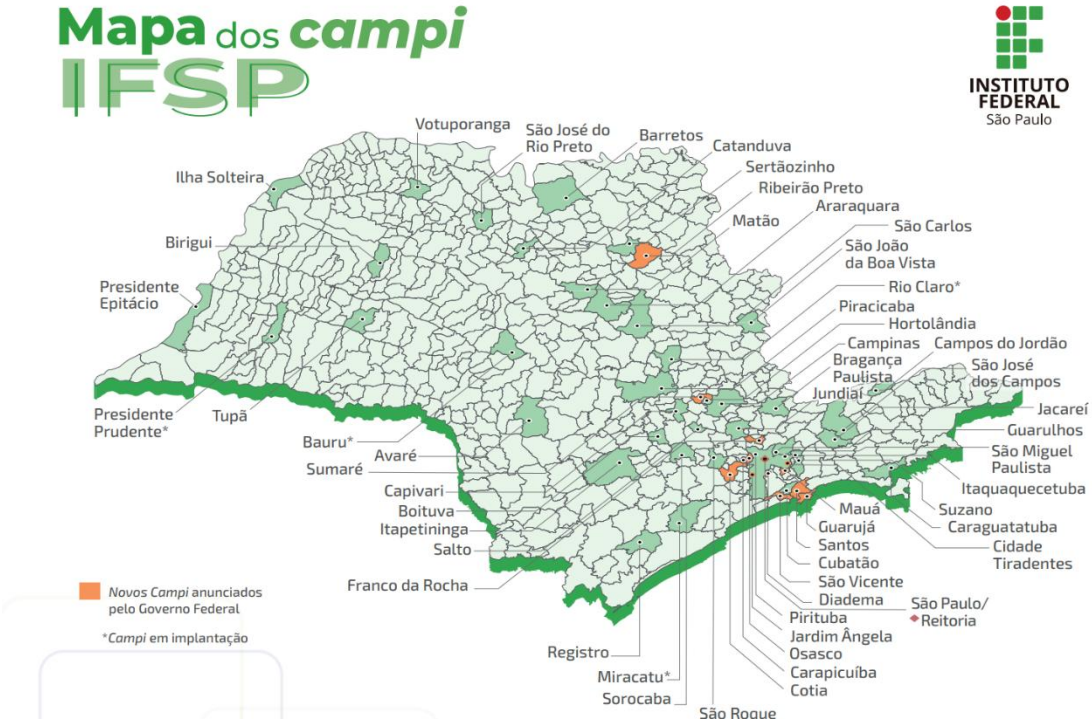
The Federal Institute of Education, Science and Technology of São Paulo (IFSP)[1] is a federal public institution that is part of the Federal Network of Professional, Scientific and Technological Education, under the Secretariat for Professional and Technological Education (Setec) of the Ministry of Education.

The mission of the institution is to train critical-thinking citizens who are prepared to enter the job market, integrating technical, technological, scientific, and cultural knowledge. Through its multi-campus structure and diverse course offerings, IFSP meets the productive and social demands of the State of São Paulo, contributing to the technical, technological, and scientific education of young people and adults.

By expanding into different cities, the institution promotes inclusion and the democratization of professional and technological education, helping to reduce social inequalities. IFSP has many campuses across the state of São Paulo, figure 1. The

integration of teaching, research, extension , and innovation enables IFSP to act not only as an educational center but also as an agent of regional and social development.

Figure 1: Map of the IFSP campuses

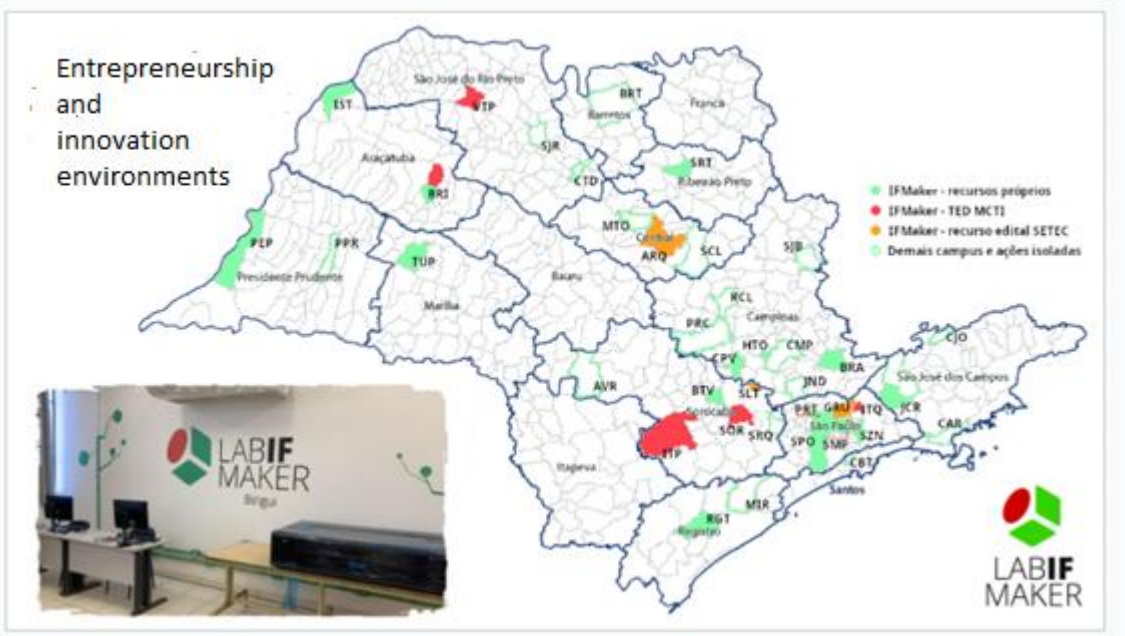


Source: *Institutional portal*. 2025. Available at: https://www.ifsp.edu.br/. Accessed on: Nov. 30, 2025.

Within IFSP, we have INOVA [2] which is the Innovation and Technology Transfer Agency of IFSP, created to manage and implement the institution's innovation policy. It was established through Resolution No. 159/2017, dated November 29, 2017 and its responsibilities include: protecting intellectual property (patents, software, etc.), transferring technology, promoting entrepreneurship within IFSP, and establishing partnerships with companies and the community.

INOVA IFSP's work reinforces IFSP's mission to promote professional, technological, and scientific education, and to contribute to regional development In practical terms, the agency helps connect students, professors, and staff with the productive or business world, creating value through innovation—not just theories, but real solutions, services, and products. For those studying or working at IFSP, INOVA represents a path to engage in projects beyond traditional education: incubating ideas, protecting inventions, and turning research into real-world applications.

Figure 2: INOVA: Entrepreneurship and innovation environments



Source: **INOVA IFSP – Innovation and Technology Transfer Agency**
Federal Institute of São Paulo (IFSP). *INOVA IFSP – Innovation Agency*. 2025. Available at: https://inova.ifsp.edu.br/. Accessed on: Nov. 30, 2025.

INOVA has launched public calls to support projects for the registration of Geographical Indications (GI) in collaboration with local productive arrangements. The goal is to integrate IFSP's technical, technological, and research expertise with local productive realities, helping formalize and promote regional products or services through GIs. This fosters innovation, institutional visibility, territorial development, and the strengthening of local value chains.

