REMIGIUSZ MAZUR | KAROLINA DERYŃSKA | EWA GOLKA-JASTRZĄB

TOURISM SKILLS
FOR THE TWIN TRANSITION

A CROSS-COUNTRY STUDY OF SUSTAINABILITY, DIGITALISATION AND EXTENDED REALITY IN EUROPEAN VOCATIONAL EDUCATION AND TRAINING



Remigiusz Mazur, Karolina Deryńska, Ewa Golka-Jastrząb

Tourism Skills for the Twin Transition: *A Cross-Country Study of Sustainability, Digitalisation and Extended Reality in European Vocational Education and Training*

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Study Overview

European tourism is undergoing a structural transformation driven by the simultaneous pressures of sustainability, digitalisation, changing visitor expectations, technological innovation, and evolving labour-market requirements. These processes are increasingly interconnected. Environmental transition alters tourism business models and destination-management practices, while digital technologies reshape visitor experience, organisational processes, communication, heritage interpretation, and professional learning. As a result, the transformation of tourism is also a transformation of competence.

This study examines these processes comparatively across Germany, Greece, Italy, Poland, Portugal, and Spain, with particular attention to sustainable tourism development, green and digital competences, Extended Reality technologies, labour-market needs, and the implications for Vocational Education and Training.

The comparative analysis demonstrates that sustainability has moved from a peripheral concern towards a more central component of tourism development, although the pathways through which this transition occurs differ substantially across national, regional, and local contexts. The evidence reveals variation in the degree of institutionalisation, the role of certification, the importance of regional and community actors, the maturity of digital infrastructure, and the capacity of organisations to translate environmental objectives into operational practice. Several distinct transformation patterns emerge.

Germany illustrates a comparatively institutionalised competence ecosystem in which standards, certification, organisational learning, and cross-sector partnerships play a prominent role. Spain demonstrates a multilevel model combining destination-level experimentation with digital and data-supported governance. Portugal highlights strategically coordinated and project-based capacity building, in which partnerships and externally supported initiatives accelerate innovation but also raise questions about the durability of institutional competence. Italy presents territorially differentiated and hybrid innovation strongly connected with cultural heritage, entrepreneurship, regional identity, and advanced digital interpretation. Poland demonstrates place-based transformation supported by intermediary organisations, local networks, and incremental digitalisation. Greece reveals a particularly strong relationship between local environmental conditions, community participation, experiential learning, and context-sensitive tourism development. Despite these differences, several common mechanisms can be identified across the six countries.

The first is the progressive institutionalisation of sustainability through standards, certification, destination strategies, organisational responsibilities, and monitoring systems. The second is the territorialisation of tourism transformation, whereby sustainability increasingly reflects the ecological, cultural, economic, and social characteristics of particular places. A third mechanism is the growing importance of cross-sector collaboration and intermediary organisations that connect tourism enterprises with knowledge, funding, technology, education, and specialist expertise.

Digitalisation constitutes another central mechanism. Digital platforms, data-supported management, artificial intelligence, and immersive technologies are increasingly used in tourism operations, visitor communication, environmental monitoring, destination management, heritage interpretation, and professional education. However, the comparative evidence does not support treating digitalisation as inherently sustainable. Its contribution depends on the problem addressed, organisational capacity, user behaviour, infrastructure, accessibility, and the ability of professionals to evaluate technological solutions critically.

Extended Reality technologies provide a particularly visible example of this relationship between digital innovation and competence transformation. The analysed cases demonstrate applications of Virtual, Augmented, and Mixed Reality in heritage interpretation, environmental education, museum learning, visitor-flow management, accessibility, tourism promotion, simulated workplace training, and the digital representation of cultural and natural resources.Their educational significance extends beyond technological novelty. XR can support simulation-based learning, access to sensitive or physically constrained environments, digital storytelling, reconstruction of historical settings, environmental interpretation, and the rehearsal of professional situations that are difficult to reproduce in conventional classrooms.

At the same time, the study shows that effective XR implementation requires considerably broader competence than device operation. Relevant capabilities include digital storytelling, user-experience design, accessibility, environmental and cultural literacy, critical interpretation, content management, collaboration with technical specialists, ethical judgement, and the ability to evaluate whether immersive technology solves a meaningful educational or tourism problem. This supports the interpretation of XR competence as an integrative professional capability rather than a narrowly technical skill. The analysis also identifies persistent competence gaps across tourism labour markets. Employers increasingly require combinations of green, digital, entrepreneurial, and transversal competences rather than isolated occupational skills. Environmental management, resource efficiency, sustainable mobility, certification, digital communication, data interpretation, sustainable entrepreneurship, accessibility, intercultural communication, customer engagement, and technological adaptability increasingly intersect within the same professional roles. The most significant change is therefore not simply the emergence of additional green or digital skills. It is the hybridisation of competence profiles.

Tourism professionals increasingly need to combine knowledge across domains and apply it to complex operational, organisational, and destination-level problems. This transformation has substantial implications for Vocational Education and Training. Conventional curricula organised around relatively stable occupational tasks are increasingly challenged by rapid technological change, evolving sustainability requirements, and new forms of interdisciplinary work. The evidence suggests that VET should move beyond the addition of isolated modules on sustainability or digital technologies. A stronger approach is to embed green and digital competences within authentic occupational tasks, project-based learning, workplace practice, simulations, collaborative problem solving, and partnerships with tourism enterprises, destinations, cultural institutions, environmental

organisations, and technology providers. The study identifies particular value in work-based learning, simulation, peer learning, mentoring, interdisciplinary projects, certification-linked training, educator upskilling, and co-designed curricula. These approaches can reduce the distance between formal education and rapidly changing professional practice. They also support the development of transversal competences such as communication, teamwork, adaptability, ethical reasoning, intercultural competence, and stakeholder coordination. A recurring challenge concerns uneven institutional capacity. Tourism SMEs, rural destinations, smaller cultural institutions, and under-resourced education providers may face limited access to funding, digital infrastructure, specialist trainers, technology, or organisational support. These inequalities affect the ability to participate in the green and digital transitions. The same innovation can therefore produce very different outcomes depending on the surrounding competence ecosystem. This finding shifts the analytical focus from individual skills gaps towards the institutional conditions under which competences can be developed, shared, updated, and applied.

The concept of the competence ecosystem consequently emerges as a central interpretative category. Tourism transformation depends not only on the capabilities of individual workers but also on relationships between enterprises, VET providers, universities, public institutions, destination organisations, communities, technology companies, cultural and environmental organisations, and intermediary actors. Innovation becomes more durable where knowledge circulates effectively between these actors, learning continues beyond individual projects, and organisations possess sufficient capacity to translate new knowledge into practice. From this perspective, VET constitutes part of the transformation infrastructure of tourism. Its role extends beyond responding to labour-market demand after new practices have already become established. Vocational education can contribute actively to transformation by creating environments in which learners, professionals, enterprises, and institutions experiment with new practices, develop hybrid competences, and adapt sustainability and digitalisation to specific tourism contexts. The comparative evidence ultimately indicates that the twin transition in tourism should be understood as a socio-technical and institutional process rather than as the parallel adoption of environmental measures and digital tools. Sustainability, digitalisation, entrepreneurship, governance, accessibility, and professional learning increasingly interact within the same tourism systems.

The success of this transformation depends less on the adoption of any single certification scheme, technology, or business model than on the capacity of people and organisations to combine these elements coherently. The central conclusion of the study is therefore that the future resilience and competitiveness of European tourism will depend on the development of adaptive competence ecosystems capable of connecting environmental responsibility, technological innovation, territorial needs, and continuous professional learning.

1 Introduction

The tourism sector is undergoing a period of profound transformation shaped by interconnected environmental, technological, economic, and social changes. Traditionally associated with economic growth, employment creation, and cultural exchange, the tourism sector is increasingly required to reconcile competitiveness with sustainability, resilience, and responsible resource management.Climate change, growing awareness of environmental impacts, changing consumer expectations, and the accelerated development of digital technologies are redefining the way tourism products and services are designed, delivered, and experienced[1].

The transition towards sustainable tourism represents one of the most significant challenges and opportunities for the sector[2]. Contemporary tourism development increasingly moves beyond traditional models focused primarily on visitor numbers and economic growth towards approaches that integrate environmental responsibility, social inclusion, local community engagement, and long-term value creation[3]. Emerging concepts such as regenerative tourism, slow tourism, eco-certification models, and community-based tourism reflect a broader transformation in how destinations and tourism organisations understand competitiveness and development[4]. However, the successful implementation of these models requires not only organisational and technological changes but also the development of new knowledge, competences, and professional capabilities among tourism workers.

At the same time, the tourism sector is experiencing rapid digital transformation. Digital platforms, artificial intelligence, data-driven services, and immersive technologies are increasingly influencing tourism operations, marketing strategies, visitor experiences, and destination management. Technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR), commonly referred to as extended reality (XR), provide new opportunities for creating innovative tourism experiences and supporting learning processes[5]. Nevertheless, technological advancement alone does not guarantee successful transformation. The effective adoption of digital solutions depends on the availability of appropriately skilled professionals capable of combining technological competences with sustainability-oriented thinking, creativity, and entrepreneurial capabilities[6].

These parallel processes of green and digital transformation have significant implications for vocational education and training (VET) systems. As a major provider of workforce preparation in

[1] Hall, C. M. (2019). Constructing sustainable tourism development: The 2030 Agenda and the managerial ecology of sustainable tourism. Journal of Sustainable Tourism, 27(7), 1044–1060. https://doi.org/10.1080/09669582.2018.1560456

[2] UN Tourism. (2023). Tourism and the Sustainable Development Goals – Journey to 2030. UN Tourism. https://doi/book/10.18111/9789284419401

[3] Bramwell, B., & Lane, B. (1993). Sustainable tourism: An evolving global approach. Journal of Sustainable Tourism, 1(1), 1–5. https://doi.org/10.1080/09669589309450696

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[6] Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens – With new examples of knowledge, skills and attitudes. Publications Office of the European Union, 19-21. https://doi.org/10.2760/115376

Europe, VET plays a strategic role in ensuring that learners acquire competences aligned with evolving labour market requirements[7]. However, the pace of change within the tourism sector has created a growing challenge for education and training systems, which must continuously adapt curricula, teaching methods, and cooperation mechanisms with industry stakeholders. Existing approaches to tourism education often remain insufficiently aligned with emerging competence demands, particularly in areas such as green skills, digital literacy, innovation capacity, and the practical application of new technologies.

The growing gap between current educational provision and future-oriented competence requirements constitutes an important research challenge. While previous studies have extensively examined sustainable tourism development, digitalisation of tourism services, or technological innovation in education, fewer studies have addressed the interconnections between these dimensions from the perspective of vocational education and training. In particular, there is a need for integrated approaches that examine how VET systems can support the development of competencies required for sustainable and digitally enabled tourism, while also considering the institutional, technological, and pedagogical conditions necessary for effective implementation[8].

This study addresses this research challenge by providing an integrated analysis of market trends, emerging skills requirements, and educational responses within the European tourism sector. It explores how sustainability and digitalisation influence the evolution of professional competences and examines the role of VET institutions in preparing future tourism professionals. Particular attention is given to the potential of extended reality technologies as innovative tools supporting competence development and experiential learning in tourism education.

The research presented in this monograph was conducted within the framework of the European TourXpeRience project, which aimed to investigate current and future competence needs in the tourism sector and explore opportunities for the application of XR technologies in vocational education and training. The study combines an analysis of tourism trends, stakeholder perspectives, skills requirements, and educational practices across six European countries: Germany, Greece, Italy, Poland, Portugal, and Spain.

By bringing together perspectives from tourism, education, labour market analysis, and digital innovation, this monograph contributes to the discussion on how vocational education systems can respond to the challenges of the twin transition towards sustainability and digitalisation. It provides insights into current competence gaps, identifies opportunities for innovation in tourism education, and highlights the importance of cooperation between VET providers, tourism organisations, technology stakeholders, and policymakers in building future-ready skills ecosystems. Specifically, the study investigates four interrelated dimensions: the current state of sustainable tourism education and green skills development, the integration of extended reality (XR) technologies into

[7] Cedefop (2020). Vocational education and training in Europe, 1995-2035: scenarios for European vocational education and training in the 21st century. Luxembourg: Publications Office. Cedefop reference series, No 114, 36-40. http://data.europa.eu/doi/10.2801/794471

[8] Sterling, S., & Thomas, I. (2006). Education for sustainability: The role of capabilities in guiding university curricula. International Journal of Sustainability in Higher Education, 7(2), 155–167. https://doi.org/10.1108/14676370610655964

VET provision[9], labour market demands and existing skills gaps within the tourism sector, and opportunities and challenges faced by VET institutions and tourism stakeholders in responding to ongoing digital and environmental transformations[10].

This monograph contributes to the discussion on the future development of tourism education by providing an integrated perspective on the relationship between market transformation, competence requirements, and innovation in vocational education and training. While existing research has extensively addressed sustainable tourism development, digital transformation, and educational innovation, these areas are often analysed separately[11]. The present study brings these perspectives together by examining how environmental and technological changes influence the skills required in the tourism sector and how VET systems can respond to these evolving demands.

A particular contribution of the monograph lies in its focus on the interconnections between sustainability-oriented competences, digital skills, and innovative learning approaches. By analysing labour market expectations, educational needs, and the potential of Extended Reality technologies, the study provides insights into the conditions necessary for developing future-oriented tourism education.

The monograph also offers a comparative European perspective based on research conducted in six countries: Germany, Greece, Italy, Poland, Portugal, and Spain. This approach enables the identification of common challenges and opportunities while recognising the influence of national and regional contexts on tourism development and VET transformation.

Through the combination of empirical research, comparative analysis, and evaluation of XR applications, the study provides evidence-based recommendations for VET providers, tourism stakeholders, and policymakers. These recommendations aim to support the development of flexible, innovative, and responsive education and training systems capable of contributing to the sustainable and digital transformation of the tourism sector.

1.1 Purpose and Scope of the Study

The purpose of this study is to examine emerging trends in tourism-related skills and to analyse the evolving educational needs resulting from the transformation of the tourism sector towards greater sustainability and digitalisation. The study focuses on the relationship between labour market developments, competence requirements, and the capacity of vocational education and training systems to respond to new challenges and opportunities.

Specifically, the study investigates four interrelated dimensions. The first concerns the development of sustainable tourism models and the associated demand for green competences

[9] Council Recommendation on VET (2020/C 417/01), §11: "VET programmes should be more flexible and agile … including through the use of state-of-the-art digital tools, simulations, virtual and augmented reality."
[10] Cedefop. (2020). Vocational education and training in Europe, 1995–2035.
[11] Hall, C. M. (2019). Constructing sustainable tourism development: The 2030 Agenda and the managerial ecology of sustainable tourism. Journal of Sustainable Tourism, 27(7), 1044–1060.
https://doi.org/10.1080/09669582.2018.1560456

required to support environmentally responsible tourism practices. The second focuses on the changing skills landscape within the tourism labour market, including the identification of existing gaps between employer expectations and current educational provision. The third dimension explores the integration of extended reality (XR) technologies into vocational education and training, with particular emphasis on their educational potential, implementation conditions, and limitations. The fourth dimension examines the broader challenges and opportunities faced by VET institutions and tourism stakeholders in adapting to ongoing environmental and technological transformations.

The study aims to provide a comprehensive understanding of how tourism education and training systems can contribute to the development of a workforce capable of supporting sustainable, innovative, and digitally enhanced tourism. Rather than considering sustainability and digitalisation as separate processes, the research adopts an integrated perspective, recognising that future tourism competitiveness will increasingly depend on the ability to combine environmental responsibility, technological innovation, and human-centred competence development.

Drawing on empirical evidence collected through quantitative and qualitative research methods, including surveys, interviews, focus group discussions, and evaluation of XR applications, the monograph identifies key challenges and opportunities for VET innovation. The findings are used to formulate recommendations supporting stronger alignment between educational provision and evolving sectoral needs.

The scope of the study encompasses six European countries – Germany, Greece, Italy, Poland, Portugal, and Spain–allowing for comparative analysis of different approaches to sustainable tourism development, skills formation, and technological adoption. Through this comparative perspective, the monograph seeks to contribute to a better understanding of both common European challenges and national or regional specificities influencing the transformation of tourism education.

1.2 Research and Policy Context

The transformation of the European tourism sector cannot be understood without considering the broader policy agenda that increasingly links economic competitiveness with sustainability, digital innovation, and lifelong skills development. Over the past decade, European institutions have recognised that the successful implementation of the green and digital transitions depends not only on technological progress but also on the capacity of education and training systems to prepare a workforce equipped with appropriate competences[12]. As a result, vocational education and training (VET) has assumed a more strategic role in supporting economic resilience, labour market adaptability, and social cohesion.

The transition towards sustainable tourism reflects broader European ambitions to achieve climate neutrality while promoting inclusive and balanced regional development. Tourism, as one of

[12] European Commission. (2020). European Skills Agenda for sustainable competitiveness, social fairness and resilience. Brussels: European Commission, 12-15. https://pact-for-skills.ec.europa.eu/community-resources/publications-and-documents/european-skills-agenda-sustainable-competitiveness-social-fairness-and-resilience_en

Europe's most important economic sectors, is expected to contribute to these objectives through more responsible resource management, the protection of natural and cultural heritage, the promotion of circular economy principles, and the development of environmentally conscious tourism services[13]. Consequently, tourism professionals are increasingly expected to possess competences extending beyond traditional occupational skills to include environmental awareness, sustainable resource management, stakeholder collaboration, and innovation-oriented thinking.

