From Skills to Applied Research Ecosystems:

Strengthening Competences for Productivity and Economic Growth

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International Models for VET-UAS-Embedded SME Innovation in Creative and Industrial Sectors

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Abstract:
In a context of accelerating technological change, green and digital transitions and intensifying global competition, the capacity of small and medium-sized enterprises (SMEs) to innovate depends increasingly on the quality of skills ecosystems and on the existence of institutional interfaces between education and applied research. While the European Union has articulated ambitious strategies in the fields of skills, innovation and SME support, implementation remains fragmented, especially in vocational education and training (VET) and universities of applied sciences (UAS). This paper analyses how different jurisdictions organise applied research within post-secondary institutions to support SME innovation, with particular attention to design-intensive and creative sectors.

The paper examines Europe's skills and innovation challenge in a global perspective, emphasising the gap between strong educational foundations and weaker mechanisms for translating skills into applied innovation, particularly for SMEs and design-intensive sectors. It analyses European experiences that illustrate both potential and limits: France's competitiveness clusters, which achieve scale and thematic coherence but only partial integration between education and innovation; and the Basque VET system, where applied research is embedded in institutional mandates and sustained through direct collaboration with SMEs. The paper then discusses the Canadian College Centres for Technology Transfer (CTTC) as a fully institutionalised model of VET-college-based applied research, supported by stable funding, strong governance and demonstrable SME impact. Finally, it reflects on an emerging Finnish initiative inspired by the CTTC model, using international benchmarking and national evidence to develop pilot centres embedded in VET and UAS institutions. The aim is to help SMEs adopt cutting-edge technological solutions in their production processes, while also upgrading teachers' skills in latest technologies to promote economic growth, employment and competitiveness.

Across these cases, a common insight emerges: Europe's core limitation is not a lack of strategic vision, but the absence of a systemic model that positions applied research as a permanent function of VET and UAS providers, supported by clear mandates, durable funding and networked governance. The paper therefore argues for a shift from project-dependent collaboration to institutional capacity-building, enabling VET-UAS embedded applied research ecosystems capable of supporting SMEs at scale and strengthening Europe's competitiveness in knowledge-intensive and creative sectors, i.e. a transferable institutional framework for VET–UAS embedded applied research centres in Europe.

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1 Introduction: Skills, Competence, and SMEs Growth in a Global Competitive Environment

The global competition for skills has intensified. In the EU, only about 54% of adults possess at least basic digital skills, and fewer than 5% are employed as ICT specialists (European Commission, 2023a). Meanwhile, the United States benefits from a digitally literate workforce supported by decentralized, innovation-friendly educational systems and labor markets (GTCI, 2023). China, on the other hand, continues to scale its vocational and tertiary education sectors, producing over four million STEM graduates annually (OECD, 2023).

Skills, innovation, and SME competitiveness are increasingly central to Europe's ability to thrive in a rapidly transforming global economy. With emerging technologies, sustainability transitions, and demographic shifts reshaping labor markets, advanced skills and innovation competences are no longer optional: they are prerequisites for competitiveness, resilience, and inclusive growth. In this landscape, the European Union (EU) faces a dual challenge: closing critical skill gaps and enabling small and medium-sized enterprises (SMEs) to scale innovation.

1.1 From Europe's Structural Strengths and Bottlenecks to Global Models

Europe's vocational education and training (VET) and university of applied sciences (UAS) systems are robust, but often vaguely connected to applied innovation pathways. Many SMEs—particularly in design, crafts, and creative sectors—struggle to access skills and tools needed for digital transformation and product lifecycle innovation. According to Eurofound (2023), SMEs account for over 99% of EU firms but frequently cite skills shortages as a barrier to growth. Fragmented support structures, limited access to venture capital, and regulatory burdens further compound their challenges (European Commission, 2024a).

Indeed, Europe's competitive edge lies in its quality of education, commitment to sustainability, and deep traditions of craftsmanship and design. Yet, it lacks mechanisms to turn these into scalable innovation outcomes. In design-led sectors such as furniture, fashion, digital content, and arts & crafts, the innovation potential is high—but unrealized due to weak links between VET, UAS, and SMEs. These industries require transversal competences: design thinking, digital prototyping, circular economy awareness, and entrepreneurial mindsets. Embedding these across the education-to-innovation continuum is essential for future resilience (Eurofound, 2023). In this direction education and training systems often fail to align with the sector's evolving needs—especially for practical innovation and sustainable production. In this respect, the United States has outpaced Europe by integrating design education with business incubation and digital capability-building (GTCI, 2023).

In fact, United States has cultivated a strong pipeline from educational institutions to innovation-driven firms. Its top universities act as startup incubators, while state-level workforce

development programs foster agility and responsiveness (OECD, 2023). The U.S. startup ecosystem benefits from access to over half the world's venture capital, enabling firms to scale quickly (European Commission, 2024a). This entrepreneurial environment rewards risk-taking and facilitates rapid deployment of innovation talent across sectors—from digital media to advanced manufacturing. On the otherside, China's approach is more centralized, but no less ambitious. Through strategies such as "Made in China 2025," the government has directed massive investments into upskilling, technological upgrading, and SME clustering (CSIS, 2020). While Chinese SMEs often operate under tight state influence, local innovation hubs provide incentives, training, and infrastructure—particularly in green technology, AI, and consumer electronics. Although, China has been lagging in fostering critical thinking and user-centered innovation as they are understood in Western countries. (WEF, 2018), recent analyses of China's national innovation system emphasize its dynamic evolution, structural strengths, and growing global competitiveness, suggesting that characterizations of China as simply "lagging" in innovation may overlook the systemic growth and complexity of its innovation ecosystem (Băzăvan, 2024)

Unlike the U.S. or China, Europe's strength lies in policy coherence and public investment. Yet, the scale and pace of transformation are not keeping up with global competitors. For example, the EU invests 2.3% of its GDP in R&D compared to 3.5% in the U.S. and 2.6% in China (OECD, 2023). Venture capital, meanwhile, remains fragmented—representing only 5% of global VC flows (European Commission, 2024a). Europe must therefore strengthen institutional capacity at the intersection of education, innovation, and enterprise.

The problem in Finland is that vocational education does not attract young people. Declining enrollment is due to a lack of interest and encouragement. If the schools were more dynamic towards businesses and teachers were equipped with the latest knowledge and skills, it would attract more students and then further increase teachers' motivation to update their own competencies.

This is particularly relevant in the creative economy, where knowledge and skills—not fixed capital—are the main drivers of value. These sectors contribute substantially to EU GDP and employment, and they concentrate distinctive capabilities in design, storytelling, cultural production and user-centred innovation. Yet education and training systems often fail to align with their evolving needs. Curricula remain weakly connected to real-world innovation processes, and institutional incentives for educators to engage in applied research with SMEs are limited. By contrast, in some non-European contexts design education is more systematically integrated with incubation, entrepreneurship and digital capability-building, creating denser interfaces between creative talent, technology and business development.