Integra IFSP [3] is the institutional portal and platform of IFSP responsible for facilitating the connection between the institution, its network of researchers, laboratories, and technical capabilities, and potential public and private partners. Integra allows IFSP staff and units to register their laboratories, technical competencies, and research portfolios in order to offer services or collaborate externally. In addition to enhancing institutional visibility, the platform aims to facilitate partnerships, service agreements, innovation projects, collaborative research, and technology transfer between IFSP and external companies or organizations.

EMBRACE Project

The project Education Modernization Brazil, Colombia and Europe – the new era of digital higher education cooperation (EMBRACE)[4] envolves universities and institutes in Europe and Latin America. Its objectives are to develop the digital and pedagogical competences of higher-education teachers to design, implement and assess student-centred and competence-based (online) education, thereby contributing to equity and accessibility in higher education; to support educational management in handling impactful pedagogical change and organising the innovative learning ecosystem with all relevant stakeholders; and to build an innovative collaboration between Higher Education Institutions (HEIs) and partners from the world of work/society that results in a stronger learning ecosystem, as well as in the economic and social development of the partner regions.

Beyond that the EMBRACE project is based on the design and execution of work packages (hereafter WPs) with clearly defined activities and targets. The WPs were divided into tasks to assist in distributing responsibilities and estimating the working hours required to achieve the goals of each. As an experienced project coordinator, HAMK researched previous management processes and the resources needed to guide partners in determining best project-management practices, including information from the programme guide and the grant agreement model.

The EMBRACE project is structured around five Work Packages (WPs), each with defined activities and goals. These were broken down into tasks to distribute responsibilities and estimate workload. Drawing on prior experience and resources such as the programme guide and grant agreement, project coordinator HAMK established best practices for project management.

- WP1 – Management and Quality Assurance**:** Oversees project execution, focusing on schedule, cost, task tracking, and quality control.
- WP2 – Digital and Pedagogical Competence of Teachers: Develops learning modules to enhance teacher skills in digital pedagogy, CLIL, sustainability, equity, and inclusion. Teachers co-create these based on research and practice.
- WP3 – Management Support for Competence Development: Builds HEI leadership capacity to manage digital and pedagogical transformations and fosters collaboration between educators and societal partners.
- WP4 – Collaboration with the Third Sector: Strengthens ties between HEIs and the community through challenge-based projects, addressing real stakeholder needs and promoting ecosystem development.
- WP5 – Impact and Dissemination: Targets a broad audience to ensure long-term impact through open educational resources, competence frameworks, and scholarly outputs, culminating in a final seminar at IFSP.

II. DESCRIPTION OF THE INNOVATION ECOSYSTEM

Regarding the framework of Work Package 4, the Federal Institute of São Paulo (IFSP) has established a sustainable and innovative ecosystem that effectively integrates academic expertise with practical societal and economic demands, thereby contributing to regional development across diverse sectors. In response to ongoing transformations in the global educational landscape, IFSP serves as a paradigm of how higher education institutions can extend beyond conventional pedagogical functions to assume strategic roles within regional innovation systems. This institutional model is underpinned by systematic methodologies, inclusive governance mechanisms, and long-term stakeholder engagement, all of which are informed by experiential learning and continuous refinement.

This ecosystem is structured around five interrelated pillars: education, research, community engagement, internationalisation, and core infrastructure. Its educational strategy is characterised by competency-based, interdisciplinary, and flexible learning modalities that align with evolving industry needs. Research activities are centred on priority themes and foster strong collaborations with industry, promoting applied innovation and knowledge transfer. Community engagement initiatives enhance social inclusion and regional capacity through extension and local partnerships. These pillars

are supported by advanced technological infrastructure, decentralised governance enabling local responsiveness, and diversified funding models, ensuring institutional adaptability and inclusive participation in strategic decision-making.

The Federal Institute of São Paulo (IFSP) employs a structured five-phase methodological framework to foster sustainable stakeholder collaboration and continuous improvement within its innovation ecosystem.

Phase 1 (Mapping) systematically identifies and prioritises stakeholders through surveys, interviews, and an ecosystem observatory.

Phase 2 (Co-Design) involves stakeholders in collaborative workshops to align educational offerings with industry needs, producing jointly designed curricula and partnership frameworks.

Phase 3 (Implementation) translates co-designed initiatives into tangible outcomes such as challenge-based projects, internships, and patentable innovations.

Phase 4 (Monitoring) ensures accountability through key performance indicators (KPIs), impact dashboards, and qualitative feedback mechanisms.

Phase 5 (Dissemination) promotes transparency and scalability by sharing outcomes through reports, toolkits, and public events, thereby transforming institutional practices into adaptable knowledge goods. This phased approach reinforces inclusive governance, experiential learning, and strategic alignment, positioning IFSP as a model for responsive, ecosystem-driven education and innovation.

The IFSP model embodies a quadruple helix framework that integrates academic, industrial, governmental, and societal stakeholders into a co-creative innovation ecosystem. Internally, students, faculty, and campus managers actively shape governance, curricula, and research, while externally, industry partners, government agencies, NGOs, and international collaborators contribute to relevance, policy alignment, and social impact. Co-creation is operationalised through challenge-based projects, innovation labs, curriculum co-design, mentorships, and formal research partnerships. Governance structures include an ecosystem observatory, decentralised campus innovation hubs, and an inclusive advisory board. Capacity building focuses on faculty development, infrastructure investment, and diversified funding. The implementation roadmap spans short-, medium-, and long-term phases, moving from foundational development and pilot projects to full institutional integration and international benchmarking. This approach fosters sustained stakeholder engagement, institutional adaptability, and regional innovation leadership.

The IFSP INNO-ECO model (Figure 3) demonstrates institutional versatility through a wide array of partnerships spanning industry, government, and civil society. Case studies illustrate success across diverse funding levels, from knowledge-based collaborations to multimillion-real research contracts. Central to all initiatives is student development—through employment, research, teaching, and civic engagement.

Figure 3 - IFSP INNO-ECO model

Source: Embrace Team – IFSP (2024).

The model integrates technical education with social impact, addressing digital inclusion, prison education, gender equity, and community development. It fosters innovation via intellectual property generation and platform development, with several projects earning national recognition. Strategic partnerships with public sector entities enhance sustainability and legitimacy. Curricular integration ensures long-term engagement, while decentralised and scalable approaches allow adaptation to local and national contexts. Theoretical underpinnings—such as anticolonial pedagogy and digital competence frameworks—anchor practice in scholarship. Collectively, these initiatives validate IFSP's capacity for inclusive innovation, institutional learning, and alignment with UN Sustainable Development Goals and national policy priorities.

The IFSP model operationalises a quadruple helix system that merges academic, industrial, governmental, and societal perspectives in a continuous co-creation cycle.

Internal Stakeholders

Students (Co-Researchers)

- Active participants in research and innovation projects;
- Contributors to institutional planning;
- Representatives in governance structures;
- Bridge between academic learning and professional practice.

Faculty (Mentors and Facilitators)

- Curriculum designers incorporating industry input;
- Research leaders on collaborative projects;
- Mentors guiding student development;
- Continuous learners staying current with industry trends through training programmes.

Campus Management (Governance and Coordination)

- Strategic planners aligning institutional and ecosystem goals;
- Resource allocators ensuring adequate support for collaborations;
- Coordinators facilitating connections between internal and external stakeholders;
- Decision-makers on institutional priorities and investments.

External Stakeholders

Industry Partners

- Curricular recommendations so as to ensure relevance;
- Internship and employment providers creating career pathways;
- Research collaborators on joint development projects;
- Mentors sharing professional expertise with students;
- Funders contributing to project sustainability.