Parallel to the green transition, digital transformation is fundamentally reshaping tourism services, business models, and visitor experiences[14]. Digital platforms, artificial intelligence, data analytics, smart destination management systems, and immersive technologies have become integral components of the contemporary tourism ecosystem[15]. These developments require tourism professionals to continuously update their digital competences and adapt to rapidly evolving technological environments. At the same time, educational institutions face growing expectations to modernise teaching methodologies and integrate innovative learning technologies capable of supporting practical, experiential, and learner-centred education.

These developments are reflected in a range of European strategic initiatives that emphasise the importance of strengthening skills ecosystems and improving the responsiveness of education and training systems. The Council Recommendation on Vocational Education and Training for Sustainable Competitiveness, Social Fairness and Resilience (2020) highlights the need to modernise VET through flexible learning pathways, stronger cooperation with employers, and the integration of digital technologies into teaching and learning processes[16]. Similarly, the Osnabrück Declaration on Vocational Education and Training (2020) identifies digitalisation, sustainability, innovation, and lifelong learning as key priorities for the future development of European VET systems[17].

The strategic direction is further reinforced by initiatives such as the European Skills Agenda, the European Green Deal, the Digital Education Action Plan, and the European Pillar of Social Rights[18], all of which underline the importance of developing future-oriented competences capable of supporting sustainable economic growth and social inclusion[19]. Collectively, these policy frameworks recognise that the competitiveness of European industries increasingly depends on continuous skills development, effective cooperation between education providers and employers, and the capacity to anticipate emerging labour market needs.

[13] European Commission. (2022). Transition Pathway for Tourism. Luxembourg: Publications Office of the European Union. 5-16. https://doi.org/10.2873/344425

[14] Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: Foundations and developments. Electronic Markets, 25, 179–188. https://doi.org/10.1007/s12525-015-0196-8

[15] Buhalis, D., & Law, R. (2008). Progress in information technology and tourism management: 20 years on and 10 years after the Internet—The state of eTourism research. Tourism Management, 29(4), 609–623.
https://doi.org/10.1016/j.tourman.2008.01.005

[16] European Commission. (2020). European Skills Agenda for sustainable competitiveness, social fairness and resilience. Brussels: European Commission. https://doi.org/10.2767/978543

[17] European Commission. (2020). The Osnabrück Declaration on vocational education and training as an enabler of recovery and just transitions to digital and green economies. https://www.cedefop.europa.eu/files/osnabrueck_declaration_eu2020.pdf

[18] European Commission. (2017). European Pillar of Social Rights.

[19] European Commission. (2020). Digital Education Action Plan 2021–2027: Resetting education and training for the digital age. https://education.ec.europa.eu

Within the tourism sector, these priorities translate into the growing need to modernise vocational curricula by integrating green competences, entrepreneurial capabilities, digital literacy, and innovative pedagogical approaches. Employers increasingly seek professionals capable of combining technical expertise with transversal competences such as problem-solving, adaptability, communication, intercultural awareness, and collaborative working. This changing competence profile requires educational institutions to move beyond traditional teaching models towards more flexible, practice-oriented, and technology-enhanced learning environments.

One area receiving increasing attention is the educational application of Extended Reality (XR) technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)[20]. These technologies offer opportunities to simulate authentic working environments, develop practical skills in safe conditions, and support experiential learning that would otherwise be difficult or costly to provide[21]. Nevertheless, successful implementation depends not only on technological availability but also on institutional readiness, pedagogical design, educator competences, and long-term organisational support.

Against this background, the present study is situated within the broader European debate concerning the future of vocational education and training in the context of the twin transition. Rather than examining sustainable tourism or educational technologies in isolation, it adopts an integrated perspective that considers the interdependence between labour market transformation, competence development, educational innovation, and policy priorities. This perspective provides the conceptual foundation for the analyses presented in the subsequent chapters and supports the formulation of recommendations aimed at strengthening the capacity of VET systems to prepare learners for the evolving requirements of the tourism sector

1.3 Methodology

The research presented in this monograph was designed to investigate the evolving competence requirements of the tourism sector in the context of the green and digital transitions and to examine the capacity of vocational education and training (VET) systems to respond to these changes. Given the multidimensional nature of the research problem, a mixed-method research design was adopted, combining quantitative and qualitative approaches to provide a comprehensive understanding of emerging skills needs, educational challenges, and opportunities for innovation.

The methodological framework was developed within the European TourXpeRience project and implemented across six participating countries: Germany, Greece, Italy, Poland, Portugal, and Spain. Applying a common research protocol ensured methodological consistency while allowing the collection of data reflecting national and regional specificities. This comparative perspective made it

[20] Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. Computers & Education, 147, 103778. https://doi.org/10.1016/j.compedu.2019.103778

[21] Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2021). Immersive virtual reality as a pedagogical tool in education: A systematic literature review of quantitative learning outcomes and experimental design. Journal of Computers in Education, 8, 1–32.

possible to identify both shared European trends and country-specific characteristics influencing tourism education and workforce development.

The study employed methodological triangulation to enhance the validity and robustness of the research findings. Quantitative data provided an overview of prevailing patterns and perceptions among different stakeholder groups, while qualitative methods enabled a deeper exploration of experiences, expectations, and contextual factors influencing competence development and educational practices. Combining multiple sources of evidence allowed for a more comprehensive interpretation of the challenges facing the tourism sector and vocational education systems.

The methodological approach was organised around two complementary research strands. The first focused on identifying labour market trends, skills gaps, and training needs within the tourism sector through stakeholder-based empirical research. The second examined the educational potential of Extended Reality (XR) technologies by analysing existing applications, evaluating their pedagogical value, and assessing their suitability for vocational education and training.

In addition to empirical data collection, the study incorporated a review of relevant scientific literature, European policy documents, strategic reports, and examples of educational and technological innovation. This enabled the research findings to be interpreted within a broader conceptual and policy framework, strengthening both their analytical depth and practical relevance.

The combination of comparative analysis, mixed research methods, and multiple sources of evidence provides a robust foundation for the conclusions presented in this monograph. Rather than examining individual aspects of tourism education in isolation, the adopted methodology supports an integrated understanding of how labour market transformation, competence development, and educational innovation interact within the broader process of sustainable and digital transition.

1.3.1 Identification of Skills Gaps and Training Needs

The identification of skills gaps and training needs constituted a central component of the empirical research. The objective was to examine the extent to which existing vocational education provision corresponds with the evolving competence requirements of the tourism sector and to identify areas where further educational development is required.

To achieve this objective, quantitative data were collected through structured online questionnaires administered in paper and online formats to three key stakeholder groups: VET teachers, VET students, and representatives of the tourism industry. Although each questionnaire contained stakeholder-specific sections addressing the particular experiences and perspectives of respondents, a common core of questions ensured the comparability of findings across all groups. The survey instruments were designed to identify perceived competence gaps, emerging training needs, and the extent to which current educational provision corresponds with labour market expectations.

To complement the survey data, semi-structured interviews were conducted with selected VET teachers, students, and representatives of tourism organisations. The interviews enabled a more detailed exploration of issues that could not be fully captured through quantitative methods,

including perceived barriers to curriculum innovation, emerging competence requirements, and expectations regarding the future development of vocational education.

Focus group discussions constituted the third stage of empirical data collection. Bringing together educators, students, employers, and other relevant stakeholders created opportunities for interactive discussion, enabling participants to reflect collectively on current educational challenges, labour market developments, and opportunities for strengthening cooperation between vocational education and the tourism industry. The focus groups also facilitated the identification of areas where stakeholder perspectives converged or diverged.

The integration of surveys, interviews, and focus group discussions provided complementary sources of evidence and strengthened the validity and credibility of the research through methodological triangulation[22]. This approach enabled both the identification of broad competence patterns across participating countries and a more nuanced understanding of the institutional and contextual factors shaping skills development within the tourism sector

1.3.2 Identification and Evaluation of XR Technologies

The rapid development of Extended Reality (XR) technologies has created new opportunities for innovation in vocational education and training, particularly in sectors where practical skills acquisition, experiential learning, and authentic workplace simulation are essential[23]. By integrating Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), XR technologies offer immersive learning environments capable of supporting competence development in ways that complement conventional teaching methods[24]. Within tourism education, these technologies have attracted increasing attention due to their potential to simulate complex operational environments, enhance learner engagement, and facilitate the acquisition of practical, technical, and interpersonal skills.

Despite growing interest in XR applications, evidence concerning their pedagogical effectiveness and institutional readiness for implementation remains uneven. Existing studies indicate that immersive technologies can improve learner motivation, knowledge retention, and experiential understanding; however, successful implementation depends on multiple organisational, technological, pedagogical, and financial factors. Consequently, evaluating XR technologies requires a multidimensional perspective that extends beyond technical functionality to encompass educational value, accessibility, usability, and long-term sustainability. Recognising these challenges, the present study incorporated a systematic identification and evaluation of XR solutions relevant to vocational education and training in the tourism sector. Rather than focusing exclusively on technological innovation, the research examined the extent to which XR applications can support competence

[22] Denzin, N. K. (1978). The Research Act: A Theoretical Introduction to Sociological Methods (2nd ed.). New York: McGraw-Hill.
[23] Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. Computers & Education, 147, 103778. https://doi.org/10.1016/j.compedu.2019.103778
[24] Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes. Computers & Education, 70, 29-35. https://doi.org/10.1016/j.compedu.2013.07.033

development aligned with contemporary labour market requirements and the broader objectives of sustainable tourism education.

A structured evaluation framework was developed to ensure consistency across the assessment process. The framework considered five complementary dimensions: pedagogical effectiveness, technical quality, accessibility and inclusiveness, economic feasibility, and overall educational impact. Together, these criteria enabled a comprehensive assessment of both the instructional potential and practical applicability of individual XR solutions within different educational contexts.

The evaluation process comprised several sequential stages. Initially, XR applications relevant to tourism education were identified through a systematic review of available technologies and educational practices. Following the selection process, pilot activities were organised within participating VET institutions, allowing teachers and students to engage with XR applications under authentic learning conditions. This practical implementation provided opportunities to observe user interaction, assess the suitability of different learning scenarios, and explore the extent to which immersive technologies could support the development of occupation-specific and transversal competences.

Data collection combined structured observation, user feedback instruments, and reflective evaluation conducted by both educators and learners. The integration of multiple sources of evidence allowed for a balanced assessment of the educational benefits and practical limitations associated with XR implementation. Particular attention was paid to factors influencing institutional readiness, including technological infrastructure, educators' digital competences, curriculum integration, and organisational capacity to support long-term adoption. Importantly, the evaluation was not intended to determine whether XR technologies should replace conventional forms of vocational education.

2 Sustainable Tourism: Trends, Models and Best Practices

Sustainable tourism in Europe is undergoing a multidimensional transformation driven by environmental pressures, changing consumer expectations, technological development, and an increasingly extensive policy framework supporting the green transition. Comparative analysis of developments observed in Germany, Greece, Italy, Poland, Portugal, and Spain indicates that sustainability is progressively moving from the margins of tourism policy and business practice towards the centre of destination development strategies. This transformation affects governance models, tourism products, investment priorities, technological innovation, and the relationship between tourism enterprises and local communities.

Although the pace and scope of change differ across national and regional contexts, several common tendencies can be identified. These include the growing role of environmental certification, the integration of sustainability into tourism branding, the development of regenerative and community-based tourism, the use of digital technologies to support more efficient destination management, increasing attention to climate adaptation, and the expansion of cooperation between tourism enterprises, public authorities, educational institutions, and technology providers. Taken together, these developments suggest that sustainable tourism is increasingly understood not as a separate market niche but as a broader framework for restructuring tourism activities

2.1 Emerging Trends in Sustainable Tourism in Europe

One of the principal drivers of this transformation is the increasing alignment of tourism development with European and international sustainability objectives. Policy frameworks associated with climate neutrality, resource efficiency, environmental protection, and the Sustainable Development Goals create incentives for destinations and tourism enterprises to adopt low-carbon and resource-efficient operating models. Within this context, environmental certification has acquired growing significance as both a governance instrument and a market mechanism. The comparative material examined in this study indicates that certification systems are particularly visible in countries such as Germany and Portugal, where they are increasingly used to communicate environmental performance, strengthen consumer confidence, and differentiate tourism products.

The growing importance of certification reflects a broader shift in the role attributed to environmental responsibility. Sustainability is increasingly incorporated into the value proposition of tourism products rather than treated solely as a matter of regulatory compliance. This tendency is particularly evident in examples identified in Italy and Spain, where environmental stewardship is combined with destination branding, biodiversity protection, cultural heritage, local gastronomy, and place-based tourism experiences. Such approaches seek to create economic value through the distinctiveness of local environmental and cultural resources while simultaneously strengthening links with local producers, artisans, communities, and agricultural enterprises.

A related development is the emergence of tourism models that move beyond the objective of reducing negative environmental impacts. Regenerative and community-based approaches,

identified particularly in Greece and in selected rural regions of Spain and Portugal, place greater emphasis on the capacity of tourism to contribute positively to local ecosystems and communities. Their objectives may include ecosystem restoration, the revitalisation of cultural heritage, support for local production systems, and the strengthening of long-term socio-economic resilience. In these models, local participation and stakeholder cooperation become integral elements of tourism development rather than supplementary mechanisms of consultation.

The expansion of such approaches also changes the understanding of entrepreneurship in tourism. Economic viability remains essential, but it is increasingly considered alongside the creation of environmental and social value. From this perspective, sustainable tourism requires enterprises to develop the capacity to cooperate with local stakeholders, integrate environmental considerations into business decisions, and design products that respond simultaneously to market expectations and the needs of host communities. Sustainable development therefore becomes closely linked with new forms of responsible and place-based entrepreneurship.

Digitalisation constitutes another important dimension of this transformation. Across the six countries analysed, digital tools are increasingly used to support both visitor experience and sustainability-related objectives. Examples include virtual tours, digital interpretation of cultural and natural heritage, data-supported destination management, systems facilitating resource monitoring, and tools designed to redirect tourist flows towards less congested locations or periods. In this sense, digital transformation and green transition are becoming increasingly interconnected.

The implementation of more advanced immersive technologies, including Extended Reality (XR), remains considerably less widespread. Their use is still concentrated in pilot initiatives, selected tourism attractions, heritage interpretation projects, and educational settings. Nevertheless, the analysed material indicates several areas in which XR may contribute to sustainable tourism development, including environmental education, interpretation of sensitive heritage sites, visitor-flow management, and experiential learning in tourism-related vocational education and training. The limited scale of current implementation also reveals persistent financial, infrastructural, organisational, and pedagogical barriers.

Climate change adaptation represents a further area of growing importance. The consequences of climate change are particularly relevant for destinations dependent on environmentally sensitive tourism assets, including coastal areas, mountain regions, natural landscapes, and cultural heritage sites. Responses identified in the analysed countries include measures aimed at extending tourism beyond peak seasons, reducing pressure on fragile ecosystems, applying nature-based solutions in coastal areas, and improving energy efficiency in accommodation and hospitality services. Such measures demonstrate that sustainable tourism increasingly involves not only mitigation of tourism-related environmental impacts but also adaptation of tourism systems to changing climatic conditions.

The effectiveness of these transformations depends substantially on institutional and human capacities. New technologies, certification systems, environmental management practices, and regenerative tourism models require knowledge and competences that are not always sufficiently

available within tourism enterprises, particularly among small and medium-sized businesses. The transition towards more sustainable operating models therefore has direct implications for vocational education and training, continuing professional development, and cooperation between educational institutions and the tourism sector.

The comparative analysis also points to the increasing importance of cross-sectoral collaboration. Partnerships involving tourism enterprises, vocational education providers, technology companies, public authorities, destination organisations, and local communities can facilitate the development and dissemination of sustainability-oriented solutions. Such cooperation is especially relevant where innovation requires competences that extend beyond the traditional boundaries of the tourism sector, for example in environmental management, data use, digital technologies, circular economy practices, or sustainable mobility.

From the perspective of vocational education and training, this development has two consequences. First, the changing organisation of tourism creates demand for new combinations of green, digital, entrepreneurial, and transversal competences. Second, cooperation with enterprises and other stakeholders provides VET institutions with opportunities to incorporate real sustainability challenges into learning processes. The cases examined in the study include educational initiatives addressing circular economy principles, environmental and sustainability certification, data-supported destination management, and digital or immersive technologies used for heritage interpretation. At the same time, the ability of SMEs to participate in such forms of training remains constrained by limited financial, organisational, and technological resources.

Despite the broad direction of change, sustainable tourism development remains uneven across Europe. Differences are visible in the maturity of policy frameworks, the availability of support instruments, the adoption of environmental standards, technological readiness, and the degree to which sustainability has been integrated into business models and vocational education. In some contexts, sustainable practices have become embedded in destination strategies and operational decision-making, whereas in others they remain fragmented, dependent on individual initiatives, or confined to pilot projects.