Nowadays, European policy frameworks acknowledge these tensions. The European Skills Agenda, the Pact for Skills, the Digital Europe Programme, the New European Innovation Agenda and SME-oriented instruments under cohesion policy all call for stronger regional skills ecosystems, more innovation-friendly VET-UAS systems and enhanced support for SME innovation. However, the implementation of these agendas is uneven. Investments in R&D remain below US and East Asian levels, venture capital markets are fragmented and the institutional role of VET and UAS in

innovation systems is still weakly defined. In many countries, these institutions are structurally confined to training functions, with applied research treated as a peripheral or experimental activity.

The central proposition of this paper is that addressing Europe's competitiveness gap requires moving beyond generic calls for "more skills" or "more innovation". The critical question is institutional: how can VET and UAS providers be configured as stable, mission-oriented applied research actors that work in close proximity with SMEs, particularly in creative and design-intensive sectors? To explore this question, the following chapters examine different institutional models that have attempted to bridge education and applied research for SME innovation, in Europe and beyond, and assess their relevance for European policy learning.

2 Applied Research Ecosystems: A Comparative Analysis of European and International Models

European responses to the skills–innovation–SME nexus have taken diverse institutional forms, shaped by national state traditions, regional autonomy and industrial structures. Two cases – French competitiveness clusters and the Basque VET system – offer contrasting but complementary perspectives on how applied research can be organised around or within education institutions.

2.1 Competitiveness clusters in France: Cluster-Based Innovation and the Integration of Education - *by Cécile Aillerie*

In France, several structures exist to foster RDI, but they are not aimed at the same stakeholders, whether they are companies (focusing on growth) or educational institutions (focus on skills).

The history of Competitiveness Clusters (Pôles de compétitivité in French) started in 2005, as part of the launch of a new industrial policy in France. Quite visionary at the time, this initiative was influenced by studies from the DATAR (Interministerial Delegation of Land Planning and Regional Attractiveness) and the report "For a Growth Ecosystem" ordered by the Prime Minister Jean-Pierre Raffarin in 2003. Nicolas Sarkozy, who was then Minister of the Interior and Regional Planning, said about Competitiveness Clusters that France had invented an organization mode that was unique, with a logic of clusters combined to a specific national implementation.

Competitiveness Clusters (CCs) are associations that rely on both public and private funding. They bring together companies of all sizes, research stakeholders, and training institutions within a defined geographical area and around a specific theme, in order to develop synergies and cooperation around a given sector of activity. These fields can be emerging/technological (drones, decarbonization, etc.) or more mature ones (automotive, aeronautics, etc.). The overarching goal of CCs is to support innovation in their regions. They also aim to support the development and growth of their member companies, particularly through the promotion and marketing of new products, services, or processes resulting from research projects. Today, 53 certified CCs are active in France, bringing together 2,500 research laboratories and higher education institutions and 20,000 innovative companies, of which 80% are SMEs. In 20 years, the results are significant: for every euro of public funding, 3 euros have been invested by the private sector in R&D. Thanks to CCs, 55 billion euros have been raised by companies (both public and private funding). These good results were made possible by close monitoring of the CCs' performance, and several strategic reorientations dictated by the government throughout 5 phases, the last one ending in 2026. In spite of these results, the French government is now slowly reducing its investments in CCs, due to global budget cuts. Now, in order not to lose their label, CCs must be able to generate at least 50% of their own revenues (mostly through companies memberships, paid services, EU funds).

Finally, CCs are sometimes included in a more recent initiative: the Professions and Qualifications Campus label (CMQ or Campus des Métiers et des Qualifications), launched in 2013 by the

government. These campuses bring together secondary and higher education institutions, offering initial and continuing training. They focus on sectors of economic excellence, supported by local authorities, businesses and clusters. Their main goal is to align skill provision to the companies' actual needs. The CMQ label is national and the accreditation process is interministerial but, after labels are granted, they are managed regionally, in the same way as CCs. Therefore we can see that, regardless of the focus (growth or skills), France has made the strategic choice to rely on existing regional strengths and develop them through structures and labels with a strong national impetus and control. Let's hope that these initiatives can persist and bear fruits even in times of budget cuts.

2.2 The Basque Country: Mission-Oriented Integration of VET and Applied RDI

The Basque Country represents one of Europe's most advanced examples of a mission-oriented approach to integrating VET systems with applied research and innovation. Unlike many European regions where VET operates primarily as a skills provider, the Basque model positions VET institutions as active agents in technological development, industrial upgrading, and regional competitiveness. This evolution is the result of long-term political commitment, strong regional autonomy, and deliberate policy design aimed at aligning education, innovation, and industrial strategies. The cornerstone of this architecture is TKNIKA, the Basque Centre for Research and Applied Innovation in VET. Established under the Basque VET Law, TKNIKA functions as both an institutional catalyst and an orchestrator of systemic innovation. Its mandate is explicitly threefold: stimulate technological and pedagogical innovation; build applied research capabilities within VET centres; and strengthen the connection between VET, firms, and regional development agencies. TKNIKA operates as an intermediary body, coordinating networks of VET centres and facilitating the diffusion of innovations across the system. It also acts as an interface with innovation agencies such as SPRI and with sectoral clusters, ensuring coherence with the region's smart specialisation priorities (RIS3 Euskadi).

A distinctive feature of the Basque model is the organisation of technological lines within VET centres. These lines correspond to key strategic domains—such as advanced manufacturing, robotics, energy systems, digitalisation, and biosciences—and provide the infrastructure for experimentation, prototyping, and technology testing. The operational heart of the Basque model is TKgune, a technology transfer and applied innovation network connecting VET centres directly with SMEs. TKgune enables firms—particularly small and medium-sized enterprises with limited internal R&D capabilities—to collaborate with VET centres on problem-driven projects. These projects may involve prototyping, materials testing, process optimisation, digital workflows, or the integration of new technologies.

Pedagogically, the Basque model has profound implications. The continuous participation of teachers in applied research activities generates a virtuous cycle of instructional renewal. Curricula evolve rapidly as technological developments are incorporated into training programmes, reducing the time lag—common in many European systems—between industrial innovation and educational adaptation. Students acquire not only technical competences but also transversal skills essential for innovation, such as problem-solving, project-based collaboration, and design thinking. As noted in multiple evaluations by the Basque Institute of Competitiveness, the alignment between technological change, teacher expertise, and student learning outcomes creates a synergistic

mechanism rarely achieved in other European VET systems. Institutionally, the Basque approach is grounded in a governance culture that emphasises collaboration, iterative learning, and long-term strategic continuity. Regional authorities consider VET a central pillar of economic policy rather than a separate subsystem. This has resulted in sustained investment in VET infrastructure, laboratories, teacher training, and innovation programmes. The coherence between VET policy and industrial policy—visible in joint planning processes, shared evaluation frameworks, and integrated funding streams—reinforces the capacity of the system to operate as a unified innovation actor: rather than merely enabling innovation, the system is designed to pursue explicit societal and economic missions, such as transforming the manufacturing base, accelerating digitalisation, promoting energy transition, and enhancing the competitiveness of SMEs. This mission-driven logic positions applied research in VET as a strategic instrument for territorial development rather than a technical add-on. Consequently, applied RDI activities conducted in VET institutions are not incidental nor opportunistic: they are embedded in long-term policy agendas and renewal cycles that transcend project-based funding.