Government Agencies

- Policy alignment partners ensuring regulatory compliance;
- Funding sources for strategic initiatives;
- Conveners bringing together multiple stakeholders;
- Champions of regional development priorities.

NGOs and Community Organisations

- Community project partners addressing social challenges;
- Advocates for inclusive and equitable practices;
- Connectors to underserved populations;
- Contributors to social innovation initiatives.

International Partners

- Research collaborators on global challenges;
- Exchange program hosts providing international experiences;
- Knowledge transfer facilitators sharing best practices;
- Network builders connecting IFSP to global communities.

This diverse stakeholder configuration ensures that the ecosystem remains responsive to multiple perspectives and creates value across different domains. The flexibility and effectiveness of the IFSP INNO-ECO model are demonstrated through numerous successful partnerships that vary in scope, funding, and outcomes. These cases span from traditional industry collaborations to innovative social impact projects.

III. CONTENT SPECIFIC TITLE

The diverse stakeholder configuration within the IFSP INNO-ECO model ensures that the ecosystem remains responsive to a wide range of perspectives, enabling the co-creation of solutions that generate value across educational, economic, and social domains. This inclusivity is further reflected in the model's flexibility and proven effectiveness, as demonstrated through numerous successful partnerships that vary significantly in scope, funding, and objectives. From knowledge-based collaborations

with industry to large-scale social impact initiatives, IFSP has established a dynamic platform that adapts to local and national needs while fostering innovation, regional development, and student engagement. The following industry partnership cases exemplify the model's capacity to align institutional expertise with real-world challenges, advancing both academic excellence and societal transformation.
The following industry partnership cases illustrate how such engagements have led to tangible outcomes, from intellectual property generation and job creation to national recognition and expanded research opportunities.

Industry Partnership Cases

1. Sirio Solutions Engineering (SSE)
The partnership between IFSP and Sirio Solutions Engineering (SSE) focused on turbine research and was initiated without external funding, emphasizing a knowledge-based collaboration model. It offered students hands-on qualification experiences and led to direct employment opportunities. The partnership demonstrated that authentic, small-scale, and resource-light projects can yield substantial educational and professional outcomes. It also confirmed IFSP's ability to deliver value to industry through practical collaboration. Key lessons include the non-essential role of initial funding, the effectiveness of real-world challenges for learning, and the potential for small initiatives to evolve into broader, long-term industry relationships.
2. Globaltech
Globaltech partnership, supported by dedicated student scholarships, focused on commercially oriented collaborative research. Involving around ten students, the project led to the filing of an international patent and the hiring of all participants by the company, showcasing how funded research can serve as an effective talent pipeline. The initiative demonstrated the value of financial support in attracting skilled students and enabling ambitious innovation projects. It also highlighted the need for strategic planning in intellectual property management. The partnership fostered economic value, institutional credibility, and strengthened prospects for continued industry engagement.
3. Petrobras
Petrobras partnership represents a large-scale, multi-year R&D initiative focused on deep-sea prospecting technology, with a total investment of $10 million. The project engaged multiple faculty and numerous students, leading to technological advancements, high-impact research outputs, and extensive student training in advanced technical fields. It validated IFSP's capacity to manage complex research collaborations aligned with national priorities. Key lessons include the necessity of robust infrastructure for large projects, the strategic value of aligning with national goals, and the role of major partnerships in enhancing institutional visibility and attracting future opportunities.
4. CREA-SP (Regional Council of Engineering and Agronomy)
The partnership between IFSP and CREA-SP, centered on a Robotics and Innovation Fair, exemplifies the impact of event-based collaborations with professional associations. Designed to connect students with multiple employers in the automation and robotics sector, the initiative facilitated valuable internships, broadened career awareness, and enhanced IFSP's visibility among regional industry players. It established a platform for ongoing multi-company engagement. Key lessons include the strategic value of professional associations in expanding employer networks, the effectiveness of student

showcases in attracting industry interest, and the potential of single events to generate lasting institutional relationships.

5. The Sustentare Project: intelligent, inclusive, and sustainable communities

The Sustentare Project, launched in 2019 at IFSP, evolved from an extension course into a broader initiative through strong community engagement. It promotes sustainable practices by connecting environmental, social, and economic pillars to food-related activities—production, consumption, and waste. Its key actions include sustainable cooking, urban gardening, and composting, offered through practical workshops focused on entrepreneurship and women's inclusion. Recognized with a Double Award and the ODS Seal for its innovative impact, the project aligns with the UN's 2030 Sustainable Development Goals. Sustentare also published an e-book, book chapters, and has two articles accepted by *Nature* magazine.

6. CEPEER: Center for Studies and Research in Energy Efficiency and Renewable Energies

Located at the São Paulo Campus of IFSP, CEPEER began its activities in 2023 and quickly became a reference in the field. The group conducts research, offers professional training courses, and provides training for multipliers, thereby expanding the dissemination of sustainable practices. Its work is also integrated with the EnergIF Program, an initiative that promotes actions related to Renewable Energies and Energy Efficiency throughout the Federal Network of Professional and Technological Education of the Ministry of Education (MEC). In this context, CEPEER directly contributes to the implementation and strengthening of these actions at the São Paulo Campus. Furthermore, the center has been strengthening relationships with companies in the sector, establishing partnerships that drive applied projects and reinforce the need to expand its scope in research, technology, and innovation.

Social Impact and Community Engagement Cases

1. TV Box Revolution: Transformation into Mini PCs (Campus Salto)

The Citizen Revenue Program partnership, launched in 2023 between IFSP and the Federal Revenue Service, focuses on repurposing seized illegal TV Box devices by replacing malicious software with Linux, integrating the initiative into the Computer Science curriculum. Over 1,500 devices were refurbished and donated to public schools in low-HDI areas, including 120 to Salto. The project enhances student skills in system administration and social technology, while promoting digital inclusion. Recognised nationally (Inova Award 2025 finalist). This initiative exemplifies scalable, student-led innovation that merges education, technology, and social impact.

2. Telecentro Digital Inclusion

The digital inclusion partnership between IFSP and the municipality of São João da Boa Vista, established in March 2024, delivers free digital literacy training to underserved populations. Located in a repurposed bus terminal space, the initiative—coordinated by the Lab MovIF project—enables IFSP students to act as instructors, gaining valuable experience in teaching and programme coordination. The centre serves up to 140 individuals daily, offering essential digital skills such as computer use, internet access, and public service navigation. This project exemplifies sustainable educational outreach

through public space reuse, strategic municipal collaboration, and socially impactful student engagement.

3. Women of RESEDÁS: Women's Education and Professional Qualification

The *Women of RESEDÁS* initiative is a community development partnership focused on women's professional qualification through cooperative development training. Targeting gender equity, the programme prepares participants to act as cooperative development agents, enhancing their employability and contributing to local economic resilience. Built on a community-based, participatory approach, the initiative serves as a model for inclusive and culturally responsive capacity building. Key lessons include the effectiveness of targeted programmes in addressing specific needs, the role of cooperatives in generating sustainable opportunities, and the value of gender-focused initiatives in promoting social equity and empowerment.

4. Paideia Digital: Offline Educational Technology for Prisoners

The *Paideia Digital* partnership between IFSP and the prison system develops an offline educational platform using Raspberry Pi technology to serve incarcerated individuals in restricted environments. Designed for secure, self-managed learning without internet connectivity, the project delivers programming courses while respecting institutional security protocols. It provides students with real-world experience in creating solutions under technical and ethical constraints. The initiative contributes to educational equity and rehabilitation, offering a scalable model for correctional education. Key lessons include the adaptability of technology to secure settings and the vital role of education in promoting reintegration and social innovation.