These disparities have significant implications for the transferability of good practices and for the development of competence frameworks applicable across different national and regional settings. Solutions developed in institutionally mature tourism ecosystems cannot automatically be transferred to regions characterised by lower investment capacity, weaker stakeholder cooperation, or more limited technological infrastructure. Comparative analysis therefore needs to consider not only the identification of successful practices but also the institutional conditions under which they can be implemented, adapted, and sustained.

Overall, the developments observed aross the six countries indicate a gradual transition towards a model in which environmental responsibility, technological innovation, local participation, and competence development become increasingly interconnected. Sustainable tourism is consequently evolving from a relatively narrow concern with environmental impact reduction towards a broader transformation of tourism governance, business models, destination development, and workforce

requirements. The national cases discussed in the following sections illustrate both the common direction of this transition and the significant differences in the mechanisms through which it is taking place.

2.1.1 Germany

Germany represents a relatively mature example of the institutionalisation of sustainability within tourism policy and market practice. Environmental considerations are embedded in both national and regional development strategies, while tourism enterprises increasingly operate within a framework shaped by climate objectives, environmental standards, certification schemes, and changing consumer expectations. Particularly significant in the German context is the interaction between public policy instruments and market-based mechanisms, through which sustainability is progressively incorporated into the competitive positioning of destinations and tourism businesses.

One of the most visible characteristics of the German model is the extensive use of environmental certification. Schemes such as Viabono and the German implementation of the EU Ecolabel cover different segments of the tourism economy, including accommodation, gastronomy, tour operators, and visitor attractions. Their role extends beyond verifying compliance with environmental requirements. Certification increasingly performs a communicative and market function by enabling tourism providers to signal environmental responsibility and differentiate their services in a market in which sustainability has become more relevant to consumer choice.

This development is reinforced by public support for investments aimed at improving the environmental performance of tourism infrastructure. Funding programmes supporting energy-efficient renovation, resource management, and reductions in water and energy consumption create conditions for tourism enterprises to integrate sustainability into operational practice. Such instruments are particularly important because environmental transition frequently requires substantial initial investment, which may constitute a barrier for smaller and family-owned businesses.

The growing importance of sustainability is also reflected in market expectations. Data reported by the German National Tourist Board indicate an increase in the proportion of international tourism businesses expecting higher demand for sustainable travel products, from 60% in the fourth quarter of 2023 to 65% in the first quarter of 2024. The same source reported that 79% of surveyed international experts perceived Germany as a sustainable travel destination. Although such indicators should be interpreted as measures of market perception rather than direct evidence of changes in tourist behaviour, they suggest that sustainability has become increasingly relevant to Germany's international tourism positioning[25].

This market orientation is visible in the development of tourism products combining environmental responsibility with other dimensions of visitor experience. One example is the

[25] German National Tourist Board, *2024 Q1 – Increase in Bookings of Sustainable Travel Products Expected*, GNTB Travel Industry Expert Panel, Q4 2023 and Q1 2024

growing convergence between sustainability and wellness tourism. Accommodation providers and destinations increasingly connect nature-based activities, locally embedded experiences, environmentally responsible services, and wellness offers. This illustrates a broader tendency to integrate sustainability into the design of tourism experiences rather than present it as an additional or separate attribute.

The German case also demonstrates the growing role of destination marketing in translating sustainability principles into consumer-oriented tourism products. National campaigns such as the German National Tourist Board's "Feel Good" initiative combine certified services, sustainable mobility options, regional tourism products, and environmentally responsible travel experiences within a common communication framework. The campaign's presentation of approximately 140 sustainable travel ideas across different categories illustrates an effort to make sustainability more visible and accessible to visitors while simultaneously coordinating the activities of regional tourism organisations and certified service providers.

Digital platforms play an important role in this process. By consolidating information on sustainable accommodation, mobility, attractions, and experiences, they reduce the information barriers faced by travellers attempting to make more environmentally responsible choices. In this respect, digitalisation does not operate independently of the green transition. Rather, it becomes one of the mechanisms through which environmental information can be communicated, compared, and incorporated into travel decisions. The increasing importance of environmental certification in the German hospitality sector further illustrates the connection between sustainability and competitiveness. Tourism enterprises are investing in energy efficiency, waste reduction, lower-carbon supply chains, reusable amenities, and systems for monitoring water and energy consumption. Certification is increasingly used alongside these operational changes as a means of communicating environmental performance to consumers and booking platforms.

At the same time, the expansion of certification reveals structural limitations. The initial costs of infrastructure modernisation can be particularly burdensome for smaller accommodation providers, while the coexistence of different certification systems may create difficulties for both enterprises and consumers. Meeting complex certification requirements may also require access to specialist consultancy or environmental management expertise. As a result, the capacity to participate in sustainability-oriented market transformation is unevenly distributed across tourism enterprises.

The German tourism landscape also provides examples of approaches that extend beyond the conventional understanding of sustainability as the minimisation of negative environmental impacts. In Bavaria, regenerative and community-oriented tourism initiatives increasingly encourage visitors to participate directly in activities connected with environmental restoration, local agriculture, biodiversity protection, and rural development. Examples identified in the analysed material include conservation activities, farm-based volunteering, biodiversity monitoring, and tourism products designed around the principle of contributing positively to the host destination.

Such initiatives represent an important conceptual shift. Rather than concentrating exclusively on reducing resource consumption or environmental damage, regenerative tourism seeks to create

positive ecological and social effects. In rural areas, this may involve closer cooperation between tourism organisations, local authorities, environmental organisations, cooperatives, agricultural producers, and local communities. The tourism experience thus becomes connected with broader processes of territorial development and ecosystem stewardship.

The Bavarian examples also demonstrate some of the tensions associated with regenerative tourism. Expanding such initiatives without reducing community participation to a commercialised tourism product requires careful governance. Questions concerning authenticity, the distribution of benefits, liability, insurance, and the formal organisation of volunteer activities become increasingly important as regenerative practices move beyond small-scale experimentation. Their development therefore depends not only on consumer demand but also on appropriate institutional frameworks and stakeholder coordination.

Viewed as a whole, the German case illustrates three interconnected dimensions of sustainable tourism transformation. The first is institutional: sustainability is supported through public strategies, funding instruments, environmental standards, and certification mechanisms. The second is market-oriented: environmental responsibility increasingly contributes to destination branding, product differentiation, and the design of tourism experiences. The third concerns innovation in tourism models, including the gradual emergence of regenerative and community-oriented approaches that seek to produce positive environmental and social outcomes.

These developments also have implications for competence requirements in the tourism sector. The implementation of environmental standards and certification procedures requires knowledge of sustainability management, resource efficiency, environmental indicators, and regulatory requirements. The increasing use of sustainability as a market differentiator creates demand for competences in communication, digital marketing, and the credible presentation of environmental performance. Regenerative and community-based models additionally require stakeholder coordination, partnership development, community engagement, and the ability to design tourism products that combine economic, environmental, and social objectives.

From the perspective of vocational education and training, the German case therefore suggests that the green transition cannot be addressed solely by introducing isolated environmental topics into existing curricula. Sustainable tourism increasingly requires combinations of technical, managerial, digital, entrepreneurial, and interpersonal competences. Educational provision must consequently prepare learners not only to understand sustainability principles but also to apply them in operational decision-making, customer communication, destination development, certification processes, and cooperation with multiple stakeholder groups.

At the same time, the German experience demonstrates that even relatively advanced sustainability ecosystems face barriers related to investment capacity, regulatory complexity, certification fragmentation, and the unequal resources available to tourism enterprises. This makes the German case particularly relevant for comparative analysis: it illustrates both the potential of an institutionalised sustainability framework and the challenges that emerge when sustainable tourism

moves from individual initiatives towards broader implementation across a diverse tourism economy.

2.1.2 Greece

The development of sustainable tourism in Greece is characterised by a strong interaction between national strategic priorities and locally driven initiatives. In contrast to more standardised models based predominantly on nationwide certification or regulatory frameworks, many of the most visible Greek initiatives emerge from island, rural, and community contexts. Local authorities, tourism organisations, cooperatives, non-governmental organisations, and regional stakeholders therefore play an important role in translating broad sustainability objectives into concrete tourism practices.

This decentralised character creates both opportunities and challenges. On the one hand, it allows sustainability initiatives to respond closely to local environmental conditions, cultural resources, and community needs. On the other hand, differences in institutional capacity, access to finance, infrastructure, and stakeholder coordination contribute to considerable regional variation. The Greek case therefore illustrates the importance of connecting local experimentation with a coherent national framework capable of supporting continuity, transferability, and long-term implementation.

At the strategic level, sustainable tourism has become increasingly prominent in discussions concerning the future development of the Greek tourism economy. The *Greek Tourism 2030 | Action Plans*, developed by the Institute of the Greek Tourism Confederation in cooperation with external partners, identify environmental protection and sustainability as one of the major areas requiring coordinated policy intervention. The proposed directions include strengthening the positioning of Greece as a sustainable destination, promoting eco-labelling, improving energy performance, developing sustainable transport, protecting natural and cultural heritage, and improving visitor-flow management and destination carrying capacity.

These priorities are particularly important in the Greek context because tourism activity is highly concentrated both spatially and seasonally. Measures aimed at extending the tourism season and distributing visitor demand more evenly across regions therefore serve not only economic objectives but also environmental and territorial ones. Sustainable tourism policy increasingly intersects with questions of destination capacity, pressure on local infrastructure, protection of sensitive ecosystems, and the resilience of island and coastal communities.

Environmental certification constitutes one of the mechanisms through which sustainability is being incorporated into tourism operations. The material analysed for this study indicates a growing use of schemes such as Green Key and ISO 14001 within the hospitality sector. Certification is increasingly accompanied by digital tools supporting the monitoring of environmental performance, including carbon calculators, online dashboards, and systems designed to track water and energy consumption.

The reported increase in Green Key-certified establishments, from 340 in 2020 to 510 in 2023, suggests growing interest among tourism enterprises in formalised environmental management. At the same time, certification should not be interpreted solely as an environmental instrument. It also functions as a market signal through which accommodation providers communicate environmental responsibility to visitors and differentiate themselves in an increasingly sustainability-conscious tourism market[26].

The adoption of certification and environmental management systems nevertheless remains uneven. Initial implementation costs may be difficult to absorb, particularly for small and medium-sized tourism enterprises, while fragmented incentives and limited awareness can slow broader adoption. These barriers demonstrate that the expansion of sustainable tourism depends not only on the availability of standards but also on the organisational and financial capacity of enterprises to implement them.

Digitalisation represents a second important dimension of the Greek transition. The analysed material includes examples of digital tools designed to support more sustainable travel decisions, redirect demand, and promote less environmentally intensive tourism choices. One such example is the use of AI-supported itinerary planning to connect travellers with destinations, accommodation, and transport options associated with lower environmental impacts or with off-season travel.

From an analytical perspective, the significance of such tools lies less in the technology itself than in their capacity to influence the distribution of tourism demand. Digital recommendation systems can potentially support destination-management objectives by encouraging visitors to consider less congested locations, alternative travel periods, public transport options, and certified accommodation. In this way, digitalisation becomes relevant not only to marketing and personalisation but also to broader questions of visitor-flow management and destination sustainability.

However, the use of data-driven and AI-supported tourism services introduces its own constraints. The quality of recommendations depends on the availability and reliability of destination data, which may be limited in rural and peripheral areas. Data protection requirements and the governance of personalised digital services also become relevant as tourism platforms increasingly rely on user profiling and behavioural information. Consequently, the digitalisation of sustainable tourism requires not only technological infrastructure but also data-management, regulatory, and organisational competences.

The Greek case is particularly distinctive in the development of regenerative and place-based tourism models. In rural areas such as the Peloponnese, tourism initiatives increasingly connect visitor experiences with agriculture, biodiversity, local food systems, and environmental restoration. Activities described in the analysed material include rewilding, zero-waste farming, local cooking,

[26] Hellenic Society for the Protection of Nature, *Green Key Programme in Greece*, Green Key Greece; TourXpeRience Consortium, *D2.1 Market Trends and Skills in the Tourism Sector*, 2025.

permaculture, agroforestry, and other forms of visitor participation in agricultural and ecological practices.

These initiatives indicate a transition from a model focused primarily on reducing the environmental impacts of tourism towards one that seeks to generate positive effects for ecosystems and local communities. Tourism becomes connected with the restoration of natural resources, the strengthening of local production systems, and the preservation of place-based knowledge and practices. The integration of tourism and regenerative agriculture also illustrates how sustainability can create new forms of economic diversification in rural areas.

The reported growth in bookings for interactive agri-tourism experiences suggests that such activities may also respond to changing visitor expectations. Their development nevertheless requires a broad set of competences. Tourism providers must be able to combine hospitality, agricultural knowledge, environmental interpretation, experiential design, communication, and safety requirements. Regulatory restrictions concerning educational or participatory activities on farms may additionally limit the expansion of these models.

Sustainable mobility constitutes another particularly important area of innovation in Greece, especially in island destinations. Pilot initiatives in islands such as Paros, Tilos, and Halki combine electric mobility, cycling infrastructure, renewable energy, digital mobility services, and new approaches to local transport. In such settings, the transition towards low-emission mobility is closely connected with both environmental objectives and the quality of the visitor experience.

The island context makes this transformation especially significant. Transport systems, energy supply, visitor concentration, and environmental pressures are closely interdependent, which means that mobility interventions can have effects extending beyond the transport sector itself. Electrification, shared mobility, digital ticketing, and renewable-energy integration may contribute to reducing emissions while simultaneously altering how tourists move through destinations.

At the same time, island mobility projects reveal structural barriers associated with infrastructure costs, administrative complexity, and the coordination of public and private actors. The implementation of sustainable mobility therefore depends heavily on institutional cooperation, investment capacity, and long-term planning. These conditions also influence whether successful pilot initiatives can be replicated in other destinations.

An important feature connecting the Greek examples is the central role of stakeholder cooperation. Sustainable tourism initiatives frequently involve combinations of local authorities, tourism enterprises, universities, agricultural organisations, environmental NGOs, certification bodies, and community actors. This multi-actor structure is particularly visible in regenerative tourism and island transformation, where environmental, economic, technological, and social objectives cannot be pursued effectively by a single institution.

The strong local and participatory dimension of the Greek model also has important implications for vocational education and training. Sustainable tourism in this context requires competences extending beyond traditional hospitality skills. Cultural interpretation, environmental education,

community engagement, foreign-language communication, sustainable mobility, digital tools, destination management, and cooperation with local producers all become increasingly relevant.

Digital competences are also becoming more closely connected with environmental practice. The use of environmental dashboards, certification systems, AI-supported tourism platforms, mobility applications, and data-based resource management creates demand for professionals who can combine technological literacy with an understanding of sustainability objectives. This reinforces the broader observation that green and digital competences should not be treated as separate fields of vocational preparation.

Regenerative tourism introduces an additional competence dimension. Designing tourism products linked with biodiversity, agriculture, local food systems, or environmental restoration requires the capacity to work across sectoral boundaries. Tourism professionals increasingly need to cooperate with farmers, environmental specialists, local authorities, community organisations, and technology providers. This creates demand for coordination, communication, entrepreneurial, and project-development competences alongside occupation-specific skills.

The Greek case therefore demonstrates that sustainable tourism transition is not primarily a matter of adopting individual environmental measures. It involves the reorganisation of relationships between tourism, local communities, mobility, agriculture, technology, and cultural and natural heritage. Its strength lies in the diversity of locally embedded initiatives and their capacity to connect sustainability with distinctive territorial resources.

At the same time, this diversity constitutes one of the principal challenges. Locally successful practices may remain fragmented if they are not supported by stable financing, coherent policy frameworks, institutional coordination, and mechanisms for knowledge transfer. The long-term development of sustainable tourism in Greece consequently depends on the ability to combine bottom-up innovation with national-level strategic coordination.

From a comparative perspective, Greece illustrates a model in which sustainability is strongly connected with territorial specificity. Island mobility, regenerative agriculture, local heritage, community participation, and digital visitor management respond to different aspects of the same structural challenge: how to maintain the economic importance of tourism while reducing environmental pressures and strengthening the resilience of destinations. This makes the Greek case particularly relevant for understanding sustainable tourism as a process that requires not only technological and environmental innovation but also institutional cooperation and the development of new competence configurations.

2.1.3 Italy

The Italian case illustrates a model of sustainable tourism in which environmental responsibility is increasingly combined with cultural heritage, territorial identity, digital innovation, and the development of high-value tourism experiences. Italy's diverse tourism landscape provides favourable conditions for integrating sustainability with local food systems, wine tourism, cultural tourism, rural development, and the protection of natural and historical assets. At the same time,

significant regional and organisational disparities affect the capacity of tourism enterprises and destinations to participate in the green and digital transition.

A distinctive feature of sustainable tourism development in Italy is the close relationship between place-based resources and tourism value creation. Regions characterised by strong landscape, gastronomic, agricultural, and cultural identities increasingly develop tourism products based on authenticity, local production, environmental quality, and experiential participation. Wine tourism, agritourism, cultural itineraries, slow tourism, and heritage-based experiences provide examples of how environmental and cultural assets can be incorporated into destination strategies aimed at differentiating tourism products and extending their economic value beyond conventional mass-tourism models.