2.4 Comparative Analysis Across Four Structural Dimensions

A comparative analysis of the French and Basque models reveals two distinct institutional logics underpinning the design of applied research ecosystems in VET and UAS contexts. These differences reflect divergent state traditions, industrial histories, governance cultures, and epistemologies of innovation. Drawing from the literature on national and regional innovation systems (Lundvall 2016; Edquist 2011; Navarro et al. 2013; Orkestra 2021) and from applied research studies in VET (ETF 2023; WFCP 2021), four structural dimensions emerge as analytically decisive: institutional mandate, governance architecture, funding and sustainability, and SME proximity.

2.4.1 Institutional Mandate: Alignment without Integration vs. Embedded Innovation

The institutional mandate assigned to educational institutions constitutes the foundational layer of any applied research ecosystem. In France, the mandate is bifurcated: Competitiveness Clusters (Pôles de Compétitivité) are tasked with innovation-oriented missions, while the Campus des Métiers et des Qualifications (CMQ) carry a skills-oriented mandate. The result is alignment without integration. Clusters coordinate RDI, support the emergence of technology niches, and mobilise firms and research centres around thematic priorities; however, VET institutions remain structurally peripheral to the production of innovation, participating mainly through training adaptation and occasional project collaborations. Applied research is not codified as part of their institutional purpose. The Basque model embodies an opposite logic. The VET Law positions applied research as a core institutional function, not an auxiliary activity. TKNIKA operates as the coordinating backbone, while VET centres are responsible for developing technological lines aligned with regional priorities. Innovation, skills development, and pedagogical transformation are not siloed mandates but mutually reinforcing missions. The institutional identity of Basque VET centres includes being sites of experimentation, technological problem-solving, and co-production of solutions with SMEs. This “embedded innovation mandate” radically alters the role of teachers (now innovation agents), of curricula (continuously renewed), and of students (co-producers of RDI outputs).

2.4.2 Governance Architecture: Hierarchical Coordination vs. Distributed Mission-Oriented Networks

Governance determines how actors coordinate, how decisions are made, and how knowledge flows across the system. The French model is historically rooted in centralised, hierarchical coordination, a legacy of the state's role in industrial planning. Clusters are nationally accredited, regularly evaluated, and operate under strong ministerial influence. Their thematic specialisation—decided at national level—drives regional alignment. CMQs, although managed at regional level, operate within a national labelling framework. This architecture supports coherence and scale but reinforces verticality: educational institutions plug into innovation ecosystems through structured partnerships rather than shared missions. The Basque governance architecture is better understood as a distributed network, characterised by lateral coordination, mutual learning, and institutional interdependence. TKNIKA is not a command centre but an orchestrator of innovation processes: it facilitates, connects, and amplifies. Decision-making is multi-actor, involving regional ministries, VET centres, innovation agencies, and SMEs. Knowledge flows horizontally across VET centres, and vertically between centres and firms. This governance style is closer to what innovation system theorists call a "learning region" (Asheim 2012), in which institutions evolve together through cumulative, iterative interaction.

2.4.3 Funding and Sustainability: Episodic Opportunity vs. Mission-Driven Stability

Funding architectures reflect political priorities and shape long-term institutional behaviour. France's clusters experienced substantial public investment in their first decade, catalysing private R&D and European project participation. However, recent downward pressure on national budgets has altered the landscape. Clusters must now secure at least 50% of revenue through self-financing—memberships, services, EU projects—creating financial stress and incentivising short-termism. CMQs face an even sharper constraint: their funding remains anchored in education budgets, with limited dedicated resources for applied RDI. Innovation activities often depend on external calls (ERDF, Horizon Europe) rather than stable, mission-aligned funding. In contrast, the Basque model benefits from mission-driven and structurally aligned funding streams. Since applied research is part of VET's legal mandate, investment in RDI is not discretionary. Funding for technological lines, teacher innovation time, and SME collaboration is embedded in the regional VET budget and aligned with smart specialisation strategies (RIS3 Euskadi). The system is therefore less dependent on the volatility of project-based financing and more resilient to political cycles. Its vulnerability is different: scalability. Sustaining innovation-intensive activities across many centres requires continuous investment, political stability, and institutional commitment over decades.

2.4.4 Proximity to SMEs: Ecosystemic Density vs. Direct Co-Production

Proximity to SMEs is the operational heart of applied research. Without sustained interaction, educational institutions cannot act as innovation intermediaries. French clusters exhibit extraordinary ecosystemic density: thousands of firms, research labs, and intermediary organisations interact through structured cluster platforms. This density, however, does not automatically translate into direct cooperation between SMEs and VET institutions. While clusters facilitate innovation projects, technological roadmaps, and R&D partnerships, VET centres typically sit at the outskirts of these processes. When collaboration occurs, it is mediated by the cluster rather than by direct

educational-industrial engagement. The result is a system where SMEs are close to clusters but not necessarily close to VET. The Basque system operates with inverse characteristics. Proximity is not ecosystemic but relational and operational. Through TKgune, SMEs work directly with VET centres on technological challenges, prototyping, process optimisation, and testing. Teachers and students operate as co-producers of solutions. This relational proximity strengthens trust, accelerates technology diffusion, and increases SMEs' absorptive capacity (Zubizarreta et al. 2019). While the ecosystem is smaller, the intensity and frequency of interaction are significantly higher.

2.5 Positioning Europe in a Global Context

The comparative analysis developed in this chapter reveals that Europe already possesses some of the institutional ingredients necessary to build robust applied research ecosystems within VET and UAS systems. International ecosystems—most notably in Canada, but also in the United States and China—exhibit a higher degree of institutional consolidation, where applied research in colleges is not an experimental add-on but a fully institutionalised subsystem. These systems benefit from legally defined mandates, sustained multi-source financing, standardised performance frameworks, and embedded collaboration mechanisms between education, SMEs, and research actors. Their effectiveness derives not from exceptional programmes or regional strengths, but from the normalisation of applied research as a structural function of post-secondary education. Whereas European VET-UAS systems have historically been defined through pedagogical and labour-market functions, extra-European models have progressively expanded the institutional identity of colleges to include RDI, industry services, prototyping, and innovation support. For these reasons, the next chapter turns to the Canadian College Centres for Technology Transfer (CTTC): one of the few international models where the integration of applied research within colleges has reached a level of institutionalisation, maturity, and policy coherence that makes it uniquely relevant for European policy learning. The CTTC system does not replace the findings emerging from the French or Basque cases; instead, it provides a reference framework for understanding how the fragmented strengths observed in Europe might be assembled into a fully coherent institutional model.