5. ANACA: Decolonizing Narratives in Prison - Reading and Writing Program for Prisoners

The Decolonizing Narratives in Prison (ANACA) initiative is a multi-campus partnership between IFSP and Prof. Dr. Manoel Pedro Pimentel Foundation - FUNAP, integrating prison education with the Linguistics curriculum. Centred on reading clubs and autobiographical writing, it engages incarcerated individuals through bi-monthly sessions, combining literary analysis with anticolonial pedagogy. Supported by Raspberry Pi technology for offline access, the programme enhances literacy, enables sentence reduction, and contributes to rehabilitation. It exemplifies curricularised outreach, with student-led validation committees and multi-campus coordination. ANACA addresses key UN SDGs and has gained national academic recognition. The project underscores education as a right and transformative tool in correctional settings.

Educational Innovation and Assessment Cases

1. EPLI: National English Proficiency Exam

The National English Proficiency Exam - *EPLI* is a national-level English proficiency assessment developed through a Decentralized Execution Agreement (TED) which is a

legal instrument of the Brazilian federal government that formalizes the transfer of resources between agencies and entities of the Union for the implementation of programs, projects, or activities, and a partnership between IFSP and Secretariat for Professional and Technological Education of the Ministry of Education - SETEC/MEC, with support from FACTO Foundation. The project, running through 2026, involves multi-campus collaboration and is managed via research and innovation scholarships to computing technician, faculty and students. It establishes a standardised exam platform that objectively evaluates language learning outcomes, institutional quality, and informs curriculum development. Students contribute to test design, psychometric analysis, and educational technology. The project underscores the value of scientific methods, federal funding, and multidisciplinary collaboration. It enhances institutional legitimacy through transparent processes and positions IFSP as a benchmark in language assessment.

2.COSAIC: "Sharing Knowledge and Innovation in Cyberculture"

The *COSAIC* project is a 36-month inter-institutional partnership between IFSP and the Brazilian National School of Public Administration, supported by "Arthur Bernardes Foundation" - FUNARBE under a focus on developing MOOCs for the public sector, the project integrates early-stage student research with digital education innovation. Grounded in the *DigCompOrg* and *DigCompEdu* frameworks and aligned with OECD principles, COSAIC fosters scalable, inclusive pedagogical models. Outcomes include 46 distance learning courses, enhanced research culture, and student development in educational design and web production. The initiative strengthens institutional capacity, public sector training, and national-international collaboration through multidisciplinary, real-world project engagement.

These are some of the projects developed by IFSP faculty, staff, and students. To learn more about these initiatives and explore each one in detail, visit: www.mapadeinovacaodoifsp.com.br.

IV. CASE STUDY

Case Study: Biofuel Production from Sweet Potato – A Sustainable Alternative

Brazilian government has some organizations that the main objective is to support technological research institutions, fostering innovation in the Brazilian industry. One of these is Embrapii [5], which is a social organization accredited by the Brazilian federal government, created in 2013 through a joint initiative of the Ministry of Science, Technology and Innovation and the Ministry of Education. It was established to connect companies and harness the synergy between technological research institutions and the industrial sector. Its mission is to strengthen the innovation capacity of the Brazilian market. The four sub-areas of action of the Embrapii Unit at IFSP are:

a) Research and development of innovative food analysis processes and methods: development and innovation in food analysis methods generally applied to process optimization and quality control.

b) Development of new products and value addition: this line includes projects aimed at expanding business portfolios and developing productive arrangements, both through the creation of new products and the addition of value.
c) Waste, by-products, co-products, and energy in the food industry: development of projects that transform food industry waste and residues into commercially valuable products, energy generation, and cost savings, thus achieving proper treatment with reduced environmental impact.
d) Food security and healthier food production: this will be one of the most important topics for the planet in this century, given the need for the agricultural sector to meet the ever-growing demand for food.
Embrapii provided support for the implementation of the Project *Biofuel Production from Sweet Potato – A Sustainable Alternative.* The project titled "*Biofuel Production from Sweet Potato – A Sustainable Alternative*", developed through a partnership between the Federal Institute of São Paulo – Barretos Campus, via the Research Group on the Development of Bio-inputs (GEPEDbio) led by Prof. Dr. Sérgio Vicente de Azevedo, and the company Fictor Lab, established an innovative collaboration to develop sustainable technologies for ethanol production from sweet potatoes. The initiative aims to create an efficient and environmentally sustainable process for ethanol production using this crop. The agreement, initially set for five years with the possibility of renewal, positions the campus as a key player in the search for alternatives to the traditional ethanol matrix.
Sweet potato has shown significant industrial potential, with applications not only in energy but also in the chemical, pharmaceutical, cosmetic, and food sectors.The main objective is to develop a process that encompasses the selection of the most suitable sweet potato varieties all the way through to the ethanol distillation stage.
The specific objectives include:
(i) selecting sweet potato cultivars with the highest bioenergy potential;
(ii) optimizing the hydrolysis, fermentation, and distillation stages;
(iii) characterizing the waste generated during the process; and
(iv) proposing viable alternatives for the use of these by-products, thereby adding value to the production system.
The methodology combines laboratory experimentation with field trials, ensuring the integration of theory and practice. The project began with a Technology Readiness Level (TRL) [6] between TRL 2 and TRL 3, and it is expected to reach TRL 4 or TRL 5 by its conclusion, representing the validation of the process in a relevant environment.
Additionally, the project includes technology transfer to small producers, contributing to the diversification of agricultural crops and income generation in rural communities. This extension component reinforces the commitment to local socioeconomic development, while also promoting the training of qualified human resources, involving faculty members, administrative staff, and students.
From an innovation perspective, the project proposes significant improvements to the ethanol production process from sweet potatoes, establishing technical parameters that may, in the future, enable the scalability of production in broader contexts.
The final product of the project consists of the full development of the technological process for ethanol production from sweet potatoes, as well as the identification of the most efficient varieties for this purpose. This approach reflects the transformative

potential of applied science, aligned with the principles of sustainability and the valorization of national agricultural production.

Figure 4: pH Measurement of Fermentation: Biofuel Production Process from Sweet Potatoes

Source: Project: Biofuel Production from Sweet Potato – A Sustainable Alternative, 2025.

Figure 5: Laboratory Setup for Ethanol Distillation Using a Fractional Distillation Column

Source: Project *Biofuel Production from Sweet Potato – A Sustainable Alternative, 2025.*

V. LESSONS LEARNED

The experience of the Federal Institute of São Paulo (IFSP) illustrates that inclusive and decentralised innovation ecosystems can be effectively implemented through structured methodologies and long-term stakeholder engagement. One key lesson is the importance of a clear, adaptable framework—such as the five-phase INNO-ECO model—which guides institutions in mapping stakeholders, co-designing initiatives, implementing and monitoring projects, and disseminating results. This model has proven effective across various domains, including digital inclusion, prison education, and renewable energy. The IFSP case highlights how applied research, combined with community engagement and interdisciplinary collaboration, can result in scalable and socially impactful outcomes that respond to regional and national priorities.