This approach can be observed particularly in regions where tourism development is closely connected with local agricultural production and cultural landscapes. Sustainable wine tourism, organic agriculture, culinary routes, and immersive rural experiences increasingly combine tourism consumption with environmental awareness and local economic development. Such models may create opportunities for diversification, particularly in areas seeking to reduce dependence on highly seasonal or spatially concentrated tourism.

The Italian case also demonstrates the growing interdependence between sustainability and digitalisation. Digital tools are widely used in tourism planning, booking, destination communication, cultural interpretation, and visitor management. The analysed material indicates that digital technologies are increasingly expected to support environmentally responsible travel decisions by making information about sustainable accommodation, mobility options, lesser-known destinations, and cultural attractions more accessible.

The significance of digitalisation, however, extends beyond consumer convenience. Data analytics, mobile applications, sensors, digital ticketing systems, and destination-management tools can also contribute to visitor-flow management, particularly in areas experiencing overtourism. Digital technologies may help redirect demand towards less congested sites, facilitate access to peripheral destinations, support off-season travel, and provide information required for more effective management of cultural and environmental resources.

This function is particularly relevant in Italy because of the strong concentration of tourism in internationally recognised cities and heritage sites. The promotion of lesser-known cultural destinations and smaller towns therefore has both economic and sustainability dimensions. Redistributing visitor flows may reduce pressure on heavily visited sites while generating economic opportunities in peripheral and rural areas.

At the same time, the relationship between digitalisation and sustainable tourism in Italy remains characterised by significant inequalities. The available evidence indicates substantial differences in digital readiness between large tourism enterprises and micro-businesses, as well as between metropolitan or highly developed tourism regions and rural or less digitally advanced areas.

Smaller, family-run enterprises may lack the financial resources, infrastructure, expertise, or organisational capacity required to introduce advanced digital solutions.

These disparities are particularly important because a large proportion of the Italian tourism economy is composed of small and micro-enterprises. Their limited digital capacity may restrict access to online distribution channels, data-based destination management, environmental monitoring systems, digital certification procedures, and public funding instruments. The digital transition can therefore become a source of competitive advantage for some enterprises while simultaneously reinforcing structural inequalities within the sector.

The available material also suggests that digital adoption among consumers does not automatically translate into more sustainable tourism behaviour. Although digital technologies are widely used for travel planning and booking, the use of tools specifically supporting environmentally responsible choices remains more limited. Consumer attitudes reveal a continuing gap between declared support for sustainability and willingness to accept higher costs associated with environmentally preferable tourism products.

This gap is analytically significant. It suggests that sustainable tourism cannot rely exclusively on environmental awareness or positive attitudes. Price, convenience, accessibility, trust, and the clarity of sustainability information continue to influence tourism decisions. Digital platforms can potentially reduce some of these barriers by making sustainable options easier to identify and compare, but their effectiveness depends on users' digital literacy as well as on the reliability of the information presented.

Digital sustainability should therefore be understood not simply as the presence of technology within tourism services but as the capacity to use digital tools in ways that support environmental, social, and territorial objectives. This requires competences in data use, communication, digital marketing, destination management, environmental information, and consumer engagement.

Public intervention constitutes another important component of the Italian transition. National and European funding instruments have been used to support digitalisation, environmental certification, rural regeneration, and the modernisation of tourism enterprises. One example identified in the analysed material is financial support designed to reduce the costs associated with obtaining or maintaining environmental certifications such as EMAS, the EU Ecolabel, and selected ISO standards.

Such measures are important because certification can impose disproportionate costs on smaller tourism businesses. Financial assistance may therefore lower entry barriers and expand participation in formal environmental management systems. At the same time, funding alone does not eliminate other obstacles, including administrative complexity, limited awareness of available instruments, difficulties in preparing applications, and insufficient internal expertise.

The Italian experience thus demonstrates that the effectiveness of sustainability policy depends not only on the availability of financial resources but also on the capacity of enterprises to access and use them. Administrative and digital competences become part of the green transition because

enterprises must increasingly navigate certification procedures, funding requirements, environmental standards, and digital application systems.

Environmental certification also performs a broader market function. For tourism enterprises, it can provide a means of communicating environmental performance and strengthening credibility among consumers seeking more sustainable services. This is particularly relevant in a tourism economy in which environmental quality, landscape, heritage, and local production are frequently incorporated into destination branding.

However, certification should not be considered in isolation from operational change. Its contribution to sustainable tourism depends on whether it is accompanied by improvements in resource efficiency, waste management, sourcing practices, mobility, energy use, and other aspects of tourism operations. The Italian case therefore highlights the importance of linking formal standards with substantive organisational practices.

A particularly significant direction of tourism development in Italy is the growing interest in slow and immersive tourism. These models are closely connected with rural areas, wine regions, smaller towns, cultural landscapes, and destinations seeking to reduce seasonality or attract visitors beyond traditional tourism centres. They emphasise longer stays, deeper engagement with place, local culture, food, nature, and community life.

The Lugana wine region provides an example of this tendency. Tourism experiences are increasingly organised around vineyards, local production, guided walks, wellness activities, and forms of low-impact engagement with the landscape. The substantial share of vineyards reported as organic or undergoing organic conversion creates a basis for integrating agricultural transition with tourism branding.

The importance of such models extends beyond individual tourism products. By combining accommodation, agriculture, gastronomy, environmental practices, cultural identity, and local entrepreneurship, slow tourism can support more integrated forms of territorial development. It may also contribute to extending tourism activity into the mid- and low-season, thereby reducing some of the pressures associated with seasonal concentration.

Similar dynamics are visible in cultural tourism. Italian debates on sustainable art tourism increasingly focus on the potential of lesser-known heritage sites, smaller towns, and peripheral cultural destinations. Promoting these locations can contribute to a more balanced distribution of visitor flows while creating opportunities for local regeneration.

Digital storytelling and immersive technologies are particularly relevant in this context. They can enhance interpretation of cultural assets, provide additional layers of historical and artistic information, and increase the visibility of destinations that lack the international recognition of major Italian tourism centres. Such technologies may also support new forms of visitor engagement without requiring physical modification of sensitive heritage environments.

The use of digital and immersive technologies in museums, archaeological sites, and cultural destinations consequently represents more than an innovation in visitor experience. It can become

part of a broader strategy linking heritage preservation, education, visitor-flow management, and destination diversification.

Rural and village-based tourism represents another dimension of this territorial approach. Slow tourism, outdoor experiences, distributed accommodation models, cultural events, local trails, and adaptive reuse of existing buildings can contribute to the revitalisation of areas affected by demographic decline or economic marginalisation. The Italian *albergo diffuso* model is particularly relevant in this respect because it connects hospitality provision with existing settlement structures rather than concentrating accommodation in newly constructed facilities.

The expansion of remote and flexible working also creates new possibilities for rural tourism destinations. Accommodation models combining tourism, longer stays, local community engagement, and work-friendly infrastructure may contribute to reducing seasonality and increasing the economic use of underutilised buildings. However, such opportunities depend heavily on digital connectivity, transport accessibility, local services, and professional destination management.

Across these different areas, fragmentation emerges as a persistent structural challenge. Regional differences in infrastructure, funding capacity, digital readiness, destination governance, and access to skilled personnel affect the pace of transformation. The divide between larger and smaller enterprises is particularly important, as micro-businesses may face difficulties simultaneously adapting to environmental standards, new digital technologies, changing consumer expectations, and administrative requirements.

This fragmentation also influences the transferability of innovative models. Practices developed in highly visible wine regions, major cultural destinations, or technologically advanced areas cannot necessarily be reproduced in territories with weaker institutional capacity or infrastructure. The success of sustainable tourism initiatives therefore depends on the territorial conditions in which they are embedded.

Stakeholder cooperation is consequently essential. The Italian examples frequently involve partnerships between municipalities, tourism organisations, universities, cultural institutions, technology providers, agricultural producers, local associations, and private enterprises. Such cooperation enables tourism development to connect different policy areas, including environmental protection, cultural heritage, rural development, digitalisation, entrepreneurship, and regional regeneration.

These transformations have significant implications for vocational education and training. The emerging competence profile extends considerably beyond conventional operational tourism skills. Sustainable tourism increasingly requires the ability to understand environmental standards, communicate sustainability credentials, use digital booking and management systems, interpret data, participate in certification procedures, develop place-based tourism products, and cooperate with multiple stakeholder groups.

The development of slow, rural, cultural, and experiential tourism also requires competences in storytelling, local heritage interpretation, destination branding, customer experience design,

entrepreneurship, and community engagement. In wine and agritourism contexts, tourism knowledge may need to be combined with an understanding of agriculture, food systems, environmental practices, and local production.

Digital competences are particularly significant because they operate across almost all areas of sustainable tourism transformation. They influence not only marketing and reservations but also environmental monitoring, funding access, visitor-flow management, cultural interpretation, destination planning, and communication with consumers. The Italian case therefore reinforces the need to integrate digital and green competences rather than address them as separate areas of vocational education.

From this perspective, the main educational challenge is not simply to increase the number of technology-oriented training modules. It is to develop professionals capable of applying digital tools to concrete sustainability problems and territorial development objectives. This includes using data to manage visitor flows, communicating certification information, developing digital narratives for cultural heritage, supporting resource-efficient operations, and designing tourism products capable of distributing demand across seasons and locations.

The Italian case ultimately reveals a dual dynamic. On the one hand, Italy possesses a particularly rich set of resources for sustainable tourism development: cultural heritage, diverse landscapes, strong local identities, agricultural traditions, internationally recognised gastronomy, and extensive networks of small tourism enterprises. These resources support the development of slow, immersive, cultural, rural, and experience-based tourism.

On the other hand, the same decentralised and highly fragmented structure that generates diversity can impede coordinated transformation. Differences in digital readiness, institutional capacity, access to finance, infrastructure, and professional skills limit the diffusion of innovation.

Italy therefore illustrates a model in which sustainable tourism development depends substantially on the capacity to connect local assets with broader systems of digital innovation, environmental governance, public support, and competence development. Its experience demonstrates that heritage and territorial identity can become important resources for sustainable tourism, but their effective use requires institutional coordination, accessible support mechanisms, digital capacity, and a workforce equipped to integrate environmental, technological, entrepreneurial, and cultural competences.

2.1.4 Poland

The development of sustainable tourism in Poland is characterised by a strong regional and territorial dimension. Rather than being driven by a single dominant national model, many initiatives emerge around natural assets, rural areas, protected landscapes, cultural heritage, active tourism, and destinations located outside the country's main tourism centres. Digitalisation, low-emission mobility, environmental education, and the promotion of lesser-known regions increasingly contribute to this transformation.

This pattern reflects the structure of the Polish tourism market, in which domestic tourism and nature-based travel play an important role alongside urban and cultural tourism. Rural areas, lake districts, mountain regions, national parks, and smaller destinations offer considerable potential for tourism models based on lower visitor concentration, local resources, outdoor activities, and longer engagement with place. Sustainable tourism development can therefore perform not only an environmental function but also a territorial one by supporting local economies and redistributing tourism demand.

One visible area of transformation concerns environmental standards in accommodation. Regional examples indicate growing interest in eco-certification and investments in energy efficiency, renewable energy, water management, and environmentally responsible procurement. In destinations with a strong nature-based tourism profile, such measures can contribute to both environmental performance and market differentiation.

At the same time, certification remains more difficult for smaller tourism enterprises. The costs of obtaining environmental labels, limited specialist knowledge, and uncertainty concerning procedures can create substantial barriers to participation. This is particularly relevant in Poland because a significant part of tourism provision outside major cities is based on small accommodation establishments, family businesses, agritourism, and locally operated tourism services.

The effectiveness of certification-based sustainability models therefore depends not only on the existence of environmental standards but also on the availability of advisory support, accessible procedures, financial incentives, and competences allowing small enterprises to understand and implement them. Without such support, certification may remain concentrated among operators with greater organisational and financial capacity.

Low-emission mobility constitutes another important dimension of sustainable tourism development in Poland. Cycling tourism, e-bike services, integrated public transport, and digital route-planning applications are becoming increasingly relevant both in urban destinations and in rural or cross-regional tourism networks. Their significance extends beyond transport policy, as they influence destination accessibility, visitor-flow distribution, and opportunities for tourism development outside highly concentrated locations.

The development of cycling infrastructure provides a particularly visible example. Regional and cross-border routes increasingly connect tourism with sustainable mobility and local economic development. Investments in cycling trails can support accommodation providers, gastronomy, attractions, and other services located along the routes while simultaneously creating alternatives to car-based tourism.

The analysed material concerning the Pomeranian region illustrates the scale of this development through the expansion of marked cycling routes and their connection with international EuroVelo networks. It also points to growing integration between cycling and public transport, which is important for the creation of genuinely low-emission tourism systems rather than isolated recreational infrastructure.

Urban destinations are experimenting with similar solutions. In Kraków, for example, the expansion of cycling and e-bike services and the use of digital mobility tools illustrate attempts to reduce the environmental pressures associated with visitor movement. Such initiatives are especially relevant in historic urban areas, where transport capacity, air quality, pedestrian congestion, and heritage protection frequently interact.

Digital technologies are becoming increasingly connected with sustainable mobility. GPS-supported applications, route planners, public-transport integration, and visitor information systems can facilitate lower-emission travel choices and make dispersed tourism products more accessible. In this sense, digitalisation performs an enabling role: it connects infrastructure with users and allows tourism experiences to be organised across wider territories.

This relationship between sustainability and digitalisation is also visible in environmental education. The analysed material includes examples of virtual trails, immersive interpretation, digital storytelling, and XR-based approaches intended to support access to natural heritage and biodiversity education. Such technologies may be particularly useful in protected areas, where increasing physical visitor numbers can conflict with conservation objectives.

Virtual or immersive access cannot substitute for direct experience of natural environments, but it can complement conventional tourism and educational practices. Digital representations of sensitive ecosystems may support pre-visit learning, increase awareness of environmental pressures, provide access for people unable to visit physically, and reduce the need for certain forms of on-site interpretation.

The introduction of XR in protected and natural areas also illustrates broader implementation challenges. Technological infrastructure requires maintenance, specialist expertise, appropriate content design, and long-term institutional support. In public institutions, procurement procedures and limited technological capacity may further slow adoption. Consequently, the educational value of immersive technologies depends not only on technological availability but also on organisational readiness and professional competences.

Rural tourism represents another important area of sustainable tourism development in Poland. Agritourism, local food systems, environmental education, and nature-based accommodation create opportunities to link tourism with regional development and climate awareness. In regions such as Podkarpackie, the analysed material points to tourism initiatives combining farm stays with permaculture, local production, and educational components related to climate and sustainable lifestyles.

Such models may become increasingly relevant as travellers seek quieter destinations, nature-based experiences, and alternatives to heavily commercialised tourism centres. They also offer opportunities to strengthen local value chains because tourism expenditure can be connected with agriculture, food production, crafts, guiding, and other locally provided services.

At the same time, rural tourism faces structural constraints. Weak destination coordination, limited transport accessibility, insufficient promotion, spatial planning restrictions, and uneven digital

infrastructure can make it difficult for individual initiatives to achieve market visibility. The development of sustainable rural tourism therefore requires cooperation that extends beyond individual tourism enterprises.

The role of local action groups, non-governmental organisations, municipalities, and regional tourism organisations is particularly important in this respect. These actors can connect tourism development with broader objectives related to rural development, environmental education, cultural heritage, and community participation. European and national funding programmes can further support infrastructure and innovation, although the continuity of initiatives after external funding ends remains an important issue.

Mountain tourism reveals another dimension of the sustainability challenge. The concentration of visitors in the most popular areas creates pressure on trails, transport systems, local communities, and sensitive ecosystems. Approaches associated with slow tourism can contribute to reducing these pressures by encouraging travel outside peak periods, promoting alternative routes, and increasing the visibility of local cultural and natural attractions beyond the most congested sites.

In the Polish context, the Tatra Mountains provide a particularly relevant example of the tension between high-volume tourism and environmental capacity. Measures aimed at redistributing visitors across routes and seasons demonstrate that sustainable tourism increasingly involves active management of tourist flows rather than simply promotion of environmental awareness.

Such approaches require strong guiding and interpretation competences. Local guides and tourism operators can influence where visitors travel, how they understand natural and cultural environments, and whether less visible locations become meaningful alternatives rather than merely substitutes for overcrowded attractions. Sustainable visitor management therefore depends partly on human competences and not exclusively on infrastructure or regulation.

Climate change is also beginning to influence tourism behaviour and destination choices. The analysed material suggests that Polish travellers are increasingly aware that extreme weather and changing climatic conditions may affect their travel decisions. At the same time, financial considerations remain a major determinant of tourism behaviour.

This interaction is important for understanding the limits of sustainability-oriented consumer change. Environmental awareness does not automatically lead to more sustainable purchasing decisions when lower-emission transport, certified accommodation, or environmentally responsible services are perceived as more expensive or less accessible. Sustainable tourism strategies must therefore take into account affordability as well as environmental preference.

The relatively strong preference for domestic travel may nevertheless create opportunities for sustainable destination development within Poland. Greater interest in national and regional destinations can support rural areas and smaller tourism centres, particularly if tourism products are connected with rail and cycling mobility, local culture, natural heritage, and environmentally responsible accommodation.