3 The Canadian Model: Integrating Applied Research into VET in Canada

3.1 Origins and Evolution of the CTTC Model

Canada's Centres collégiaux de transfert de technologie (CTTC) represents a mature model of applied research embedded within vocational and technical education. The concept took root in Quebec in the early 1980s as an initiative to bolster innovation in local industries via colleges. One of the first CTTCs, Inovem, was established in 1983 at Cégep de Victoriaville, focusing on wood and furniture industries. Over the ensuing decades, the network expanded significantly. Today Quebec alone counts 59 CTTCs, each specialising in a specific technological or social innovation domain. Crucially, CTTCs have been formally institutionalized by law – they are accredited under Quebec's CEGEP Act – which grants them a clear mandate to conduct applied research, technical assistance, information dissemination, and training in support of innovation. This legislative anchoring has been instrumental in entrenching applied R&D as a core function of the college (CEGEP) system, ensuring the model's stability and longevity as an integral part of the vocational education and training (VET) landscape.

While CTTCs are often described as applied research centres, their defining function is technology transfer: structured technical assistance and prototyping that enables SMEs to renew production processes, adopt technologies, and improve productivity. The "research" component is instrumental to this transfer mission, not an end in itself. From a handful of pioneering centers in the 1980s, the CTTC model has grown into a province-wide innovation network. The scope of specializations now spans nine broad fields, from advanced manufacturing, digital technologies, and advanced materials to life sciences, sustainable development, and even social innovation domains. This breadth allows the network to serve a highly diversified set of industries and community needs, reflecting the evolving economic priorities of Quebec and Canada. The expansion was driven by demonstrated success in bridging college expertise with industry needs, leading to periodic accreditation of new centers. The number of CTTCs has steadily increased in response to regional innovation gaps ("Evolution of the Number of CTTCs" is often highlighted in network presentations), showing the model's adaptability over time. By 2025, all regions of Quebec are covered by at least one CTTC, indicating a truly territorial reach of this VET-embedded research infrastructure. Such growth underscores how the CTTC concept evolved from a few experimental centers into a fully institutionalized system for applied research, now viewed as a cornerstone of Canada's college sector innovation strategy.

3.2 Structural Features and Governance

Each CTTC is affiliated with a public college (CEGEP), ensuring a strong link between the center's activities and the educational institution. Two governance models coexist within the network: about half of the CTTCs are integrated units of their host college, functioning as college departments with shared services and direct oversight by the college administration; the others operate as independent non-profit organizations legally separate from the college, with their own boards of directors comprising external stakeholders. Regardless of the model, all CTTCs maintain tight

institutional anchoring to their college, which grants credibility and facilitates access to facilities, faculty, and students. In both cases, the provincial Ministry of Higher Education formally accredits the centers and signs renewable five-year performance agreements to define expectations and accountability. Centers undergo comprehensive evaluations every five years to renew their accreditation, ensuring they continue to meet their innovation and education mandates. This governance framework balances autonomy and accountability: CTTCs have the agility to act entrepreneurially in research collaborations, yet they remain aligned with public education goals through ministry oversight.

At the network level, Quebec's CTTCs are federated under an association known as Synchronex (Réseau des CTTC). Synchronex plays a crucial role in governance and capacity-building across the system. It represents the collective interests of CTTCs to government and industry (advocacy), facilitates inter-center collaboration and knowledge exchange (networking and training), and promotes the centers' services. All CTTCs contribute a portion of their budget (approximately $18,000 per year each) to fund the network's operations. This modest levy supports shared resources, joint initiatives, and a unified voice for the network. The result is a highly coordinated model in which individual centers benefit from belonging to a larger ecosystem, avoiding silos. The network structure also enables common standards and practices – for example, peer exchanges on project management, dissemination of best practices, and collective metrics for impact – further institutionalizing the model's operational logic.

Another distinctive feature of CTTC governance is its dual mission, targeting both industry impact and educational enrichment. As formally stated in their mandate, every CTTC is expected to "facilitate and accelerate innovation projects in user organizations (companies, communities) while also enriching teaching and aligning training with workforce needs". This dual mandate is reflected in governance: CTTCs typically have advisory committees or boards that include industry representatives as well as college leaders, ensuring alignment with market needs and academic programs. The Ministry of Economy and Innovation often supports the industry-facing mission, while the Ministry of Higher Education supports the pedagogical mission – a governance symmetry that reinforces CTTCs' bridging role. In practice, this means CTTCs not only answer to their college administration but also engage closely with local economic development stakeholders. Such integrated governance has made the CTTCs effective "boundary spanners" between education and industry, an attribute that is often lacking in European VET research initiatives. The clear governmental recognition and structured oversight of CTTCs stand in contrast to more ad-hoc or project-based approaches, providing a stable institutional backbone for applied research in the college sector.

3.3 Funding Structures and Operational Logic

The financial model of CTTCs combines core public funding with a high degree of self-financing, aligning incentives for industry collaboration. Each center receives an annual base grant from the Quebec Ministry of Higher Education – roughly on the order of $300k–$350k per year for technology-focused centers, and a smaller base (around $80k–$100k) for centers in social innovation domains. These core funds cover a portion of salaries and operating costs, providing a stable

foundation and signaling government commitment. However, base funding constitutes only about 13% of the CTTCs' total revenues on average. This means the vast majority (nearly 87%) of each center's funding is externally earned through projects, service contracts, and competitive grants. Remarkably, few research organizations achieve such a high leverage of public funds, especially while serving mainly SMEs that often could not engage in R&D without this support. In fact, an evaluation by KPMG found that each dollar of public operating funding for CTTCs generates about $4.30 in applied R&D projects – an impressive leverage effect of over 4:1. The significance of this leverage lies not only in financial efficiency, but in institutional orientation: core public funding enables risk-taking and experimentation, while externally earned revenues keep CTTCs tightly aligned with SMEs' productivity, modernization and competitiveness needs. This sustainable funding model incentivizes performance and industry relevance: CTTCs must remain agile and entrepreneurial to secure project revenues, yet their modest guaranteed funding ensures continuity and risk-taking capacity.