Another significant lesson is the value of cultivating multi-sector partnerships through a quadruple helix approach that integrates academic, industrial, governmental, and societal actors. Initiatives like INOVA, Integra, EMBRAPII, and EMBRACE demonstrate that innovation flourishes when educational institutions become hubs for co-creation and applied problem-solving. Moreover, case studies developed by the multi-campuses iniciatives show that student involvement and real-world application enhance educational outcomes and institutional relevance. The IFSP model affirms that innovation ecosystems grounded in critical pedagogical frameworks, strategic governance, and community responsiveness are essential for achieving sustainable development and inclusive educational transformation.

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IFES Innovation Ecosystem

Marcelo Queiroz Schimidt[1], Marize Lyra Silva Passos[1], Vanessa Battestin[1], Igor Carlos Pulini[1], Juliana Cristina dos Santos de Andrade[1]
[1]Federal Institute of Espírito Santo (Ifes)

Abstract

This article presents the role of the Federal Institute of Espírito Santo (Ifes) in its innovation ecosystem, focusing on the articulation between teaching, research, extension and the world of work within the scope of the international Embrace project. Based on institutional information and case studies, it describes Ifes's multi-campus structure, its offer of programs ranging from technical/vocational education to graduate studies, and the role of Cefor in distance education through the Open Courses Platform (MOOC), including its co-coordination of WP2 and the development of multilingual MOOCs. The functioning of the institutional innovation ecosystem is analyzed, involving units such as the Project Management Office, AGIFES, LEDS, incubators and technology services, highlighting the Innovation Hub and the Ideas Hub as structures that connect companies' demands to the Institute's academic and technological capabilities. Drawing on the "Polo–Vale Connection" and "Polo–Unimed Connection" events, the article shows how challenges from the industrial and health sectors were turned into Research, Development and Innovation (RDI) projects with the participation of different campuses, faculty members and students. It concludes that the model adopted makes it possible to articulate vocational training and applied research with real-world problems from the world of work.

Keywords: Innovation ecosystem; MOOCs; University–industry collaboration; Vocational education.

I. INSTITUTIONAL OVERVIEW

The Federal Institute of Espírito Santo (Ifes) is the result of the merger of four former federal educational institutions: the Federal Center for Technological Education of Espírito Santo (Cefetes), the Federal Agricultural School of Alegre, the Federal Agricultural School of Colatina, and the Federal Agricultural School of Santa Teresa. The history of these institutions spans more than a century, the oldest being Cefetes, founded in 1909, during the government of Nilo Peçanha, under the name Escola de Aprendizes Artífices do Espírito Santo [1].

The institution's mission is to promote excellent professional, scientific and technological education, integrating teaching, research and extension in order to build a more democratic, just and sustainable society. It seeks to offer high-quality training at different levels, from technical/vocational programs to graduate studies, as well as to contribute to local socioeconomic development through applied research and extension activities.

Ifes is a large institution in the state of Espírito Santo and currently has 23 campuses in operation, including the Center for Reference in Training and Distance Education (Cefor), in addition to three campuses under implementation, being present in all micro-regions of the state. The Institute also has an Innovation Hub, an Innovation City, and operates 49 distance education centers in Espírito Santo [1].

In terms of educational offerings, Ifes provides more than 55,000 places in 105 technical programs, 67 undergraduate programs, 54 lato sensu graduate programs, 13 master's programs and two doctoral programs, as well as several shorter courses, such as FIC (initial and continuing training) and MOOCs.

At Ifes, coordination of the Embrace project is carried out by Cefor, created in 2006 with the purpose of contributing to the advancement of distance education and educational technologies, promoting the training of qualified professionals and the development of a more inclusive and innovative society [1]. Cefor is also responsible for the Open Courses Platform (MOOC), which offers more than 100 free and open courses to society in various areas of knowledge, democratizing access to quality education and reaching, in 2025, more than 250,000 enrollments.

Within the Embrace project, Ifes took on the co-coordination of WP2 in partnership with Häme University of Applied Sciences (Hamk), due to its recognized expertise in offering MOOC courses. As a first action, Ifes hosted and organized the Kick-off event in August 2023 at Cefor, in Vitória, Espírito Santo. The meeting brought together 47 managers and professors from the seven partner institutions for a week of training and exchange of experiences that underpinned the implementation of the project. Between late 2023 and the first half of 2024, faculty members were organized into three groups with the aim of developing a trilogy of MOOCs. The construction of the MOOCs

was coordinated by the Ifes team, based on the institutional ADDIEM model [2], and the courses were published on the institution's Open Courses Platform. The collaborative work among professors from seven institutions, with different languages, time zones and methodologies, represented a major challenge but also an institutional advance. In addition to leading this action, Ifes adapted its platform to support multilingual courses. Thus, the three MOOCs began to be offered in Portuguese, English and Spanish, with certification in the respective languages. In May 2025, Ifes led another milestone action: the public launch of the MOOCs.

The Embrace project at Ifes also involves professionals from other campuses and units, among which the Innovation Hub stands out as a central element in the landscape of research, innovation and technological development. Its mission is to work on Research, Development and Innovation (RDI) projects, managing and executing projects that generate innovative solutions for society and the economy of Espírito Santo [1]. It operates as a mechanism for the relationship between Ifes and companies, facilitating technology transfer and the sharing of infrastructure. For this reason, the Innovation Hub at Ifes played a key role in WP4 of Embrace, which establishes the institution's relationship with the world of work.

II. DESCRIPTION OF THE INNOVATION ECOSYSTEM

The world of work plays a central role in Ifes's innovation ecosystem, acting simultaneously as a partner, point of reference, and privileged field of activity. Far from being limited to the traditional productive sector, it encompasses a broad set of actors—companies of different sizes, government agencies, industries, startups, third-sector organizations and communities—that both influence and are influenced by the actions developed by the institution [3]. It is on the basis of the demands, challenges and transformations present in these environments that Ifes guides a large part of its educational, scientific and technological initiatives.

The world of work thus operates as a continuous source of real problems to be investigated, professional settings for student placement, contexts for the application of research and environments for the co-creation of solutions. At the same time, these external actors benefit from Ifes's academic expertise, receiving scientific, technological and educational support that helps modernize processes, increase competitiveness and foster regional socioeconomic development. This is an intrinsically bidirectional relationship, sustained by ongoing exchanges of knowledge, experience and innovation.

It is in this context of interdependence that the Ifes innovation ecosystem, shown in Figure 1, is structured, grounded in the organic integration of teaching, research and extension. These three dimensions, pillars of vocational and technological education, also constitute the main institutional channels through which collaboration with the world of work is realized. Although they have distinct characteristics and dynamics, they operate in an interconnected manner, creating an environment that fosters high-quality training, the production of scientific and technological knowledge, and the provision of services that directly impact the region.