From this perspective, the development of sustainable tourism in Poland is closely linked with the concept of territorial redistribution. Digital tools can increase the visibility of lesser-known destinations, cycling routes can connect smaller communities, slow tourism can reduce seasonal and spatial concentration, and rural tourism can create new forms of local economic activity. Sustainability therefore intersects with regional cohesion and local development.

However, the analysed material also indicates persistent fragmentation. Infrastructure quality differs between regions, environmental certification remains uneven, sustainable mobility networks are not consistently integrated, and tourism initiatives often depend on local institutional capacity. Differences in resources and governance can therefore determine whether sustainable tourism remains a set of individual projects or develops into a more coherent destination model.

This fragmentation is particularly significant from the perspective of vocational education and training. Although examples of cooperation between tourism enterprises and education providers can be identified, the relationship between the VET system and emerging green competence requirements remains relatively weak. The development of isolated training modules does not necessarily create a coherent response to changing labour-market needs.

The Polish case indicates demand for several interconnected competence areas. Environmental certification requires knowledge of standards, resource efficiency, environmental management, and sustainable procurement. Low-emission tourism requires competences associated with mobility planning, route development, infrastructure management, and digital navigation systems. Rural and slow tourism require entrepreneurship, local-product development, interpretation, guiding, storytelling, and community cooperation.

Digital competences cut across all of these areas. Mobile applications, tourism platforms, XR tools, visitor-flow monitoring, online promotion, route planning, and digital interpretation increasingly shape both tourism operations and visitor behaviour. As in the other national cases, the distinction between green and digital skills therefore becomes increasingly difficult to sustain in practice.

Sustainable tourism also creates demand for transversal competences. Developing regional tourism networks requires cooperation between enterprises, local authorities, NGOs, educational institutions, transport providers, and destination organisations. Professionals must consequently be capable of partnership building, project management, communication, and working across institutional and sectoral boundaries.

For VET providers, this suggests the need to move beyond narrowly defined occupational training. Learning environments should enable students to address real destination-level challenges, including visitor congestion, low-emission mobility, environmental management, rural tourism product development, and the use of digital technologies in natural and cultural interpretation.

Cooperation with small and medium-sized enterprises is particularly important because these businesses often have limited capacity to invest independently in training or innovation. Work-based

learning and jointly developed curricula can help ensure that green and digital competences are connected with the actual operating conditions of the tourism sector.

The Polish case therefore illustrates a model of sustainable tourism transition that is strongly rooted in regional resources and decentralised initiatives. Its potential lies in the combination of nature-based tourism, domestic travel, cycling and active mobility, rural development, environmental education, and digital tools capable of increasing the visibility and accessibility of less intensively visited destinations.

At the same time, the transition remains uneven. Limited coordination, differences in infrastructure, inconsistent access to expertise, and weak integration between emerging tourism practices and vocational education reduce the capacity to scale individual innovations.

From a comparative perspective, Poland demonstrates that sustainable tourism need not develop primarily through premium positioning or highly institutionalised certification systems. It can also emerge through the gradual integration of mobility, regional development, natural assets, digital accessibility, and local entrepreneurship. The long-term effectiveness of this model will depend on whether dispersed regional initiatives can be connected through more coherent governance, competence development, and cooperation between tourism enterprises, education providers, public authorities, and local communities.

2.1.5 Portugal

Portugal represents a comparatively strategic and policy-driven model of sustainable tourism development, in which environmental objectives, destination competitiveness, digitalisation, and evidence-based management are increasingly integrated within a common national framework. This approach reflects the particular vulnerability of Portuguese tourism to climate-related pressures, including coastal exposure, water scarcity, seasonality, and the concentration of visitors in selected destinations and cultural sites.

A significant feature of the Portuguese approach is the long-term integration of sustainability into national tourism policy. The Estratégia Turismo 2027 positions sustainability, competitiveness, innovation, and territorial cohesion as interconnected objectives rather than separate policy areas. The framework emphasises responsible tourism practices, resource efficiency, circular economy principles, energy efficiency, waste reduction, reduction of seasonality, and the development of year-round tourism products.

This strategic orientation is important because it provides a broader institutional context for regional and local initiatives. Rather than relying solely on isolated tourism projects, the Portuguese model seeks to connect destination development with public policy, stakeholder consultation, innovation support, entrepreneurship, and investment mechanisms. The involvement of public authorities, tourism organisations, enterprises, financial institutions, and regional stakeholders reflects an effort to treat sustainable tourism as a system-level transition.

The environmental dimension of this transition is particularly visible in coastal and water-sensitive destinations. Programmes associated with environmental quality, coastal protection,

environmental education, and sustainable mobility illustrate the need to respond to the ecological vulnerability of tourism-intensive areas. In coastal regions, sustainability therefore involves not only reducing the environmental footprint of tourism activity but also adapting destination management to the effects of climate change.

Low-emission mobility forms part of this response. Investment in cycling, walking, maritime routes, and their integration with public transport can reduce dependence on private cars while improving access to local attractions and distributing visitor flows across wider territories. Such infrastructure can simultaneously contribute to environmental objectives and to the development of slow and experience-based tourism.

The Portuguese case also demonstrates the increasing importance of data in sustainable destination management. The development of sub-national indicators and regional observatories reflects a shift towards more evidence-based approaches to tourism policy. Networks such as Destination Watch are intended to improve the monitoring of seasonality, resource use, visitor distribution, and other indicators relevant to sustainability.

This development is particularly important because national averages can conceal substantial regional differences. Tourism pressure, water availability, mobility patterns, accommodation structures, and seasonality vary significantly across Portuguese destinations. Sub-national data therefore enable tourism policy to respond more precisely to local environmental and economic conditions.

The use of sustainability indicators also changes the competence requirements associated with destination management. Tourism professionals increasingly need to understand not only conventional market indicators but also data concerning water consumption, emissions, visitor concentration, transport patterns, and environmental performance. The green transition consequently becomes closely connected with data literacy and analytical capability.

Water management provides a particularly relevant example. In destinations affected by water scarcity, accommodation providers and destination organisations increasingly need to monitor consumption, introduce efficiency measures, and integrate environmental resource constraints into operational planning. Such practices illustrate how climate adaptation is becoming embedded in everyday tourism management.

Seasonality remains another major structural challenge. The concentration of overnight stays within relatively short periods generates pressure on infrastructure, natural resources, local communities, and labour markets. Strategies aimed at distributing tourism activity across seasons and regions can therefore serve multiple sustainability objectives simultaneously.

Digitalisation supports this redistribution in several ways. Digital platforms can increase the visibility of lesser-known destinations, facilitate travel planning, promote alternative tourism products, and improve access to cultural and natural heritage. Data-based destination management can additionally help identify areas of excessive concentration and support decisions concerning visitor flows.

The use of digital and immersive technologies is particularly visible in cultural tourism and heritage interpretation. Portuguese museums and cultural institutions have experimented with Virtual Reality and Augmented Reality to create more interactive and accessible visitor experiences. Virtual tours, three-dimensional models, digital reconstructions, and immersive interpretation tools can extend access to cultural resources while providing additional educational value.

These technologies gained further significance during and after the COVID-19 pandemic, when museums and cultural institutions expanded online access and digital forms of engagement. Their continued use suggests that immersive technologies are becoming part of a broader digital transformation of cultural tourism rather than remaining exclusively emergency substitutes for physical visits.

However, the contribution of immersive technologies to sustainable tourism should not be reduced to visitor entertainment. In heritage contexts, they may support conservation, accessibility, interpretation, and visitor management. Digital access can provide alternative ways of engaging with sensitive sites, while augmented interpretation can enrich visitor experience without requiring extensive physical intervention in historical environments.

The Douro region illustrates a related form of digital transformation. In wine tourism and cultural heritage contexts, digital platforms, AR, VR, AI-supported services, and data analytics are increasingly considered as tools for enhancing interpretation, personalising visitor experiences, and strengthening destination attractiveness.

The relevance of these technologies to sustainability lies partly in their capacity to connect heritage preservation with tourism development. Digital interpretation can make cultural assets more accessible while reducing pressure on particular physical locations. Data-supported destination management may also help balance visitor flows and improve the planning of tourism services.

At the same time, technology adoption in regional destinations remains uneven. Infrastructure gaps, implementation costs, limited access to expertise, and the need for professional training can restrict the diffusion of immersive technologies. Cultural sensitivity is also important: digital innovation must support rather than displace the authenticity and meaning of local heritage.

This tension is particularly relevant in wine tourism, where the value of the visitor experience depends heavily on landscape, local production, tradition, and place-based identity. Technologies can enhance interpretation and accessibility, but their contribution remains dependent on how effectively they are integrated with local cultural and economic ecosystems.

The Portuguese case also reveals the importance of managing the relationship between tourism intensity and heritage conservation. The example of the Jerónimos Monastery demonstrates how high visitor numbers can affect indoor environmental conditions and potentially threaten the conservation of sensitive historic structures.

Monitoring systems for temperature, humidity, carbon dioxide, and visitor density illustrate the role of technology in balancing access with preservation. In this context, digitalisation and

sustainability converge around a concrete management problem: how to maintain the economic and cultural benefits of tourism without exceeding the physical capacity of heritage environments.

This approach shifts the discussion from tourism growth alone towards questions of carrying capacity and resource limits. Sustainable cultural tourism requires decisions about the number, timing, and distribution of visitors, as well as the ability to monitor the effects of tourism activity on buildings, collections, and the visitor environment.

Such decisions depend on interdisciplinary competences. Tourism professionals increasingly need to work with conservation specialists, data analysts, engineers, cultural institutions, and public authorities. Sustainable destination management therefore requires the ability to interpret evidence and coordinate across professional and institutional boundaries.

The strong strategic orientation of Portuguese tourism is also reflected in the emphasis on partnership. National and regional tourism organisations, universities, local authorities, destination management organisations, technology companies, museums, and tourism enterprises increasingly participate in collaborative arrangements supporting innovation and sustainability.

This cooperation is particularly important in areas where individual tourism enterprises lack the capacity to implement new technologies or sustainability measures independently. Shared observatories, regional innovation networks, collaborative digital-content development, and public-private initiatives can reduce some of the barriers associated with cost, expertise, and organisational capacity.

Nevertheless, uneven participation remains a challenge. Micro-enterprises may have greater difficulty engaging with certification processes, digital transformation, data collection, or technological innovation. Regional disparities can also affect access to funding, infrastructure, and specialised knowledge.

The Portuguese model therefore combines relatively coherent strategic direction with uneven implementation capacity. This distinction is important because the existence of a national sustainability framework does not automatically guarantee equivalent transformation across all destinations or business categories.

These developments have direct implications for vocational education and training. Climate adaptation, water management, environmental communication, sustainable mobility, digital heritage interpretation, and data-based destination management all require competences that extend beyond traditional tourism occupations.

The integration of XR technologies into tourism education and professional training adds another dimension. Immersive simulations and digital reconstructions can support the development of guiding, interpretation, conservation awareness, and visitor-management competences. They may be particularly valuable where direct access to fragile environments or heritage sites is limited.

At the same time, the effective educational use of XR requires more than technical access. Educators and tourism professionals need competences in pedagogical design, digital storytelling,

content development, accessibility, and critical evaluation of technology. This reinforces the broader conclusion that digital competence in tourism should be understood as an applied and context-dependent capability.

The Portuguese case also highlights the growing need for environmental-management competences. Professionals increasingly require the ability to interpret sustainability indicators, monitor resource consumption, understand climate-related risks, and translate environmental information into operational decisions.

The combination of data, climate adaptation, heritage management, mobility, and digital interpretation suggests that future tourism competence profiles will be increasingly hybrid. Tourism professionals will need to integrate hospitality and service competences with environmental awareness, digital literacy, analytical skills, communication, and stakeholder coordination.

From a comparative perspective, Portugal therefore illustrates a sustainable tourism model in which strategic governance and evidence-based management play a particularly prominent role. While local initiatives and technological experimentation remain important, they are increasingly embedded within broader national objectives concerning competitiveness, resource efficiency, seasonality, territorial distribution, and climate resilience.

The strength of this model lies in its capacity to connect sustainability with tourism policy, destination data, heritage conservation, digital transformation, and professional development. Its main limitation lies in the uneven capacity of regions and enterprises to participate fully in this transition.

Portugal consequently demonstrates that sustainable tourism increasingly depends not only on adopting environmentally responsible practices but also on developing institutional systems capable of monitoring, coordinating, and adapting tourism activity. The long-term effectiveness of this transition will depend on whether strategic ambitions can be translated into consistent implementation across regions, enterprises, cultural institutions, and vocational education systems.

2.1.6 Spain

Spain represents a model of sustainable tourism transformation in which environmental objectives are increasingly combined with territorial diversification, heritage management, tourism standards, circular economy principles, and the development of regenerative forms of tourism. The scale and diversity of the Spanish tourism economy make this transition particularly complex. Coastal destinations, major cities, rural areas, cultural heritage sites, wellness centres, and nature-based tourism regions face different sustainability pressures and require differentiated responses.

A central feature of the Spanish approach is the growing emphasis on destination-level transformation. Programmes such as the *Plan de Sostenibilidad Turística en Destinos* support the modernisation of tourism infrastructure, improvements in energy and water efficiency, and the development of more sustainable destination-management practices. This reflects a broader shift away from sustainability understood primarily as an attribute of individual tourism enterprises towards sustainability understood as a characteristic of entire destinations.

Such an approach is particularly important in a country where tourism activity is highly concentrated in selected coastal, urban, and cultural destinations. Sustainable tourism policy therefore increasingly addresses not only the environmental performance of individual businesses but also the spatial distribution of visitor flows, the capacity of local infrastructure, the quality of life of residents, and the long-term resilience of destination economies.

Territorial diversification is one of the mechanisms through which these pressures are being addressed. Spain continues to develop tourism products connected with rural areas, cultural landscapes, gastronomy, wine tourism, industrial heritage, nature-based tourism, and less intensively visited destinations. These forms of tourism can contribute to reducing pressure on established tourism centres while creating economic opportunities in inland and peripheral regions.

The promotion of sustainable mobility, green accommodation, active tourism, local food systems, hiking routes, and nature-based experiences forms part of this process. Digital platforms and national tourism communication strategies increasingly present such products as components of a more responsible and diversified tourism offer.

This development has implications that extend beyond marketing. By increasing the visibility of less congested destinations and alternative forms of tourism, digital promotion can contribute to the spatial redistribution of tourism demand. In this sense, digitalisation becomes one of the instruments through which territorial cohesion and sustainability objectives can be pursued simultaneously.

The relationship between sustainability and destination branding is particularly visible in national tourism promotion. Turespaña's communication activities increasingly emphasise environmental responsibility, local communities, sustainable transport, natural assets, and certified tourism products. The strategic importance of such communication lies in its capacity to influence how Spain is positioned internationally: not exclusively as a high-volume sun-and-beach destination, but increasingly as a diversified tourism system capable of offering nature-based, rural, cultural, wellness, gastronomic, and low-impact experiences.

Certification and standardisation constitute another significant dimension of the Spanish transition. The development of UNE 0083:2024 reflects an effort to formalise sustainability requirements and provide tourism organisations with a framework for aligning operational practices with broader sustainability objectives[27].

The importance of standardisation is particularly evident in a highly decentralised tourism system. Differences in regional policies, incentives, certification procedures, and implementation capacity can make it difficult to establish comparable sustainability practices across territories. Common standards can therefore contribute to greater transparency and coherence.

Certification also performs a market function. Tourism organisations may use formal sustainability standards to communicate environmental and social performance, strengthen

[27] Asociación Española de Normalización (UNE), *Especificación UNE 0083:2024. Contribución de las organizaciones turísticas a los Objetivos de Desarrollo Sostenible (ODS). Requisitos y recomendaciones*, UNE, 2024.

consumer trust, and differentiate their services. At the same time, certification processes can be demanding, especially for small and medium-sized enterprises that lack specialist staff, financial resources, or familiarity with environmental management systems.

The Spanish case therefore illustrates a recurrent challenge of sustainable tourism transition: instruments designed to improve environmental performance may unintentionally favour better-resourced organisations unless accompanied by accessible training, advisory services, financial support, and simplified implementation procedures.

This issue is especially relevant in rural and inland destinations, where tourism businesses are frequently small and where the development of sustainable infrastructure may require substantial initial investment. Energy systems, water management, environmental certification, digital tools, and new tourism products can generate long-term value, but the initial costs may exceed the financial capacity of individual operators.

Public and European funding consequently play an important enabling role. Investments associated with the green and digital transitions can support destination modernisation, rural diversification, and the development of tourism products capable of reducing seasonality and pressure on heavily visited areas.

Another important development in Spain is the growing relevance of circular economy principles and broader concepts of corporate responsibility. Tourism enterprises increasingly experiment with waste reduction, renewable energy, sustainable sourcing, reuse of materials, elimination of single-use products, and systems for measuring environmental performance.