Operationally, how do CTTCs generate income and value? Their day-to-day work consists of R&D and innovation projects carried out in partnership with external organizations (primarily companies). These projects take various forms: contract research fully paid by a private client, collaborative applied research co-funded by government grants and industry, technical assistance or consulting mandates, training services, and even prototype development or testing services. CTTCs thus function akin to innovation intermediaries or applied R&D labs embedded in colleges. They maintain specialized equipment and expert staff (collectively over 2,300 scientists and technologists across the network) to meet industry needs in their niche. Notably, CTTCs serve on the front lines for SME innovation. Each year, they assist roughly 6,000 client organizations, of which about 60–70% are small and medium-sized enterprises (SMEs). Through more than 13,000 applied projects annually, the centers help firms design or improve products, develop and test new processes, adopt emerging technologies, and solve technical problems. Companies benefit from accessible, unbiased expertise and state-of-the-art facilities that would be prohibitively expensive to develop in-house. CTTCs often possess unique equipment (some centers host one-of-a-kind research infrastructure in Canada) and highly specialized know-how, which they make available to local businesses to spur innovation. This arrangement significantly lowers the barriers for SMEs to engage in R&D – they can partner with a CTTC at modest cost and risk, leveraging public grants and the center's expertise, rather than undertaking expensive research alone.

A cornerstone of the CTTC operational logic is its supportive approach to intellectual property (IP) and commercialisation. Unlike university tech transfer offices that may focus on patents and licensing revenue, CTTCs primarily aim to transfer knowledge and innovation into the hands of the client firms for economic impact. In general, any IP arising from a CTTC-industry collaboration is assigned to the industry partner best positioned to commercialize it. Many projects use non-disclosure and trade secret arrangements rather than formal patents, ensuring the company can swiftly exploit the innovation in the marketplace. This IP policy lowers potential collaboration friction for SMEs – they know that working with a CTTC will not lead to complex IP disputes or claims on their future profits. At the same time, when breakthrough technologies with no immediate taker emerge (including social innovations), the network has expressed an interest in mechanisms to help further "mature" such innovations to market (since CTTCs themselves typically do not spin off companies). Overall, the

operational ethos is service-oriented: success is measured less by owning IP or publishing papers, and more by industrial uptake and tangible improvements in clients' competitiveness.

The funding landscape for CTTC projects is diverse, combining provincial and federal innovation programs. Provincially, centers tap programs from ministries such as the Ministry of Economy, Innovation and Energy (e.g. support for sectoral research clusters) and the Ministry of Higher Education (e.g. a dedicated program for technological and social innovation research in colleges). Quebec's three research granting funds (for science, culture, and health) also offer college-level applied research grants on a competitive basis. Federally, CTTCs benefit greatly from the College and Community Innovation (CCI) Program administered by NSERC and other agencies, which between 2008 and 2019 invested over $553 million in 3,158 college research projects across Canada. This includes Innovation Enhancement grants and Technology Access Centre grants that often fund CTTC activities. The CTTCs likewise partner with the National Research Council's IRAP program to deliver innovation support to SMEs – a special IRAP envelope for Quebec's CTTCs (about $500k annually) is typically exhausted within 8 months due to high demand. Capital funding for advanced equipment is another critical piece: the Canadian Foundation for Innovation (CFI) has a dedicated College-Industry fund that, while competitive, has allowed many CTTCs to acquire cutting-edge instruments (though the network has argued for higher CFI grant maxima to meet growing needs). Thus, the CTTC model is underpinned by a web of funding programs that together sustain its operations – core provincial funding for baseline capacity, plus multi-source project funding that encourages centers to continuously engage industry and deliver results. The outcome is a financially resilient system where applied R&D is not an occasional activity but a permanent, institutionalized function of colleges, with stable public backing and market-driven revenues reinforcing each other.

3.4 Impact on SMEs and Educational Integration

Over four decades, the CTTCs have accumulated an extensive track record of economic and educational impacts. For industry partners – especially SMEs – the model's value proposition is clearly reflected in outcome metrics. In the most recent year reported (2022–2023), the CTTC network collectively supported thousands of innovation projects which yielded concrete results: 905 new or improved products, 394 new or optimized processes, and 308 patent applications or invention disclosures were attributable to CTTC collaborations, alongside the creation of an estimated 382 new jobs within client firms. An even larger impact is seen in firms' growth and productivity. According to a survey by Quebec authorities, a large share of CTTC client businesses credit the services received with increased productivity and reduced production costs, leading to outcomes like higher sales, new market expansion (including exports), and job creation at the firm level. A comprehensive economic analysis by KPMG-SECOR quantified these benefits: it found that CTTC interventions helped client firms realize an annual increase of roughly $1.3 billion in value-added to the Quebec economy, sustaining over 10,000 jobs each year that otherwise might not exist. This value-added comes not only from new sales generated by innovation, but also from cost savings and productivity gains that strengthen the firms' competitive position. The same study highlighted that CTTC activity has a significant multiplier effect; direct project outcomes (e.g. new hires at a client company) produce indirect ripple effects in supply chains, contributing additional jobs and GDP growth regionally. In sum, the CTTC model has proven to be a powerful engine for SME

innovation and regional economic development, bridging the gap that often exists between small businesses and R&D resources. By providing SMEs with affordable access to expertise, advanced labs, and innovation mentoring, CTTCs help overcome the resource constraints that typically limit innovation in smaller firms. This is particularly important in a context like Quebec's, where improving lagging productivity has been a long-standing challenge – the CTTCs directly tackle this by injecting new technology and processes into firms, thereby boosting productivity and competitiveness.

Equally important are the educational and skills-development impacts of the CTTC system, which reinforce the broader VET-UAS mission. Because the centers are embedded in colleges, they create rich opportunities for students and faculty to engage in applied research. Each year, an estimated 18,000 students benefit from CTTC-related activities – ranging from attending workshops and seminars, to using new equipment in their courses, to participating directly in research projects. Notably, around 900 students per year actively take part in CTTC projects (as research assistants, technicians, or interns), gaining hands-on experience in innovation. This involvement has a twofold benefit: it provides companies with extra talent and fresh ideas, while giving students practical skills and an innovation mindset that make them more work-ready. It is important to clarify roles within the CTTC model. Applied research and technology transfer activities are led by dedicated CTTC staff, including scientists, engineers and technologists appointed specifically for this function. Vocational teachers and college staff do not replace this expertise; rather, they participate as assistants, learners and educational interfaces, supporting projects while updating their own technical skills through exposure to real-world innovation processes. Colleges report that CTTC projects have enriched teaching content and methods – faculty integrate real-world case studies and emerging technologies from CTTC work into the curriculum. The presence of a research center on campus also tends to spark student interest in STEM and entrepreneurship, as they see tangible examples of innovation and often interact with industry professionals. Furthermore, the CTTCs act as a conduit for updating faculty skills: college instructors who collaborate with CTTCs get exposure to cutting-edge developments in their field, which can flow back into teaching. The overall result is an improved alignment between training and labor market needs, one of the explicit goals of the model. By working on industry projects, students acquire the exact technical competencies and problem-solving abilities that local employers are seeking, thereby easing the school-to-work transition.