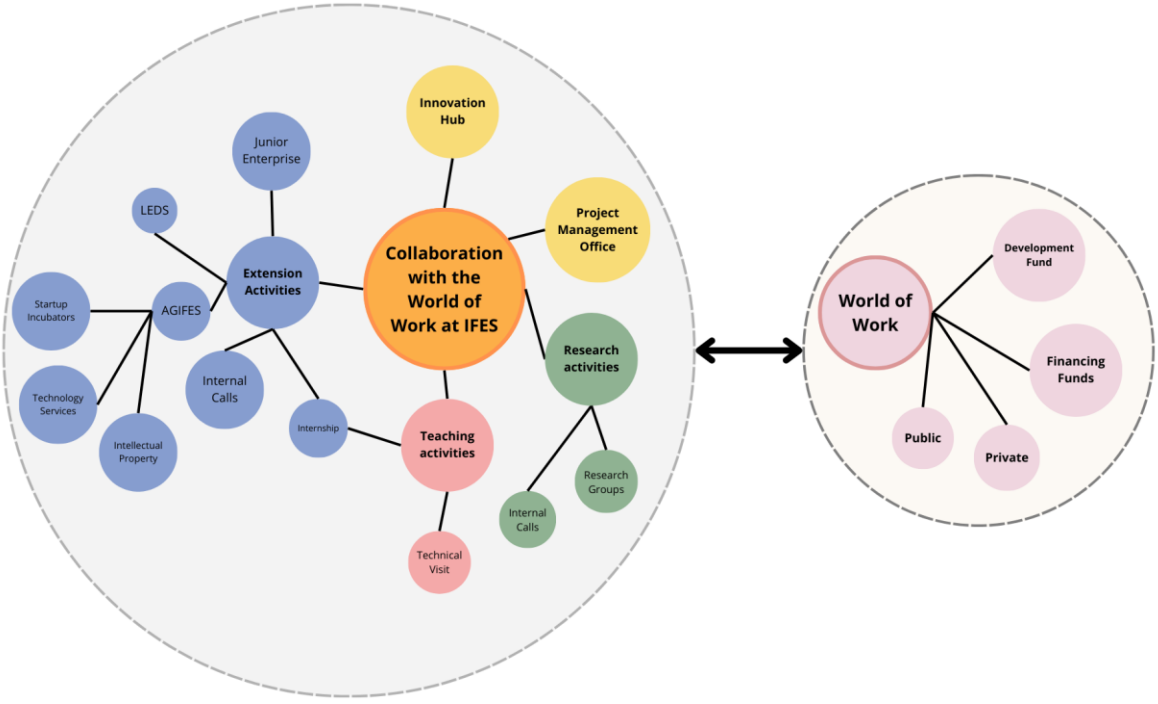

Figure 1. Ifes innovation ecosystem.

Teaching goes beyond the traditional classroom format and incorporates practices that bring students closer to real contexts of professional activity. Technical visits, carried out in companies, industries and public institutions, allow the direct observation of production processes, emerging technologies and work routines. Curricular and extracurricular internships place students within professional environments, offering practical experiences that dialogue with theoretical training and strengthen their understanding of the real challenges faced by organizations. The very dynamics of the programs, with integrative projects and diversified curricular practices, create situations in which students solve real problems, develop prototypes and work in teams, fostering the development of competences for innovation and entrepreneurship. Teaching, therefore, contributes to the ecosystem not only by training technically prepared professionals, but above all by forming agents capable of creating, analyzing and proposing solutions.

Research constitutes the second axis that feeds the innovation ecosystem. Research groups bring together faculty members, students and technical staff around strategic themes for scientific and technological development, producing new knowledge and sustaining long-term lines of investigation. This research environment is strengthened by internal funding calls, which support emerging initiatives and reinforce the continuity of studies. In this way, research articulates science, technology and real-world demands, generating applicable solutions and strengthening the Institute's innovative capacity.

Extension, in turn, represents the dimension of Ifes that reaches beyond the institution's walls, fostering continuous interaction with communities, companies, public organizations and social movements. Within this axis, Junior Enterprises function as spaces for entrepreneurial training, in which students carry out consultancy work and projects for real clients under faculty supervision. The Software Development Extension Laboratories (LEDS) broaden this interface by creating digital solutions for external demands, bringing students closer to contemporary technological challenges. The Innovation Agency of Ifes (AGIFES) brings together actions related to intellectual property, business incubation and technology services, acting as a specialized hub for technology transfer [4]. Through the incubators, entrepreneurial ideas are supported from their conception through to the structuring of business models. The technology services offered by Ifes—such as laboratory tests, analyses and consultancy—contribute to regional competitiveness, while the intellectual property office protects creations and ensures legal security for partnerships. Internal extension calls foster social, cultural and technological projects that address community demands and strengthen citizenship education. Internships are also recognized as an extension activity, as they place students directly in the world of work and create a permanent bridge between academic training and professional practice. In this way, extension consolidates Ifes as an institution that is present in the territories, contributing both to social development and to the economic dynamics of the state.

Although extension has traditionally been regarded as the main bridge between the institution and society, in the context of Ifes the ideal is that teaching, research and extension operate in an integrated way and in co-partnership with the world of work. This articulation broadens institutional impact, as it allows professional training to engage directly with real demands, research to produce knowledge guided by concrete problems, and extension to transform academic solutions into social, technological and economic benefits. When these three dimensions operate in a coordinated manner, the innovation ecosystem is strengthened, generating continuous feedback processes between Ifes and the various external actors—companies, governments, the productive sector, communities and social organizations.

In addition to the axes of teaching, research and extension, Ifes has institutional structures that, although not directly linked to these pillars, play a strategic role in supporting and expanding its activities in relation to the world of work. The **Project Management Office**, for example, is responsible for organizing, securing and managing resources, providing specialized support to researchers in building partnerships, preparing proposals and submitting projects to national and international funding agencies.

Among these support structures, the Ifes **Innovation Hub** stands out as the main institutional unit dedicated to applied research, technological development and innovation within the Federal Network. Formally integrated into the Institute's organizational structure and recognized as a relevant element of the National Innovation System, the Hub has the mission of meeting the demands of productive chains for Research, Development and Innovation (RDI) activities, professional training in technology-based sectors and the provision of high-complexity technology services. To fulfill this mission, it brings together expertise in applied technologies, develops innovative products and processes, and expands the institution's access to new market segments, operating in a continuous and coordinated way with the various Ifes campuses [4].

The scope of the Hub ranges from the development of technological solutions and prototypes to the provision of consultancy, technical advisory services and advanced laboratory services, responding to challenges arising from different economic and social sectors. By involving students in RDI projects and technical activities, this unit strengthens professional training at all levels, directly connecting teaching to the concrete needs of the territory. In addition, the Innovation Hub acts as a driver of the institution's innovation policies, promoting a culture of

technological innovation across all Ifes units and contributing to local, regional and national development. Thus, the Hub not only operates as a bridge between academia and industry, but is consolidated as a catalyst for the practices, strategies and policies that sustain the Institute's innovation ecosystem, enhancing its capacity to generate scientific, technological and social impact.

In this way, the Ifes innovation ecosystem is configured as an articulated, dynamic and responsive network, capable of integrating professional training, knowledge production and territorial impact. By promoting convergence between teaching, research, extension, strategic structures such as the Innovation Hub, and the multiple actors of the world of work, the Institute strengthens its institutional mission and positions itself as a key player in the scientific, technological and social development of Espírito Santo. This ecosystem not only sustains the quality of the education offered, but also generates innovative solutions that respond to real demands and expand the possibilities for transformation in the territory. It is within this articulated context that the initiative presented in the next section is situated, concretely illustrating the collaborative and innovative potential that characterizes Ifes's actions.

III. HUB OF IDEAS

The **Hub of Ideas** constitutes an intermediary arrangement within the Ifes innovation ecosystem, organizing the connection between real demands from the world of work and the institution's academic and technological capabilities. Its design is aligned with the Triple Helix model, in which universities, firms and government share functions in the production of knowledge and in driving innovation-based development, with particular emphasis on the role of educational institutions as articulating and entrepreneurial agents [8]. The literature on university–industry collaboration indicates that stable intermediary structures, with clear rules, standardized processes and a focus on problem solving, are decisive in overcoming barriers such as language asymmetry, distrust and unclear scope [9]. In this context, the Hub of Ideas becomes the institutional space responsible for organizing actions, reducing the dependence on ad hoc and individual initiatives.