The growing visibility of B Corp[28] approaches and other models based on measurable social and environmental responsibility illustrates a shift from sustainability as a limited operational programme towards sustainability as an element of organisational identity and governance. This distinction is important because environmental measures alone do not necessarily transform the business model. Circular and responsibility-oriented approaches require organisations to reconsider procurement, supply chains, resource use, relationships with local communities, and the way tourism value is created and distributed.

The Spanish material also points to growing interest in regenerative tourism. While sustainable tourism traditionally focuses on reducing negative environmental and social impacts, regenerative approaches seek to generate positive effects for ecosystems, communities, and local economies. Examples identified in the analysed material include projects linked with marine ecosystem restoration, local gastronomy, community engagement, cultural revitalisation, and environmental education. Such initiatives demonstrate how tourism can be connected with conservation and social development rather than functioning as an activity external to them.

The significance of regenerative tourism lies partly in this change of perspective. Instead of asking only how tourism can become less harmful, regenerative approaches ask how tourism activity

[28] B Lab, *About B Corp Certification*, B Lab, https://www.bcorporation.net/en-us/certification/

can contribute to improving the ecological or social condition of the destination. This model nevertheless presents significant implementation challenges. Regenerative tourism requires close cooperation with local communities, environmental organisations, public authorities, and other stakeholders. It also requires the ability to distinguish substantive environmental and social outcomes from superficial sustainability communication.

The risk of greenwashing becomes particularly relevant as sustainability increasingly contributes to tourism branding. Businesses and destinations may have strong incentives to communicate environmental responsibility even when their operational practices remain limited. Transparent standards, measurable indicators, and credible reporting therefore become increasingly important.

Regenerative approaches also require competences that differ from those traditionally associated with tourism operations. Professionals must increasingly understand stakeholder participation, environmental restoration, community engagement, impact assessment, and the management of relationships between tourism enterprises and local ecosystems.

Wellness tourism represents another emerging dimension of the Spanish sustainability landscape. Tourism products related to health, wellbeing, nature, mindfulness, nutrition, and restorative experiences increasingly intersect with environmental and regenerative approaches.

This connection is especially visible in destinations seeking to combine nature-based tourism with longer stays, lower seasonal concentration, and higher-value visitor experiences. Wellness tourism can provide opportunities for destinations located outside the most heavily visited tourism centres, particularly where natural landscapes and local food systems form part of the visitor experience.

From a sustainability perspective, the significance of wellness tourism lies less in the wellness market itself than in its potential connection with territorial diversification. When developed in rural, inland, or natural settings, wellness products may contribute to redirecting tourism demand away from highly concentrated urban and coastal destinations.

However, this model also involves risks. The development of environmentally responsible wellness infrastructure can require significant investment, while specialised professional competences combining health, hospitality, sustainability, and management remain limited. Without appropriate standards, there is also a risk that sustainability becomes primarily a marketing attribute rather than a substantive component of service design. The strong relationship between sustainability, wellbeing, and destination development therefore creates new competence requirements. Professionals need to understand not only customer service and tourism operations but also environmental management, healthy lifestyles, local products, responsible consumption, and the design of tourism experiences aligned with the environmental capacity of destinations.

Technology is increasingly present across these different areas of transformation. Digital platforms support destination communication, sustainable product visibility, visitor-flow management, and environmental monitoring. XR applications are also used in cultural tourism and

heritage interpretation, including virtual reconstructions of monuments and immersive cultural routes.

Such technologies may contribute to sustainability by improving accessibility and enabling visitors to engage with heritage in alternative ways. Virtual and augmented experiences can provide access to cultural content for people with mobility limitations, support interpretation of damaged or inaccessible sites, and potentially reduce physical pressure on sensitive environments. In heritage management, the value of immersive technologies depends on how they are integrated with conservation objectives. Technology should not be treated solely as an attraction in itself. Its contribution becomes more significant when it supports interpretation, accessibility, education, or more balanced management of visitor flows.

The Spanish case therefore reveals an increasingly complex relationship between digital innovation and sustainability. Technologies are relevant not only to marketing and customer experience but also to resource monitoring, carbon-footprint measurement, accessibility, certification, destination planning, and the management of cultural heritage.

These transformations have important implications for vocational education and training. Sustainable tourism requires competence profiles combining environmental knowledge with digital skills, entrepreneurship, customer experience design, heritage interpretation, stakeholder cooperation, and destination management.

Certification and standardisation create demand for knowledge of sustainability criteria, environmental indicators, documentation, and compliance procedures. Circular economy models require understanding of resource flows, procurement, waste management, and organisational change.

Regenerative tourism introduces additional requirements associated with community engagement, environmental and social impact, co-creation, and partnership development. Wellness tourism creates demand for interdisciplinary competences connecting hospitality, wellbeing, environmental awareness, and personalised service.

The increasing use of digital and immersive technologies adds another layer. Tourism professionals and educators need to understand not only how to operate digital tools but also how to use them purposefully in visitor management, heritage interpretation, accessibility, environmental communication, and sustainable product development.

This suggests that the Spanish tourism transition cannot be addressed through isolated training modules dedicated separately to sustainability, digitalisation, or entrepreneurship. The emerging competence profile is inherently integrated. Professionals need to understand how environmental, technological, social, and business considerations interact within specific tourism contexts.

The decentralised institutional structure of Spain adds further complexity. Autonomous communities have significant influence over tourism development, which allows policies and products to respond to regional conditions but can also produce differences in standards, incentives, implementation capacity, and strategic priorities.

This creates a governance challenge. Sustainable tourism requires enough flexibility to respond to territorial diversity while also maintaining sufficient coordination to ensure transparency, transferability of practices, and comparable levels of environmental and social responsibility.

For VET systems, this means that cooperation with regional tourism authorities, enterprises, destination organisations, and local communities becomes especially important. Education and training programmes need to reflect the diversity of tourism models while also preparing learners for broader standards and sustainability principles. The Spanish case therefore illustrates a model of sustainable tourism transformation built around diversification, standardisation, regenerative approaches, territorial cohesion, and increasingly integrated forms of destination management.

Its particular strength lies in the possibility of using tourism diversification to connect sustainability with regional development. Rural tourism, wellness, cultural heritage, nature-based experiences, regenerative projects, and thematic routes can reduce excessive dependence on highly concentrated tourism centres while creating opportunities for local economies. At the same time, this model faces significant challenges associated with implementation costs, regulatory fragmentation, differences between autonomous communities, limited capacity among SMEs, and the need to ensure that sustainability commitments produce measurable environmental and social outcomes.

From a comparative perspective, Spain demonstrates that the transition towards sustainable tourism increasingly involves not only environmental improvement but also a reconsideration of where tourism takes place, how tourism value is distributed territorially, and how destinations manage the relationship between visitor demand, local communities, cultural heritage, and environmental capacity.

The long-term effectiveness of the Spanish model will therefore depend on the ability to combine destination-level investment with coherent standards, accessible support for smaller enterprises, appropriate professional competences, and governance mechanisms capable of balancing regional diversity with common sustainability objectives.

2.2 Repository of Best Practices

The transition towards sustainable tourism depends not only on policy frameworks and changing market expectations but also on the capacity of tourism organisations, destinations, educational institutions, and local communities to translate sustainability principles into operational practice. The examples analysed in this section provide insight into how environmental objectives are implemented through concrete organisational models, competence-development mechanisms, forms of entrepreneurship, and stakeholder cooperation.

The analysis focuses particularly on the relationship between green competences and entrepreneurial capabilities. Sustainable tourism practices increasingly require knowledge related to resource efficiency, biodiversity protection, sustainable mobility, environmental certification, renewable energy, waste management, and climate adaptation. Their effective application, however, also depends on competences traditionally associated with entrepreneurship and organisational

development, including innovation, business modelling, risk management, marketing, service design, partnership building, and the ability to identify new sources of value.

The cases examined across the six countries therefore provide more than examples of environmentally responsible tourism activity. They illustrate different mechanisms through which sustainability becomes embedded in organisational routines, tourism products, business strategies, educational processes, and regional development. Particular attention is paid to the conditions that support implementation, the competence gaps that constrain it, the forms of training used to address those gaps, and the extent to which particular practices may be adapted to other tourism contexts.

2.2.1 Germany

The German examples reveal a comparatively mature ecosystem in which sustainable tourism practices are supported by environmental certification, cross-sectoral cooperation, regional networks, vocational and workplace learning, and the development of specialised tourism products. Although the initiatives differ considerably in scale and organisational form, they demonstrate a recurring pattern: environmental objectives are most effectively implemented when green competences are combined with entrepreneurial capabilities and embedded within stable networks of institutions and stakeholders.

This pattern can be observed across initiatives ranging from individual tourism enterprises to regional mobility systems, ecological corridors, cross-border destination networks, and education-oriented programmes. The cases considered include the Lake Constance sustainable tourism initiative, Biohotel Eggensberger, Green Key certification, Green Belt Germany, Alpine Pearls, and the Wadden Sea Ecotourism Academy. Together, they illustrate how sustainability can be operationalised at business, destination, regional, and transnational levels.

One of the clearest findings concerns the importance of cooperation. The Lake Constance initiative demonstrates the complexity of sustainable tourism development in a cross-border region, where transport, accommodation, agriculture, environmental protection, and destination management involve actors operating under different institutional and regulatory systems. The initiative brings together local governments, transport providers, tourism enterprises, environmental organisations, SMEs, and agricultural cooperatives.

Its significance lies not only in the environmental measures implemented but also in the organisational capabilities required to coordinate them. Sustainable mobility, water conservation, agritourism, and certification depend on actors being able to cooperate across administrative, sectoral, and linguistic boundaries. Competence development therefore includes not only technical knowledge but also intercultural communication, partnership management, collaborative planning, and the capacity to design integrated tourism services.

The same case demonstrates how entrepreneurial competences can reinforce environmental transformation. Green marketing, sustainable service design, business coaching, regional clustering, and joint innovation activities help translate environmental objectives into tourism products that can

generate economic value. Digital route planners, integrated mobility solutions, and farm-to-table tourism experiences illustrate how sustainability can become a source of product and service innovation rather than merely a compliance requirement.

Cross-border cooperation nevertheless creates significant barriers. Differences in regulation, funding mechanisms, language, and institutional responsibilities increase transaction costs and can slow implementation. This suggests that the transferability of sustainable tourism models depends partly on governance capacity. Environmental innovation alone is insufficient when organisations lack mechanisms for coordinating decisions across jurisdictions and sectors.

A different scale of transformation is illustrated by Biohotel Eggensberger. In this case, sustainability is integrated into the operating model of an individual family-owned hospitality enterprise. Renewable energy, resource conservation, waste management, local and organic sourcing, biodiversity considerations, and environmental certification are incorporated into everyday hotel management.

The case is particularly relevant because it demonstrates that green transformation involves organisational learning. Staff require practical knowledge of energy systems, waste management, environmental standards, and sustainable service delivery. These competences cannot be developed exclusively through formal instruction; they are also acquired through workplace learning, cooperation with vocational schools, certification workshops, and continuous engagement with operational sustainability problems.

This interaction between formal and workplace learning is important for vocational education and training. The hotel functions not only as an enterprise implementing sustainability measures but also as a learning environment in which environmental knowledge is translated into professional practice.

Entrepreneurial competence is equally important. Environmental investments involve financial risk, decisions about positioning, relationships with suppliers, and uncertainty regarding customer demand. The ability to integrate sustainability into business strategy therefore becomes as significant as technical environmental knowledge. The case illustrates how eco-certification and environmental performance can contribute to brand differentiation, customer loyalty, and the development of new tourism products.

However, the experience also reveals constraints that are particularly relevant to SMEs. Access to green investment, availability of sustainable suppliers, certification requirements, and the time needed to develop staff competences may limit the pace of transformation. The case therefore demonstrates that environmentally responsible entrepreneurship depends partly on the surrounding business and skills ecosystem.

The Green Key model illustrates a more standardised mechanism for disseminating sustainable practices. Unlike an individual enterprise case, certification creates a structured framework through

which environmental requirements can be introduced across a larger number of accommodation providers[29]. Its value lies partly in converting broad sustainability principles into operational criteria concerning energy, water, waste, procurement, environmental communication, and staff behaviour. Certification can therefore function as a competence-development instrument by defining what organisations and employees need to know and implement.

Training, guidelines, audits, toolkits, and peer learning complement the formal certification process. This suggests that standards are most effective when accompanied by learning mechanisms rather than treated exclusively as control instruments.

The case also illustrates the connection between environmental and entrepreneurial competences. Hotels need not only to comply with environmental requirements but also to communicate them effectively, redesign services, manage investment decisions, and integrate sustainability into market positioning. Certification can strengthen credibility and reduce information asymmetry for consumers, but only when organisations possess the managerial capacity to maintain standards and translate them into meaningful customer value.

The main limitation concerns smaller independent establishments. Infrastructure costs, administrative complexity, limited staffing, and insufficient familiarity with environmental management may reduce participation. This recurring problem suggests that broad diffusion of certification requires differentiated support mechanisms rather than identical expectations for organisations with very different resource capacities.

Green Belt Germany represents a different form of sustainable tourism development because environmental conservation constitutes the starting point rather than an additional element of tourism activity. The transformation of the former inner-German border into a large ecological corridor demonstrates how biodiversity protection, historical memory, local development, and tourism can become interconnected[30].

In this model, tourism depends on the preservation of the ecological resource itself. Competences related to biodiversity, land management, environmental education, and monitoring are therefore fundamental. At the same time, local tourism development requires entrepreneurial capabilities related to guiding, accommodation, interpretation, product development, and community engagement.

The combination of natural and historical heritage creates opportunities for differentiated tourism products, but it also produces a potential tension between conservation and commercialisation. Increasing visitor numbers can generate local income while simultaneously creating new environmental pressures.

[29] Foundation for Environmental Education (FEE), *Green Key Programme*, Green Key International, https://www.greenkey.global/our-programme.
[30] Bund für Umwelt und Naturschutz Deutschland (BUND), *Grünes Band Deutschland*.

The case therefore demonstrates that sustainable tourism entrepreneurship must operate within ecological limits. Business development cannot be assessed independently of environmental carrying capacity, which creates a need for monitoring, adaptive management, and close cooperation between conservation organisations and tourism stakeholders.

Sustainable mobility forms the central mechanism in the Alpine Pearls initiative. Rather than concentrating solely on the environmental performance of individual tourism businesses, the model addresses the way visitors reach and move within destinations[31].

This is significant because transport frequently constitutes a substantial component of tourism-related environmental pressure. Car-free concepts, integrated mobility services, and environmentally responsible leisure activities demonstrate how destination attractiveness can be connected with lower-emission mobility.

The model requires competences in transport planning, destination management, environmental assessment, service design, and partnership development. It also illustrates the systemic nature of sustainable tourism: accommodation providers cannot independently create a low-emission destination if transport systems, municipal infrastructure, visitor information, and tourism services remain disconnected.

The network structure of Alpine Pearls is particularly relevant from the perspective of transferability. Shared criteria and cooperation between municipalities allow individual destinations to benefit from collective learning and common positioning. At the same time, differences in local resources and institutional commitment mean that network membership does not automatically produce identical implementation outcomes.

The initiative demonstrates how educational institutions can function as intermediaries between environmental science and tourism practice. Cooperation involving universities, protected-area authorities, NGOs, local businesses, and community actors enables specialised knowledge to be translated into tourism services and professional practice. Entrepreneurial capabilities are developed simultaneously through eco-branding, circular business models, digital platforms, and diversification of tourism services. Nature education, guided experiences, environmentally responsible mobility, and locally certified products create opportunities for new revenue streams while maintaining a close connection with conservation objectives.

Digital tools also play a supporting role. Augmented reality, online learning environments, and digital knowledge platforms can enhance environmental interpretation and broaden access to specialised knowledge. Their effectiveness nevertheless depends on staff competences, technological acceptance, and the availability of trainers capable of combining scientific, pedagogical, and digital expertise.

Taken together, the German practices demonstrate several mechanisms through which sustainability becomes embedded in tourism development. The first is standardisation through

[31] EGTC Alpine Pearls, *Alpine Pearls – Sustainable Mobility and Tourism in the Alps*, https://www.alpine-pearls.com.

certification. The second is organisational learning within enterprises. The third is network-based cooperation at destination and regional level. The fourth is integration between environmental conservation and tourism entrepreneurship. The fifth is the use of education and training as an infrastructure for long-term transformation.

Across these models, green competences and entrepreneurial competences are closely interdependent. Knowledge of environmental management, biodiversity, energy efficiency, sustainable mobility, and resource conservation creates the technical basis for sustainability. However, implementation requires additional capacities related to innovation, business strategy, communication, financing, service development, risk management, and stakeholder cooperation.

This relationship is particularly important for vocational education and training. The analysed practices suggest that competence development is most effective when it is closely connected with authentic operational environments. Workplace learning, regional training networks, cooperation with vocational schools and universities, field-based education, certification workshops, and business mentoring all provide mechanisms through which sustainability knowledge can be translated into professional action.

The German examples also demonstrate that the principal barriers are rarely technological alone. Regulatory complexity, access to funding, organisational resistance, limited staffing, fragmented responsibilities, and difficulties involving smaller enterprises repeatedly constrain implementation. Sustainable tourism transformation therefore depends as much on institutional and managerial capacity as on environmental technologies.