This assisted participation is not incidental. Over time, involvement in CTTC projects contributes to raising the competence baseline of VET-UAS staff, strengthening their capacity to understand industrial innovation cycles, emerging technologies and applied problem-solving. While not transforming teachers into researchers, the model enables vocational institutions to progressively enhance their contribution to SME innovation and skills formation.

From a system perspective, the integration of CTTCs in education yields broader societal returns. Higher college graduate productivity and employment (attributable partly to the applied learning via CTTCs) contribute to the economy and tax base. For instance, an analysis found that the combined activities of colleges and CTTCs generated over $2.0 billion in value-added in Quebec in one year, supporting more than 27,000 jobs (direct and indirect) when accounting for both educational and innovation impacts. This indicates that applied research in colleges amplifies the traditional

economic contributions of education by adding innovation-driven growth on top of human capital development. The government's returns on investing in the college sector are thus magnified: not only do college graduates pay higher taxes and reduce social costs (a known benefit of education), but the CTTC-facilitated innovation in industry produces additional fiscal revenues (hundreds of millions of dollars annually in extra tax receipts). In qualitative terms, the CTTCs also strengthen regional innovation ecosystems by networking colleges with universities, firms, and other actors. Many CTTCs collaborate with university researchers and participate in joint projects or industry clusters, which helps integrate SMEs into broader innovation networks – a key factor for sustaining regional economic competitiveness. This collaborative approach has made CTTCs catalysts in their communities, often spearheading local innovation initiatives and disseminating new practices among groups of firms. Overall, the Canadian CTTC model demonstrates that applied research can be successfully woven into the fabric of vocational education, yielding synergistic benefits: companies get accessible innovation support, students get better training, and regions gain economic resilience.

3.5 Relevance for Europe

The Canadian CTTC model offers valuable insights for Europe, especially in light of the challenges discussed in Chapter 2 regarding applied research in European VET-UAS systems. A recurring issue in Europe has been the lack of institutionalized mechanisms in VET-UAS to conduct R&D and transfer technology to SMEs. Often, applied research in these educational institutes is project-based, peripheral, or dependent on time-limited EU initiatives, leading to fragmentation and sustainability problems. A key lesson for Europe concerns staffing and role differentiation. The CTTC model relies on permanent, specialised technology transfer teams embedded in colleges. Expecting regular VET-UAS teaching staff to deliver applied R&D without dedicated profiles would likely undermine both quality and credibility. Policy transfer should therefore focus on institutionalising specialised innovation units within VET and UAS structures, while using project participation as a structured pathway for teacher upskilling. By contrast, the CTTC model illustrates a fully institutional strategy: clear mandates enshrined in law, permanent funding streams, and dedicated research centers attached to colleges. This addresses governance and funding gaps by assigning responsibility for innovation support to specific college entities and backing them with long-term resources. European VET-UAS institutions seeking to play a bigger role in regional innovation can learn from the CTTC governance structure – notably, the strong government endorsement and the dual mission approach. The CTTCs show how aligning objectives of economic innovation and skills training under one roof can create a win-win for both companies and learners. Importantly, the model demonstrates the efficacy of targeted base funding to initiate applied R&D capacity at colleges, combined with competitive project funding to stimulate demand-driven activity. European policymakers might consider similar multi-tier funding: a core grant to vocational colleges for R&D personnel and equipment, augmented by innovation vouchers or collaborative R&D programs that bring in industry co-funding, mirroring Canada's CCI program and provincial support.

Another relevant aspect is the emphasis on SME support mechanisms. CTTCs are explicitly designed to serve SMEs, from their IP policies to their outreach methods, which helps overcome SMEs' reluctance to engage with external research. Europe's SMEs often struggle to absorb advanced knowledge from universities; an intermediary like CTTC embedded in local colleges could bridge this

gap, as shown by Quebec's success in reaching thousands of small firms annually. The model's focus on agility and applied problem-solving (versus fundamental research) is well-suited to SME innovation needs. Additionally, the CTTCs highlight the benefit of having a networked approach: a central network (Synchronex) coordinating multiple centers provides unified branding and one-stop access for industry to find the expertise they need. It suggests that European VET-UAS systems could increase impact by fostering consortia of college-based innovation centers that share best practices and collectively interface with government and industry.

This sets the stage for the next chapter, which will delve into Finland's recent efforts to pilot a CTTC-inspired approach. Finland's experimentation will shed light on how key elements of the Canadian model can be translated into a European context, and what adjustments are needed to fit different educational and innovation ecosystems. Through this exploration, we move from studying a proven North American model to assessing its adaptability and potential impact in Europe – a critical step in informing future policy and collaboration in applied research within VET-UAS systems.

4 The Finnish Case Study

4.1 International Benchmarking as a Catalyst for Systemic Reflection

The origins of Finland's recent initiative to strengthen collaboration between vocational education and training (VET), universities of applied sciences (UAS) and small and medium-sized enterprises (SMEs) lie in a concrete and practical experience. In autumn 2024, the Erasmus + Centres of Vocational Excellence (CoVE) funded MOSAIC project consortium undertook a study visit to Canada and observed an institutional model in which applied innovation centres embedded within educational institutions provided SMEs with rapid, low-threshold support for product development, testing and technical problem-solving. The agility and accessibility of these centres stood in contrast to the more fragmented arrangements common in Europe and immediately raised questions about potential relevance for Finnish – and more broadly European – contexts. For Finnish entrepreneur Ola Kukkasniemi, the model's value was evident. Although Finland possesses strong educational institutions and advanced facilities, the mechanisms needed to convert these assets into practical support for SMEs are often slow, discontinuous or administratively burdensome. Also, the teaching of technological skills does not meet the fast developing needs of companies or the industries in general. Daily challenges familiar to many firms – accessing prototyping tools, obtaining testing services, or solving technical issues – proved difficult to address through existing structures. The Canadian experience therefore highlighted what Kukkasniemi perceived as a structural gap within Finland's innovation landscape.

4.2 Entrepreneurial and Policy Imperatives for Structural Reform

During his return journey, Kukkasniemi discussed these observations with Dr. Elina Pylkkänen, Under-Secretary of State at the Ministry of Economic Affairs and Employment (MEAE). Their exchange brought into focus two complementary perspectives. From an entrepreneurial standpoint, Finland requires more responsive and practice-oriented mechanisms to support SME development. From a public policy perspective, Finland faces long-standing challenges: slow productivity growth, labour market pressures and uneven regional innovation capacity. The observations from Canada thus resonated not only as an operational idea but as a potential response to a wider economic challenge.