The Hub's activities begin with the prospecting of challenges together with companies, conducted by the Innovation Hub, focusing on technological demands, production processes, digital transformation, sustainability and service improvement. This stage is aligned with the recommendations from studies on open innovation in the public sector and in science and technology institutions, which emphasize the role of specialized intermediaries in identifying and translating complex problems into structured opportunities for research, development and innovation [7]. Next, the mapped demands are brought into the dynamics of the "**Innovation City**", a space that brings together company representatives, professors and researchers from different campuses, research groups and students.

During the event, company representatives present their demands, while the Innovation Hub provides a work plan template that includes the definition of objectives, deliverables, indicators, timetable, and alignment with funding instruments and the institutional innovation policy. This framing is based on the idea that clear rules and contracts facilitate cooperation between university and industry. On this basis, groups of faculty and students choose one or more demands and prepare proposals aligned with Ifes's capabilities and the organizations' needs.

In the next stage, a round of table discussions is held: company representatives move between groups, assess the proposals, suggest adjustments and select those that will move forward for joint development. This type of meeting allows different actors to build solutions in successive stages, starting from already defined problems. As a result, the time between identifying challenges, formulating projects and formalizing partnerships is reduced, especially when the process involves public science and technology institutions embedded in regional innovation ecosystems.

Within the Ifes ecosystem, the Ideas Hub has three main roles. First, to maintain a continuous flow of prospecting, selecting and developing proposals with the productive sector. Second, to bring teaching, research and extension closer together by involving students in groups that work directly on company demands. Third, to reinforce Ifes's role as an ecosystem coordinator by providing a stable structure to organize interactions, reduce uncertainty and improve the technical quality of projects.

The analysis of the Ideas Hub is presented, in this context, through two case studies with Vale and Unimed. In these cases, the methodology made it possible to transform demands presented by the companies into RDI projects, involving different campuses, research groups and student profiles, with a clearer definition of scope, goals and results. These cases show that the model is effective in generating solutions aligned with organizational needs and in strengthening medium- and long-term ties. New cycles are already being prepared, including initiatives linked to the Vale Reserve, which indicates that the Ideas Hub is not an isolated action, but a permanent and active component of the Ifes innovation ecosystem, aimed at transforming challenges from the world of work into opportunities for technological development and professional training.

IV. CASE STUDIES: VALE AND UNIMED

In recent years, the Federal Institute of Espírito Santo (Ifes) has been consolidating a strategic role in strengthening Science, Technology and Innovation policies in Brazil, standing out for its capacity to foster consistent interactions between academia, the productive sector and society. The Ifes Innovation Hub plays a central role in this ecosystem by structuring an institutional model based on agility, multi-sector cooperation and a focus on the real demands of companies and public organizations.

In the context of the EMBRACE Project, especially within Work Package 4 (WP4), which deals with the development of collaboration models between education and the world of work, the actions carried out by the Hub put into practice the principles of collaboration, co-creation and joint construction of knowledge. The Conexão Polo–Vale 2025 and Conexão Polo–Unimed 2025 events constitute exemplary case studies of this model, demonstrating how participatory methodologies can generate real opportunities for applied research, active learning and institutional integration.

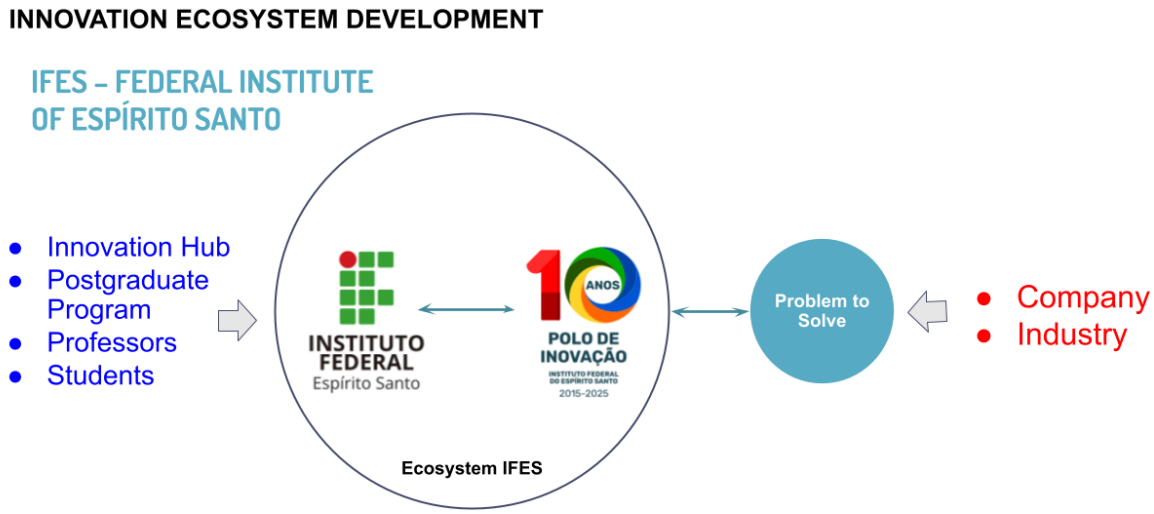

Figure 2. Innovation Ecosystem Development.

CASE STUDY 1 — POLO–VALE CONNECTION 2025

The Polo–Vale Connection 2025 event was conceived as a strategic initiative to bring Ifes closer to Vale, one of the largest mining and pelletizing companies in the world. The initiative was aligned with WP4 of EMBRACE, encouraging the mapping of real technological demands, the structured consultation of industrial experts and the formation of collaborative groups to generate proposals for applied research.

Figure 3. Polo–Vale connection 2025.

The event brought together 15 engineers from Vale, 32 professors from Ifes, 17 students, 3 representatives from AGIFES, 1 from FACTO, as well as 2 pro-rectors, 3 research directors and participants from 6 campuses. This diversity fostered a highly technical and collaborative environment.

The methodology drew on the Hub's prior prospecting experience and on EMBRACE principles: technical lectures, thematic round tables, guidance for drafting proposals, structured discussions in mixed groups and collective synthesis of opportunities.