From the perspective of transferability, network-based models appear particularly significant because they allow knowledge, standards, infrastructure, and branding resources to be shared among multiple actors. However, transfer cannot be understood as simple replication. Successful adaptation requires consideration of local governance structures, enterprise capacity, environmental conditions, professional skills, and access to financial support.

The German practices therefore indicate that sustainable tourism is most resilient when competence development is embedded within broader innovation ecosystems. Environmental standards, vocational education, business development, scientific knowledge, destination management, and community participation reinforce one another when they are connected through stable institutional relationships.

This finding has broader relevance for the subsequent national cases. The central question is not merely which individual practices should be classified as successful, but which mechanisms allow sustainable practices to become durable, transferable, and economically viable. The analysis of good practices consequently shifts attention from isolated examples towards the institutional, educational, and entrepreneurial conditions that enable sustainable tourism transformation.

2.2.2 Greece

The Greek practices demonstrate a strongly place-based model of sustainable tourism development in which competence requirements are closely shaped by local environmental,

economic, and social conditions. Coastal areas, mountain regions, rural communities, islands, and large hospitality enterprises face different sustainability challenges, yet the analysed cases reveal several recurring mechanisms: cooperation across sectors, experiential and workplace learning, the integration of environmental knowledge with entrepreneurial capabilities, and the use of local identity as a basis for tourism innovation[32].

The cases considered include BlueCycle, ecotourism initiatives in the Zagori–Voidomatis area, Nature Diaries in rural Central Greece, the Tilos Smart Island project, and the Sani Green sustainability programme. Together they show that green transformation does not follow a single organisational model. It can emerge through circular design, nature-based tourism, community education, renewable-energy transition, or strategic environmental management within a large hospitality enterprise.

A particularly distinctive example is BlueCycle, which connects marine-waste management with tourism, design, and entrepreneurship. The initiative demonstrates how circular economy principles can be translated into tourism products by transforming recovered marine materials into functional and decorative objects used by hospitality businesses.

The competence requirements associated with this model extend beyond conventional environmental awareness. Participants need to understand material identification, sorting, reuse, product lifecycle considerations, and environmental principles in design. At the same time, the creation of commercially viable products requires competences in design thinking, sustainable branding, storytelling, business modelling, and market communication. The significance of the initiative lies in the connection between waste management and value creation. Marine plastic is not treated exclusively as an environmental problem but also as a material around which new products, narratives, and tourism experiences can be developed. This illustrates a broader characteristic of circular entrepreneurship: environmental challenges may become starting points for innovation when actors possess the capacity to redesign products and services.

Cross-sectoral learning is central to this process. Workshops involving designers, artisans, tourism SMEs, students, and environmental organisations create an environment in which knowledge moves between sectors that do not traditionally cooperate closely. This interdisciplinary structure is important because circular tourism requires competences that cannot be located within a single occupational profile. Digital tools can reinforce this process. The use of QR codes to communicate the origin and transformation of recovered materials illustrates how environmental information can become part of the visitor experience. Technology therefore serves not simply as an operational tool but as a mechanism for environmental storytelling and transparency. The principal barriers concern scaling, legal classification of reused materials, financing, and market acceptance. These challenges demonstrate that circular innovation depends not only on creativity but also on regulation, supply-chain organisation, investment capacity, and consumer trust.

[32]Eumelia Organic Agrotourism Farm, *Regenerative Agritourism and Ecotourism Farmstay in Laconia, Peloponnese*, Eumelia, Greece.

The Zagori–Voidomatis case[33] represents a different pathway, centred on protected landscapes, biodiversity, guiding, and nature-based tourism. Here, sustainable tourism depends directly on the quality and conservation of natural resources, which makes environmental knowledge a core professional requirement. Guides and tourism operators need competences in biodiversity protection, nature interpretation, trail management, zero-waste practice, local flora and fauna, and environmental monitoring. The case also identifies a gap between traditional guiding skills and the more complex competence profile required for contemporary ecotourism. Field-based training is particularly important in addressing this gap. Biodiversity interpretation, trail maintenance, environmental observation, and visitor management are difficult to develop solely through classroom-based instruction. Cooperation with universities, conservation organisations, local authorities, and protected-area institutions therefore provides opportunities for situated learning in authentic tourism environments. The Zagori case also demonstrates how environmental competences can contribute to product diversification. Birdwatching, guided eco-hikes, wellness-oriented walking experiences, nature interpretation, and participation in conservation monitoring create tourism products targeted at more specialised visitor segments.

Entrepreneurial competences are therefore closely connected with environmental knowledge. Local operators need the ability to design niche experiences, build partnerships, communicate environmental value, use digital marketing, and combine accommodation with nature-based services. Digital tools have an additional function in this setting. QR-supported environmental observation and storytelling applications can turn visitors into active participants in interpretation and monitoring. This creates a form of co-creative tourism in which the visitor experience generates both educational value and potentially useful environmental information. The case nevertheless reveals constraints common to rural and mountain destinations. Limited digital infrastructure, insufficient business-development capacity, lack of formal accreditation for specialised eco-guiding roles, and restricted access to finance can reduce the ability of local enterprises to develop and commercialise sustainable products.

A rural learning model identified in the Greek material illustrates a more explicitly educational form of sustainable agritourism, connecting environmental interpretation, local knowledge, experiential learning and cooperation among small rural enterprises. The competence challenge in this context is particularly significant because small family businesses may possess extensive tacit knowledge of local landscapes, agriculture, and community practices while lacking structured knowledge of environmental management or tourism interpretation.

The initiative therefore demonstrates the value of translating local knowledge into professional tourism competences. Training in composting, agricultural-waste reuse, storytelling, low-impact hosting, biodiversity interpretation, and the organisation of educational visits can strengthen both environmental performance and the quality of visitor experience.

[33] Vikos–Aoos UNESCO Global Geopark, *Training* and *The Vikos–Aoos Geopark*; UNESCO World Heritage Centre, *Zagori Cultural Landscape*.

Peer learning is especially relevant in this model. Small tourism enterprises often lack the resources to participate in extensive formal training programmes, whereas learning networks among guesthouses, producers, guides, and cooperatives can provide more accessible mechanisms for competence development.

This approach also reduces the distance between training and practice. Sustainability is learned through changes in hosting, waste management, visitor communication, product design, and cooperation with neighbouring enterprises rather than as an abstract set of environmental principles. The main limitation concerns standardisation. Competence levels among small rural enterprises can vary considerably, while limited budgets and workloads may reduce participation in training. This demonstrates that community-based approaches require flexibility and adaptation rather than highly uniform training structures.

Tilos represents a more systemic model in which tourism transformation is linked with energy transition at destination level. The island's renewable-energy strategy changes not only the environmental infrastructure of the destination but also the way sustainability can be incorporated into its tourism identity. The competence requirements extend beyond technical understanding of renewable energy. Tourism professionals need to be able to explain the significance of energy transition to visitors, connect energy systems with destination branding, integrate low-emission mobility into tourism services, and translate technological change into meaningful tourism experiences[34].

This illustrates an important principle of sustainable destination development: technological innovation generates tourism value only when tourism professionals are capable of interpreting and communicating it.

The project therefore creates demand for hybrid competences combining energy literacy, environmental communication, digital marketing, destination management, and entrepreneurship. Such combinations do not fit neatly within traditional occupational boundaries. The Tilos experience also demonstrates the role of public-private cooperation. Technological infrastructure requires public investment and strategic coordination, while tourism enterprises determine how sustainability becomes visible within accommodation, mobility, marketing, and customer experience. This relationship between public infrastructure and private entrepreneurship is especially important on islands, where energy, mobility, tourism, and local community life are closely interdependent. At the same time, the adoption of new practices is constrained by limited digital connectivity, access to finance, infrastructure requirements, and differences in technological readiness among local entrepreneurs. These barriers reinforce the importance of introducing competence development early in the transformation process rather than treating training as a secondary activity after infrastructure has already been deployed.

[34] European Commission, *Tilos – Clean Energy for EU Islands*; European Commission, *The Island of Tilos, Greece – RESponsible Island Prize*.

The Sani Green programme demonstrates another model: sustainability embedded within the strategic management of a large hospitality organisation. In contrast to small rural or community-based initiatives, this case shows how environmental objectives can be institutionalised across multiple operational departments. Energy efficiency, waste reduction, sustainable sourcing, water management, biodiversity protection, and certification require coordinated organisational procedures. Sustainability therefore depends not only on specialist environmental staff but also on the behaviour and competences of employees across the organisation. Internal training becomes a central implementation mechanism. Workshops, departmental training, environmental activities, and cooperation with external organisations help translate strategic sustainability objectives into daily practice. The case also demonstrates the importance of leadership. When environmental targets are incorporated into organisational strategy and supported by management, sustainability becomes less dependent on individual employee motivation and more closely connected with operational procedures, performance expectations, and investment decisions[35].

However, top-down commitment alone is insufficient. Training must be adapted to the roles of different departments because the sustainability challenges faced by food services, housekeeping, technical staff, management, or guest relations are not identical. This provides an important lesson for vocational and continuing education: sustainability competence should not be treated as one universal body of knowledge. It needs to be contextualised according to occupational tasks and organisational responsibilities. The Sani case also illustrates the relationship between sustainability and premium tourism. Environmental management can become part of brand positioning and customer experience rather than being perceived as incompatible with high service standards.

At the same time, this creates a demanding managerial challenge. Tourism enterprises must integrate resource efficiency and circular practices without reducing service quality or creating the perception that environmental measures are merely cost-saving mechanisms transferred to guests. Across the five Greek cases, several broader patterns emerge. One of the most important is the strong relationship between sustainability competence and territorial context. Marine environments, mountain ecosystems, rural communities, energy-transition islands, and large hospitality organisations require different combinations of environmental knowledge and professional capability. This place-specific character of competence development is closely connected with the relationship between green and entrepreneurial competences. Environmental knowledge becomes economically meaningful when tourism actors are able to translate it into product design, value communication, branding, partnership development, market access, and viable business models. Sustainable tourism therefore requires not only an understanding of environmental principles but also the capacity to transform them into services, organisational practices, and forms of value creation that are appropriate to particular destinations and business contexts.

The Greek cases also underline the importance of experiential and practice-based learning. Field-based workshops, peer learning, workplace training, community activities, mentoring, and

[35] Sani Resort, *Sustainability*; Sani/Ikos Group, *ESG Report 2023.*

cooperation with universities, NGOs, and other specialist organisations repeatedly appear as mechanisms through which sustainability competences can be developed. This is particularly relevant for vocational education and training because many of the capabilities required in sustainable tourism are contextual and applied rather than purely theoretical. Biodiversity interpretation, circular product design, low-impact hospitality, environmental communication, and the integration of destination-level energy transition into tourism experiences are more effectively developed through engagement with authentic problems and real operating environments. Intermediary organisations play an important role in making such learning possible. NGOs, universities, municipalities, protected-area authorities, tourism clusters, and certification bodies can connect enterprises with environmental expertise, training opportunities, funding, specialist knowledge, and innovation networks. Their role is especially significant for smaller tourism businesses that may lack the internal resources required to develop specialised sustainability competences independently[36].

These actors are particularly important for SMEs, which may lack sufficient internal capacity to employ specialists or develop training independently.

The Greek practices also reveal the importance of community participation. Local knowledge, social acceptance, and involvement of residents frequently determine whether sustainability initiatives become embedded in the destination or remain externally driven projects.

This is visible particularly in rural, mountain, and island contexts, where tourism is closely connected with everyday community life. Sustainability initiatives that do not account for local priorities, generational differences, and existing business practices may encounter resistance even when their environmental rationale is strong.

Digitalisation appears across the cases but performs different functions. It supports environmental storytelling in BlueCycle, promotion and monitoring in Zagori, knowledge-sharing in Nature Diaries, destination branding and carbon-related communication in Tilos, and strategic environmental management in hospitality. This diversity is analytically important. There is no single category of “digital skills for sustainable tourism”. Digital competence needs to be understood in relation to the specific environmental, organisational, and entrepreneurial problem being addressed.

The cases further demonstrate that barriers to sustainable tourism transformation are rarely attributable to a lack of environmental awareness alone. Financing constraints, regulatory complexity, insufficient infrastructure, resistance to organisational change, limited business-development skills, and shortages of specialised trainers repeatedly affect implementation.

These conditions have direct implications for VET policy. Training provision needs to combine technical environmental competences with entrepreneurship, communication, digital skills, and stakeholder cooperation. It also needs to recognise the diversity of tourism settings rather than applying identical sustainability curricula to all occupations and destinations. The Greek practices

[36] A. Vlami, G. Tsamos, A. Christidou, “Place-Based Lifelong Learning in Tourism Pedagogy: Developing Sustainability Competences among Children in Learning Tourism Destinations”, *Frontiers in Sustainable Tourism*, vol. 5, 2026; Region of Peloponnese, *Peloponnese Tourism Academy*, 2025.

suggest particular value in hybrid professional profiles. Eco-guides combining environmental interpretation with digital communication, hospitality professionals capable of applying circular economy principles, tourism entrepreneurs familiar with renewable energy and environmental branding, and managers able to integrate sustainability indicators into business strategy illustrate the kinds of competence combinations likely to become increasingly important.

From a transferability perspective, the Greek cases also caution against simple replication of good practices. The success of initiatives in Zagori, Tilos, or Halkidiki is partly rooted in specific environmental, institutional, and community conditions. Transferability should therefore be understood as adaptation of mechanisms rather than copying of solutions. Community participation, interdisciplinary training, sustainability-oriented business development, public-private cooperation, and experiential learning may be transferable even when the specific tourism product is not.

Taken together, the Greek practices demonstrate that sustainable tourism competence development is most effective when it is embedded in local ecosystems of cooperation. Environmental expertise, entrepreneurial initiative, education, community knowledge, digital tools, and institutional support reinforce one another when they are connected around concrete destination challenges. The central lesson from the Greek material is therefore not that one particular sustainable tourism model should be preferred. Rather, effective transformation depends on the capacity to combine environmental knowledge with entrepreneurship and learning in forms appropriate to the ecological and socio-economic characteristics of each destination.

2.2.3 Italy

The Italian practices illustrate a particularly diverse set of pathways through which sustainability can become embedded in tourism entrepreneurship, destination management, rural development, mobility systems, and organisational culture. The analysed cases range from small agritourism enterprises and food-sector SMEs to luxury ecotourism ventures, regional mobility initiatives, destination-level certification frameworks, and environmental awareness programmes implemented across mountain tourism areas.

This diversity is analytically significant because it demonstrates that sustainable tourism transformation does not depend on a single organisational model. In the Italian context, sustainability emerges through different combinations of environmental knowledge, entrepreneurship, local identity, organisational learning, public-private cooperation, technological innovation, and territorial governance.

The cases examined include circular-economy practices in Sicilian agritourism, green leadership in an Italian food SME, the Oasyhotel eco-luxury model, bike-friendly tourism services in Apulia, the development of a sustainable tourism district in Trentino, Bio Agriturismo La Ginestra in Tuscany, and

the “Let’s Green” initiative in Madonna di Campiglio. Together, they provide insight into the different scales at which green and entrepreneurial competences can contribute to tourism transformation[37].

A first important pathway concerns the integration of circular economy principles with rural and agritourism development. The Sicilian case demonstrates how sustainability can be incorporated into tourism through waste reduction, composting, energy and water conservation, local food sourcing, and the protection of landscape and biodiversity.

The significance of this model lies in its close connection with local identity. Agritourism already operates at the intersection of agriculture, hospitality, food production, landscape, and rural culture. Introducing circular economy principles therefore does not require the creation of an entirely new tourism product. Instead, it involves reorganising existing activities so that resource use, local sourcing, and environmental responsibility become more coherent components of the tourism experience. This process requires both technical and entrepreneurial learning. Operators need practical knowledge of resource efficiency, circular practices, and environmental management, but they also need to understand how sustainability can be communicated to visitors and incorporated into business planning.

The Sicilian case indicates that much of this learning takes place informally. Peer exchange, experimentation, experience sharing, and gradual adaptation appear alongside more formal regional support mechanisms. This is particularly relevant for small rural enterprises, which may have limited access to structured professional training. Such informal learning has important strengths. It is closely connected with actual business problems, allows rapid adaptation, and can build trust among local actors. At the same time, its limitations become apparent when enterprises need more specialised knowledge concerning environmental technologies, financing, certification, or strategic marketing. The case therefore reveals a gap that is relevant to vocational and continuing education: many sustainable tourism entrepreneurs develop environmental practices through experience but lack systematic opportunities to connect this experiential knowledge with formal competence development. A second mechanism concerns the role of green soft skills and leadership in organisational transformation. The Italian food-sector SME case is particularly valuable because it demonstrates that sustainability does not depend exclusively on technical environmental competences.