This alignment was not uniquely Finnish. The issues revealed by the exchange reflected structural concerns identified across Europe. EU-level frameworks, including the EU SME Strategy, the European Skills Agenda, the Pact for Skills, and the New European Innovation Agenda, highlight that SMEs frequently lack access to applied research, technical services and skills development pathways. Crucially, this gap is reinforced by the current configuration of RDI funding systems, which tend to be designed around the capacities of larger firms. As a result, RDI instruments are predominantly accessed by companies that already possess the financial resources, administrative structures and internal competences required to apply for and manage complex funding schemes, leaving small businesses without a functional and continuous support system for applied research and innovation. Additionally, RDI instruments are mainly used by larger companies who possess the resources, skills and competences to apply funding. These constraints hinder Europe's capacity to advance the green

and digital transition. In this sense, the Canadian model arrived at a moment when the EU was calling for more innovation-friendly VET-UAS systems, more integrated regional skills ecosystems, and stronger institutional cooperation. Recognising this broader relevance, MEAE encouraged deeper national exploration. Early consultations with Finnish VET and UAS leaders revealed both strong interest and a clear need for a nimble process. To avoid the inertia typical of large stakeholder structures, the coordinating actors adopted a small, agile steering arrangement. This enabled rapid iteration while remaining consistent with EU guidance on flexible and innovation-supportive governance.

4.3 Alignment with EU Strategic Frameworks and Policy Priorities

In spring 2025, MEAE and the coordinating team assembled a multisectoral expert delegation to carry out a more detailed study mission. Representatives came from ministries, universities of applied sciences, VET providers, employer organisations and regional authorities - a composition well aligned with the regional skills partnership approach promoted under the Pact for Skills. Their work was supported by an analytical report documenting the Canadian experience and its potential implications for Finland (Kukkasniemi, 2025).

Following the mission, a series of structured reflection sessions examined the feasibility of adapting the model. Several systemic constraints became clear. First, cooperation between SMEs and education institutions in Finland relies heavily on short-term project funding, limiting continuity and making long-term partnerships difficult to sustain. Second, although many VET and UAS institutions possess strong internal capabilities, collaboration across institutional and regional boundaries remains fragmented and lack of coherence prevents the full realization of the benefits of development investments in the long term. Third, the operating conditions of teachers and lecturers seldom allow them to participate systematically in applied development work. Fourth, equipment investments made by educational institutions are far too underutilized. Fifth, some fields of study fail to attract enough applicants. Sixth, teachers lack systematic familiarization with the latest technologies and upgrading their skills.

In the case of VET-UAS institutions, collaboration with companies is in practice largely limited to the placement of trainees and interns, with little or no involvement in applied research, joint development activities, or structured mechanisms for updating teachers' professional competences. As a result, interaction with enterprises remains episodic and transactional, rather than developmental. Empirical evidence from technologically advanced SMEs suggests that opportunities for teacher mobility into companies, including on-the-job training, are extremely rare, particularly when compared with other European contexts such as Germany or France. This limited engagement points to deeper structural and cultural barriers, including weak institutional incentives, risk-averse organisational practices, and persistent asymmetries between education institutions and industry. Taken together, these factors contribute to the absence of a functional and continuous collaboration framework capable of supporting applied research, skills renewal and productivity-enhancing innovation.

These insights mirror challenges identified by CEDEFOP and other EU bodies regarding the role of VET-UAS in innovation.

4.4 National Consultations, Evidence Generation and Regional Insights

At the same time, regional evidence strengthened the case for reform. In the Lahti region, a facilitated consultation with wood-based SMEs in September 2025 highlighted several persistent needs: access to prototyping and product testing, certification support, technical development, skills cooperation and internationalisation guidance. Existing mechanisms - both national and EU-funded - were perceived as too distant, too bureaucratic or insufficiently responsive. The findings aligned with EU priorities articulated in the Green Deal Industrial Plan and the Bioeconomy Strategy, which emphasise the need to reinforce regional innovation capacity in sustainable material industries (LAB University of Applied Sciences, 2025, Results of workshop in Lahti).

Regional authorities echoed these concerns. The Häme ELY Centre pointed to declining enrolment in wood-technology and design programmes and warned that the region's long-term skills base would weaken without stronger institutional anchoring of applied innovation. Embedding applied development within education institutions was therefore seen as essential for strengthening both SME competitiveness and the attractiveness of VET and UAS studies in sectors central to the green transition (Hämeen ELY-keskus, 2025).

In October 2025, national-level evidence further confirmed the need for structural reform. A joint survey by Arene ry and AMKE ry revealed that RDI collaboration between UAS and VET providers is widely regarded as crucial for SME support and regional vitality, but that it remains hindered by unstable financing, fragmented governance and the absence of durable institutional arrangements. More than 90% of VET providers and nearly two-thirds of UAS institutions saw SME-oriented cooperation as a high priority, yet most activity continued to rely on temporary structural fund projects—an arrangement incompatible with long-term institutional development and inconsistent with EU recommendations on sustainable VET-UAS reform (Arene & AMKE, 2025).

4.5 Operationalisation Through Pilot Centres and Institutional Embedding

Taken together, these findings - international benchmarking, ministerial dialogue, expert analysis, regional evidence and national survey data - revealed a coherent structural gap in Finland's innovation system, one that closely aligns with challenges identified across the European Union. They also illustrated how a practical example can catalyse a broader reform process when aligned with both national needs and EU-level strategic intentions.

By the end of 2025, Finland had translated these insights into preparations for four pilot centres in different regions. As an example, educational organisations located on the west coast of Finland, Centria UAS and the vocational training centers Kpedu, JEDU, and Optima announced that they had signed an agreement to launch a CTTC model-resembling collaboration. While each Finnish pilot varies regarding the thematic emphases, each oneis guided by principles consistent with EU Centres of Vocational Excellence (CoVEs): agile governance, regional embeddedness, continuous cooperation with SMEs, and the integration of students and educators into applied research and development work. For the future, it is crucial whether the existing structures can be reformed with sufficient level of ambition in terms of functionality, content and principles ensuring sustainability and alignment with EU guidance on institutional reform.

The Finnish model of a technology transfer center would ideally be an independent, agile organization with its own operational structure and staff. It would work in close cooperation with educational institutions using their equipment and machinery but operate year-round, without annual holiday breaks. The center would specialize in the region's industrial strengths and take on assignments from companies. For these assignments, the center would hire teachers and students on fixed-term contracts to solve the companies' technological challenges.

The main sources of funding would be state grants, municipal financing, private funders, and the fees from companies. The rationale for establishing such centers is to support the growth of small businesses, update teachers' skills and expertise, ensure that students acquire relevant competencies, and strengthen their employment opportunities.