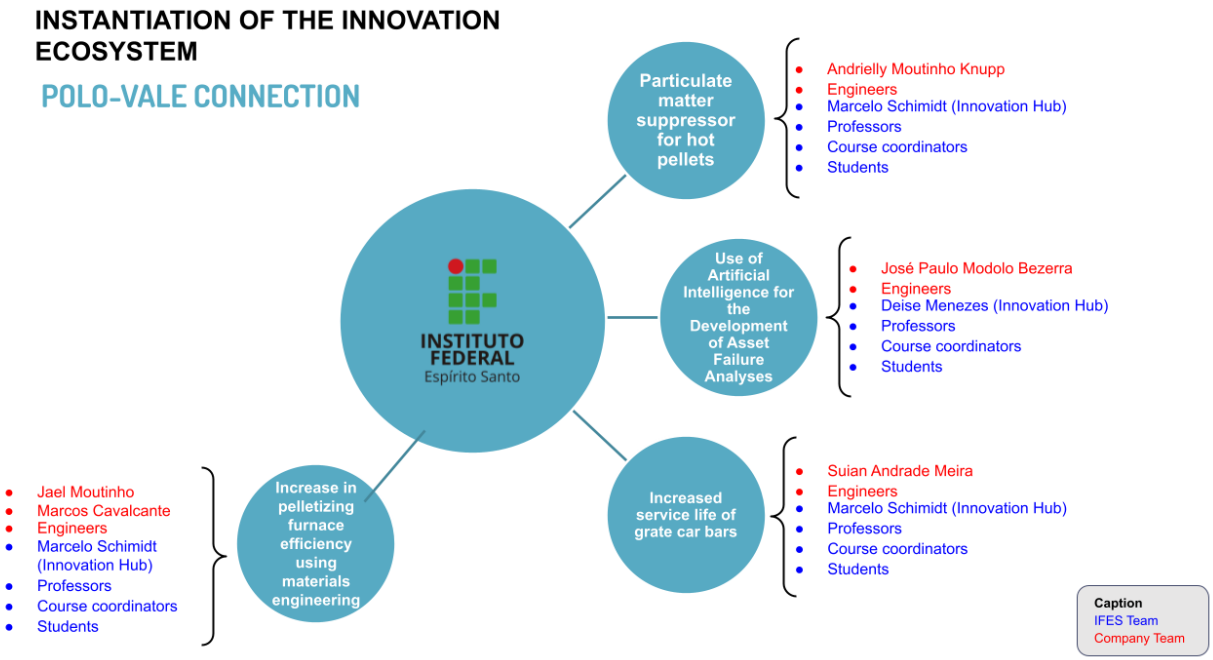

Figure 4. Instantiation of the innovation ecosystem.

In the end, three applied research projects were structured involving two Ifes campuses, including an inland campus geographically far from the company, which previously had no prospect of connection with it — thus expanding regional participation in large-scale initiatives with industry.

CASE STUDY 2 — POLO–UNIMED CONNECTION 2025

The Polo–Unimed Connection 2025 event expanded the model to the health sector, connecting lecturers, students and researchers from Ifes with managers and professionals in the healthcare area. The event had 23 participants, among them 6 Unimed staff members, 17 professors and 2 students from two campuses. Unimed Vitória is the main supplementary health insurance provider in Espírito Santo and one of the largest medical cooperatives in the Southeast Region. Founded in 1978, it has established itself as a benchmark in healthcare provision, bringing together hundreds of cooperative physicians and offering integrated services in health promotion, prevention, diagnosis and treatment.

Currently, Unimed Vitória is responsible for coverage of approximately 420,000 beneficiaries, positioning itself as the largest operator in the state in number of insured individuals. Its infrastructure includes its own hospitals, emergency care units, diagnostic centers and outpatient units strategically distributed, as well as robust health-care programs and continuous investments in expansion and technological modernization.

This structure makes Unimed Vitória a strategic partner for innovation and applied research initiatives such as those developed in cooperation with the Ifes Innovation Hub. The cooperative's participation in Conexão Polo–Unimed 2025 reinforces its commitment to digital transformation, optimization of clinical workflows and the incorporation of emerging technologies, contributing both to academic advancement and to the modernization of healthcare in the state.

Figure 5. Polo–Unimed connection 2025.

The dynamics included technical presentations on clinical workflows, the challenges of digital transformation, patient journeys and health data analysis. This was followed by activities for problem mapping, co-creation sessions and the initial proposal of research lines.

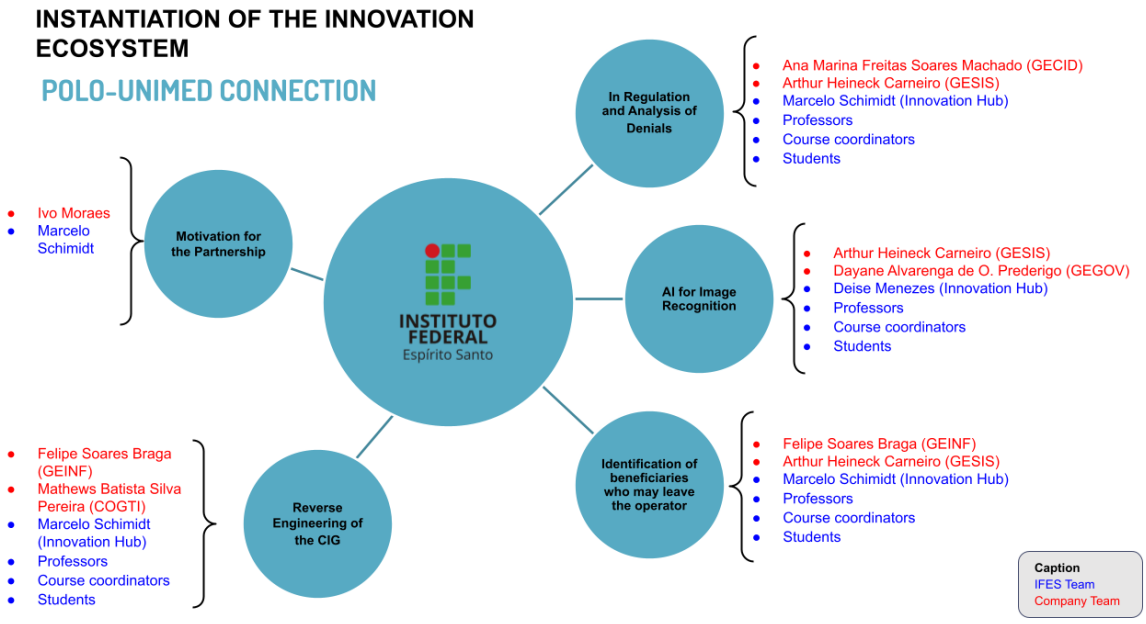

Figure 6. Instantiation of the innovation ecosystem.

As a result, two cooperation agreements were initiated, involving two Ifes campuses and addressing topics such as innovation in healthcare delivery, process digitalization and technological solutions applied to the health sector.

V. LESSONS LEARNED

The events revealed important lessons that strengthen the role of the Innovation Hub within the institutional ecosystem. One of the main points observed was the need for the Hub to assume, in a more systematic way, direct coordination with the students. Although professors maintain close contact with their students, invitations or encouragement for student participation in strategic events do not always take place. Thus, the Hub should act more intensively in dialogue with the campus Directorates, identifying courses and groups with greater potential interest in the themes brought by industry or external partners.

In this process, the possibility emerges of demonstrating how these connections can unfold into Final Course Projects (TCCs), integrative projects, scientific initiation programs, master's dissertations, and other academic activities linked to the students' educational paths, thereby strengthening the integration between theory and practice.

The importance of including incubated companies from the Ifes innovation ecosystem also became evident, as they often have solutions and competencies relevant to meeting the demands of industrial partners.

It was also observed that the time allocated to presenting Ifes's technological offerings — laboratories, research lines, research groups, and infrastructure — must be carefully planned, as well as the presentation of graduate programs, which showcase ongoing research and reinforce the institution's scientific maturity.

The experience likewise highlighted the need to establish a support team — permanent or temporary, but dedicated specifically to coordinating, around the event's theme, the interaction between interested researchers and the partner industry — formed by Ifes staff members capable of ensuring continuity of the actions initiated. This structure is essential to sustain post-event coordination, ensuring the administrative and technical continuity needed to transform isolated interactions into consolidated collaborations, conducting formalization processes, project follow-up, and ongoing communication with partners.

Finally, the relevance of including students from technical courses in these events was emphasized, keeping them up to date and inspired regarding professional opportunities related to industry demands. This direct contact helps them reflect on their trajectory and plan their education in a way that is more closely connected to the world of work.

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