5 Policy Implications

Europe faces a structural imbalance. Across multiple education and innovation systems, strong vocational and applied higher education institutions operate in parallel to strong SME sectors, yet the institutional interface between them remains fragile, fragmented and episodic. The Canadian CTTC model demonstrates that when applied research is recognised as part of the institutional mission - and equipped with governance, funding and network coordination - colleges can become powerful innovation intermediaries for SMEs and drivers of regional competitiveness. The emerging Finnish pilots show that such principles are transferable to European contexts, provided reforms address mandate, funding logic and institutional embedding rather than short-term project substitution. The following implications set out a coherent framework for European, national and operational action to systematise VET-UAS-embedded applied research, strengthen SME innovation and align skills ecosystems with the demands of green and digital transitions.

5.1 European level: institutionalising applied research in VET-UAS

At EU level, skills, SME competitiveness and innovation are recognised priorities - but policy instruments still treat applied research largely as an academic or university-led activity. This framing excludes the institutional spaces where SMEs most naturally interact: VET centres, UAS providers, design institutes and colleges. The first recommendation is therefore definitional: EU policy should explicitly broaden its concept of research and innovation to include applied research, prototyping, technical assistance and problem-solving for SMEs, delivered through VET and UAS structures. This would allow R&I frameworks under Horizon Europe, Digital Europe, ERDF and Creative Europe to support development work beyond classical research outputs, better aligned with SME innovation cycles and skill formation needs.Crucially, however, this shift should not be understood as a merely programmatic adjustment, but as a broader change in the prevailing R&D mindset: one that recognises applied research, prototyping and technical assistance as fully legitimate forms of research and innovation, based on their capacity to address SMEs' concrete needs and to enhance competitiveness.

Closely linked is a second recommendation: European programmes should be structurally reshaped to allow RDI to start from industry needs rather than from funding calls. Across stakeholder discussions, it became clear that EU instruments are often too slow, too administratively heavy, and too detached from real enterprise problems, especially for SMEs with limited absorptive and administrative capacity. A shift towards more demand-driven mechanisms - co-designed with SME intermediaries, clusters and VET-UAS-based research centres - would allow European innovation instruments to serve the majority of its enterprise base, not only the minority equipped to navigate complex applications.

Finally, EU frameworks on Centres of Vocational Excellence (CoVEs) should move beyond the current emphasis on partnership formation and curricular innovation to formally recognise applied research as a core dimension of excellence. This implies incentivising VET-UAS networks that deliver applied RDI activities, supported by mobility schemes for teachers, shared prototyping facilities and

knowledge transfer mechanisms - particularly in regions where SMEs lack proximity to university-based R&D.

5.2 National and regional level: regulatory and financial reform for SME access

National reforms are required to translate policy vision into institutional reality. First, governments should create direct, low-threshold funding schemes that allow SMEs to access applied research services without navigating lengthy application cycles. The current dependency on complex calls and structural fund programmes creates discontinuity, slows responsiveness and discourages smaller firms. New instruments should enable rapid deployment of resources for prototyping, testing, small-scale development and technology adoption, based on short expressions of interest and light reporting.

Second, national frameworks should establish stable funding for applied research capacity in VET and UAS institutions - anchored not in temporary projects but in recurrent budgets linked to clear performance and impact criteria. The CTTC model shows that even modest base funding, when combined with earned income and industry collaboration, can generate large innovation multipliers. The Finnish pilots indicate that such institutional embedding is feasible within EU systems when aligned with smart specialisation priorities and regional development strategies.

National tax and incentive systems should also be recalibrated. Options include tax credits for SMEs purchasing applied research services from VET-UAS centres, accelerated depreciation rules for equipment used jointly by education and industry, and innovation vouchers linked to sector councils. Discussions among stakeholders emphasised that reducing administrative burden is essential: SMEs need simple pathways into applied research ecosystems rather than multi-month compliance engagement.

Finally, national and regional governments should embed VET-UAS-based applied research into industrial, skills and innovation strategies, particularly in green and design-intensive sectors. Evidence from creative industries consultations and white papers highlights the need to position cultural and creative skills as strategic assets for digitalisation, sustainability and productivity growth. This requires alignment across ministries, regional agencies and sector clusters, ensuring that education, innovation and industrial policy reinforce each other rather than operate as separate domains.

5.3 Institutional and operational level: capacity, governance and culture

At institutional level, applied research ecosystems must be built deliberately, not assumed to emerge organically. The first priority is internal capacity: VET and UAS institutions require dedicated staff with research, technology transfer and project development skills. Teachers must be systematically involved in applied projects, not occasionally attached to externally funded initiatives. The MOSAIC findings underscore that staff training, role clarity and internal structures are preconditions for sustainable research activity, not secondary considerations.

Specialisation is equally important. Not every institution should attempt to work across every field. Instead, centres should develop domain-specific expertise aligned with local industrial strengths and

following the regionally identified strategies of smart specialization - supported by cross-cutting clusters in digitalisation, sustainability and AI. Shared infrastructures, pooled equipment and inter-institutional research spaces can reduce duplication and expand access. Mutualised networks, as demonstrated by Synchronex, allow institutions to share branding, standards and strategy while benefiting from distributed autonomy.

Governance architectures should reflect co-ownership between education, industry and regional authorities. This may include steering committees, joint advisory boards and performance frameworks that measure outcomes in terms of SME competitiveness, employment and productivity rather than solely academic metrics. Evaluation systems are essential—not only to demonstrate impact but to shape continuous improvement, inform funding and strengthen legitimacy.

Crucially, the operating logic must reverse the traditional sequence: applied research programmes should be triggered by enterprise needs, not by the publication of a funding call. This requires active brokerage roles, agile intake mechanisms and service-oriented models of industry engagement. AI-based foresight tools, such as those piloted in Finland, can help anticipate emerging skills and technology demands, enabling VET-UAS-based centres to respond proactively rather than reactively.

6 Conclusion: towards a European applied research architecture for SMEs

Taken together, these recommendations call for a conceptual and institutional shift: from education systems that interface with innovation occasionally, to applied research ecosystems grounded in VET and UAS institutions, structurally connected to SMEs, and supported by coherent European, national and regional policy frameworks.

The international cases examined in this paper demonstrate that such ecosystems are not speculative. They exist. They generate measurable impact. They increase productivity and support occupational sustainability. They strengthen skills formation and technological readiness. They boost competitiveness in advanced manufacturing, digital industries and design-driven creative sectors. They turn schools and colleges into engines of innovation rather than endpoints of training.

What Europe lacks is not capacity, nor talent, nor policy intent - but the connective tissue between them: institutional mandates, durable funding, and governance architectures that allow applied RDI to occur continuously, collaboratively and at scale. The next phase of European skills and innovation policy will require precisely this infrastructure. If Europe is to compete globally, deliver on green and digital transitions, and build a resilient labour market capable of sustaining rising wages and reducing inflationary pressure, then SME-centred applied research must become a structural function of VET and UAS - no longer an exception, but a norm.

The task now is to move from examples to systems. From pilots to permanence. From promising models to an architecture that is identifiably and distinctively European.

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