Environmental awareness, resource efficiency, and circular-economy knowledge become effective only when employees and managers are able to cooperate, adapt routines, communicate objectives, and manage organisational change. Leadership commitment is therefore a critical competence. Managers influence whether sustainability remains a marginal initiative or becomes integrated into organisational strategy, decision-making, and everyday operations. The case also demonstrates the importance of participatory management. Employees are more likely to engage with sustainability when they participate in identifying problems and developing solutions rather

[37] C. Farao, C. Bernuzzi, C. Ronchetti, “The Crucial Role of Green Soft Skills and Leadership for Sustainability: A Case Study of an Italian Small and Medium Enterprise Operating in the Food Sector”, *Sustainability*, vol. 15.

than simply receiving new procedures from management. This suggests that green soft skills should be treated as a substantive element of sustainability competence. Communication, adaptability, teamwork, ethical decision-making, motivation, and change management influence the implementation of environmental practices just as directly as technical knowledge. The distinction between "green skills" and "soft skills" may therefore be less clear in practice than conventional competence frameworks sometimes suggest. Environmental transformation frequently requires behavioural and organisational change, meaning that interpersonal and managerial capabilities become part of the green transition itself. The Oasyhotel case illustrates another pathway: the integration of environmental conservation with high-value hospitality and social impact[38].

This model challenges the assumption that luxury tourism and sustainability are necessarily contradictory. Instead of defining luxury primarily through material intensity or consumption, the model reinterprets it through access to nature, tranquillity, authenticity, exclusivity, and meaningful experience. The environmental dimension is embedded in biodiversity protection, land management, resource efficiency, waste reduction, renewable energy use, and low-impact hospitality. However, the business model also depends on entrepreneurial competences associated with strategic positioning, stakeholder engagement, service innovation, impact communication, and long-term planning. The hybrid structure of the initiative is particularly important. Hospitality, conservation, social objectives, community relationships, and private-sector activity are combined within a single value proposition. This creates considerable competence complexity. Staff need conventional hospitality competences but must also understand protected-area management, environmental communication, sustainability protocols, and the specific expectations of guests seeking purpose-driven tourism experiences. Training therefore becomes essential to the business model rather than an auxiliary activity. Workplace learning, environmental workshops, cooperation with conservation organisations, and continuous development of guest-experience competences help bridge the gap between high-quality hospitality and ecological objectives.

The case also illustrates the importance of storytelling. Sustainable practices create competitive value only when they can be communicated credibly and meaningfully to visitors. This requires staff who understand not only what the organisation does but why those practices matter.

A further lesson concerns the reinterpretation of innovation. In this context, innovation does not necessarily mean introducing increasingly sophisticated technology. It may involve redesigning the concept of tourism value itself by connecting hospitality, conservation, simplicity, social responsibility, and environmental experience.

The Apulia bike-friendly initiative provides a different perspective by moving the analysis from individual enterprises towards regional mobility and territorial planning. Sustainable cycling tourism requires infrastructure, but infrastructure alone is insufficient. Municipalities and destination organisations need competences in mobility planning, environmental assessment, digital mapping,

[38] Oasyhotel, *Our Project*; Oasi Dynamo, *Responsabilità*; "The Marriage Between Luxury Hospitality, Ecotourism, and Social Initiatives: A New Business Model from Italy," *Sustainability*, 2024, 16(20), 8982.

multimodal accessibility, tourism product development, and cooperation with local enterprises. This illustrates the systemic nature of sustainable tourism. A tourism business can introduce environmentally responsible practices independently, but a cycling destination can function effectively only when routes, public infrastructure, accommodation, information systems, transport connections, local services, and destination promotion are coordinated. The Apulia case demonstrates the importance of data-driven planning in this process. Digital mapping, route visualisation, stakeholder surveys, and online tourism platforms can support both infrastructure planning and visitor engagement. Digital competence therefore becomes embedded in destination management. It is not limited to marketing but includes data collection, spatial information, service monitoring, route management, and evidence-based decision-making. The case also exposes the consequences of uneven institutional capacity. Smaller municipalities may lack mobility plans, dedicated tourism offices, technical personnel, infrastructure, or financing. As a result, sustainability initiatives may develop unevenly across the region. This reveals an important distinction between individual competence and institutional competence. Even skilled tourism professionals may be unable to implement sustainable mobility systems when local institutions lack planning capacity or coordination mechanisms. Regional agencies, universities, and technical institutions can help address this gap by providing expertise, training, research capacity, and shared planning tools. The Apulia model therefore demonstrates the potential value of intermediary institutions in supporting municipalities that would otherwise be unable to develop complex tourism innovation independently. Trentino represents an even more explicit shift towards destination-level sustainability governance. The development of a sustainable tourism district based on recognised sustainability criteria illustrates an attempt to embed sustainability within the governance structures of a wider tourism territory rather than treating it as the responsibility of individual businesses. This changes the competence requirements substantially. Tourism operators and destination organisations need to understand environmental management, ESG indicators, certification frameworks, stakeholder participation, reporting, community engagement, and long-term strategic planning.

The introduction of dedicated sustainability management roles is particularly significant. It suggests that sustainability is gradually becoming a professional function within destination governance rather than an additional responsibility attached informally to existing positions. This professionalisation can strengthen implementation by creating institutional ownership of sustainability objectives. At the same time, it generates demand for new competence profiles combining tourism management, environmental knowledge, data interpretation, stakeholder facilitation, and strategic communication. The Trentino model also illustrates the difference between certification as a label and certification as a transformation process. If certification is treated primarily as a marketing credential, organisations may focus on achieving formal compliance while leaving operational practices largely unchanged. By contrast, a process-oriented approach requires continuous monitoring, stakeholder participation, measurable improvement, and repeated organisational learning. This distinction is crucial for avoiding greenwashing. Credible sustainability requires evidence that environmental and social commitments are reflected in governance structures

and operational decisions. The challenge becomes particularly significant at destination level because actors differ widely in size, resources, priorities, and readiness. Hotels, municipalities, tourism organisations, small service providers, residents, and other stakeholders cannot be expected to adopt sustainability practices at the same pace.

The role of destination governance is therefore partly to facilitate collective learning and gradual alignment. Shared strategies, stakeholder workshops, professional support, and common indicators can create a structure through which organisations move towards sustainability without requiring identical starting conditions. Bio Agriturismo La Ginestra demonstrates a contrasting pathway based on long-term entrepreneurial evolution[39]. Rather than being created as a tourism enterprise implementing sustainability from the outset, the business developed through the gradual integration of organic agriculture, hospitality, local food, biodiversity, direct sales, experiential activities, and digital promotion. This makes the case particularly important for understanding learning-by-doing. Competences were developed over time through experimentation, interaction with guests, cooperation with local partners, adaptation to market conditions, and gradual diversification. The case demonstrates that sustainable entrepreneurship can emerge incrementally rather than through a formal strategic transformation programme.

Organic farming provides the environmental foundation, but tourism diversification creates additional economic resilience. Accommodation, gastronomy, farm experiences, beekeeping, cooking activities, local products, and wellness-related services generate multiple forms of value around the same territorial and agricultural resources. This illustrates the close relationship between sustainability and diversification. Environmental commitment alone does not automatically create a viable tourism business. Entrepreneurial competences are needed to transform environmental resources and local knowledge into products and experiences for which visitors are willing to pay.

Digital capabilities become increasingly important as the business develops. Social media, online marketplaces, direct communication, e-commerce, dynamic pricing, and online distribution influence the ability of rural enterprises to reach markets beyond their immediate region. The case therefore demonstrates how traditional forms of rural entrepreneurship increasingly depend on modern digital competences. At the same time, the long-term development of La Ginestra reveals the limitations of relying exclusively on informal learning. Early mistakes associated with limited tourism experience and weak local support structures suggest that targeted training and stronger business networks could accelerate the transition of similar enterprises. The “Let’s Green” initiative in Madonna di Campiglio introduces yet another mechanism: destination-wide behavioural change.

Waste management in mountain and protected-area tourism depends partly on infrastructure, but also heavily on the behaviour of enterprises, residents, employees, and visitors.

The initiative therefore combines waste-reduction infrastructure with communication, environmental interpretation, experiential activities, digital promotion, and stakeholder

[39] Bio La Ginestra, *The Farm*; EU Tourism Platform, *A case study of sustainable agritourism in Tuscany.*

engagement. This is important because many sustainability challenges are behavioural rather than purely technical. Providing recycling infrastructure does not guarantee that waste will be separated correctly. Refillable water systems have limited impact if visitors continue to prefer disposable products. Environmental standards cannot be implemented consistently if operators perceive them as inconvenient or unnecessary. Competence development in this context involves environmental communication, behaviour-change strategies, stakeholder engagement, destination management, and public-private cooperation. The use of environmental ambassadors, excursions, demonstrations, digital storytelling, and visitor-facing campaigns demonstrates how education becomes part of destination management. Such measures can make sustainability visible and experiential. Visitors are not simply asked to comply with environmental rules; they are invited to understand the environmental characteristics of the destination and participate in its protection. This approach is especially significant in protected mountain environments, where the connection between tourism behaviour and environmental impact can be made relatively tangible.

However, voluntary participation creates limitations. Not all businesses or mountain huts engage equally, and maintaining consistent environmental practices across a destination requires long-term coordination. This demonstrates that behavioural change cannot be treated as a short-term communication campaign. It requires repeated engagement, visible infrastructure, stakeholder trust, and integration of sustainability into the identity of the destination.

Across the Italian cases, several broader mechanisms emerge. Sustainability is consistently linked with local identity and territorial resources. Agritourism in Sicily and Tuscany, eco-luxury in protected areas, cycling tourism in Apulia, mountain tourism in Trentino, and destination-based environmental initiatives all draw on specific landscapes, food systems, heritage assets, agricultural traditions, mobility patterns, and community characteristics. Sustainability therefore often strengthens rather than replaces local identity, becoming more credible and economically meaningful when it is embedded in the distinctive features of place. This territorial anchoring is closely connected with diversification. Many of the analysed practices generate new forms of value by combining tourism with agriculture, conservation, mobility, environmental education, gastronomy, wellness, digital services, and experiential activities. Sustainable tourism entrepreneurship should therefore not be understood solely as a process of reducing environmental impacts; it can also involve the development of new business models, services, and tourism products that connect environmental responsibility with territorial differentiation and economic opportunity.

A further recurring mechanism is organisational learning. Workplace training, peer learning, participatory workshops, learning-by-doing, university collaboration, technical assistance, and environmental education appear repeatedly across the Italian cases. Formal education is only one component of this wider learning ecosystem, since substantial competence development also takes place within enterprises, destination organisations, public institutions, and local networks. This has important implications for VET. Education providers should not be understood solely as institutions preparing people before they enter employment, but also as potential participants in regional innovation ecosystems, supporting continuing education, business transformation, applied projects,

and cooperation between tourism operators and specialist knowledge providers. The durability of sustainability-oriented change also depends on leadership and governance. Responsibility becomes more stable when it is clearly embedded in organisational or destination structures, whether through committed SME leadership, dedicated sustainability managers, regional agencies, tourism boards, or coordinated destination-management organisations. Without such institutional ownership, sustainability initiatives risk remaining dependent on individual enthusiasts or temporary projects.

The Italian cases also reveal the growing importance of hybrid competence profiles. The practices analysed combine areas that have traditionally been treated separately, including hospitality and biodiversity, tourism and mobility planning, agriculture and digital marketing, environmental management and customer experience, and certification and stakeholder facilitation. Emerging labour-market demand therefore concerns not simply the addition of green skills to established occupations, but the ability to combine different knowledge domains within integrated tourism practice. Digitalisation forms part of this hybridisation. Digital tools are used for regional mapping, destination management, marketing, customer communication, storytelling, online distribution, e-commerce, monitoring, and stakeholder engagement, but their significance depends on the environmental and entrepreneurial problems they are used to address. At the same time, transformation remains constrained by the position of small enterprises and municipalities, which may face limited funding, weak technical capacity, difficulties accessing structured training, regulatory complexity, and fragmented networks. These constraints reinforce the broader conclusion that sustainable tourism transformation depends not only on innovative practices themselves, but also on the institutional, organisational, and learning capacities that allow them to be implemented, connected, and sustained.

This suggests that sustainable tourism policy should not focus exclusively on defining standards. It must also create the support structures that enable smaller actors to meet them. From a vocational education perspective, the Italian practices indicate particular demand for competence combinations in environmental management, circular economy, digital technologies, sustainable mobility, destination governance, entrepreneurship, communication, leadership, and stakeholder cooperation.

They also demonstrate the importance of green soft skills. Adaptability, teamwork, ethical leadership, participation, communication, and change management are not secondary competences. They frequently determine whether technical sustainability measures become embedded in everyday professional practice.

The Italian evidence additionally suggests that competence development needs to operate at multiple levels. Individual workers require practical green and digital skills; managers require strategic and leadership competences; entrepreneurs require innovation and business-development capabilities; and destination institutions require governance, coordination, and data-related capacities. Sustainable tourism education should therefore avoid treating the workforce as a homogeneous target group. Different professional roles require different configurations of competences, even when they contribute to the same sustainability objective. The cases also caution

against understanding transferability as replication. A luxury conservation model cannot simply be transplanted into rural agritourism, just as a regional cycling strategy cannot be reproduced through actions taken by an individual SME.

What can be transferred are underlying mechanisms: workplace learning, participatory governance, competence development linked with real operational problems, shared sustainability standards, public-private cooperation, use of local resources, data-supported planning, and integration of environmental responsibility with economic value creation. Taken together, the Italian practices reveal a gradual movement from sustainability implemented through individual environmental measures towards more systemic forms of transformation.

At one end of this continuum are changes introduced within individual businesses, such as resource efficiency, organic production, or staff development. At the other are destination-level systems involving certification, mobility infrastructure, regional governance, shared indicators, and collective behavioural change. The central lesson from the Italian material is therefore that sustainable tourism transformation depends not only on environmentally responsible enterprises but also on the institutional and educational ecosystems that allow individual practices to become coordinated, scalable, and durable.

From this perspective, the development of green and entrepreneurial competences should be viewed as part of a wider process of organisational and territorial transformation. Skills, governance, entrepreneurship, infrastructure, technology, and local identity interact in shaping whether sustainability remains an isolated practice or becomes an integrated feature of tourism development.

2.2.4 Poland

The Polish practices reveal a model of sustainable tourism development strongly rooted in local resources, territorial cooperation, small-scale entrepreneurship, and regional diversification. The analysed initiatives range from integrated territorial strategies and local action groups to eco-lodging, craft tourism, culinary trails, urban green tourism, and nature-based adventure tourism. Despite their diversity, they share a common feature: sustainability is frequently developed through the mobilisation of place-based assets rather than through highly centralised sectoral mechanisms.

This territorial character is important because many sustainable tourism opportunities in Poland are located outside the largest tourism centres. Rural areas, mountain regions, coastal zones, post-industrial cities, agricultural landscapes, and smaller urban areas provide resources that can support distinctive tourism products while contributing to local development.

The practices considered include the Słupsk–Ustka Functional Urban Area Development Strategy, the Green Bieszczady Local Action Group, renewable-energy-oriented lodging in the Bieszczady Mountains, circular craft tourism in Łódź, green culinary trails in the Lubelskie region, urban green tourism in Warsaw, and eco-kayaking in Pomerania. Together, these examples illustrate a continuum extending from strategic territorial planning to small-scale entrepreneurial experimentation.

The Słupsk–Ustka case represents the most institutionalised form of this approach. Sustainable tourism is embedded within a broader territorial development strategy connecting local governments, businesses, civil society, residents, and educational and cultural institutions. The significance of this model lies in the fact that tourism is not treated as an isolated economic sector. Environmental management, spatial planning, natural-resource protection, entrepreneurship, digitalisation, and local development are incorporated within a common territorial framework.

This approach changes the nature of competence requirements. Sustainable tourism development at functional-area level requires not only environmental awareness among tourism operators but also capacities in strategic planning, inter-municipal cooperation, local product development, digital promotion, social entrepreneurship, and community engagement.The role of coordination is particularly important. Individual municipalities may lack sufficient resources to develop coherent tourism products or environmental infrastructure independently. Cooperation can create economies of scale, facilitate joint branding, and support more integrated planning across administrative boundaries.

However, integrated strategies create their own challenges. Long-term implementation requires stable financing, monitoring, institutional continuity, and the capacity to adapt strategic objectives as market and environmental conditions change. This suggests that territorial sustainability depends not only on the quality of the initial strategy but also on the competences of institutions responsible for its implementation. The Green Bieszczady Local Action Group illustrates a more community-oriented form of territorial coordination. The initiative connects local authorities, entrepreneurs, residents, NGOs, schools, and environmental institutions around sustainable tourism and local development. Its role as an intermediary is particularly important because rural tourism systems are often highly fragmented. Small accommodation providers, farms, local producers, guides, and community organisations may possess valuable resources but lack access to specialist knowledge, digital tools, financing, or wider tourism markets. The Local Action Group can therefore function as a connector between dispersed actors. Training, advisory support, local forums, marketing assistance, and environmental education create mechanisms through which individual enterprises can participate in a wider tourism ecosystem[40].

This intermediary function is highly relevant from the perspective of competence development. Small rural businesses often cannot maintain specialised training structures of their own. Local networks can compensate by creating shared access to knowledge and mentoring.

The Green Bieszczady case also demonstrates the importance of local branding. Sustainable tourism products based on nature, local traditions, environmental quality, and authenticity require a coherent narrative capable of distinguishing the destination in the tourism market. Brand development therefore connects environmental and entrepreneurial competences. Operators need to understand local ecosystems and sustainable practices, but they also need to communicate these

[40] Lokalna Grupa Działania „Zielone Bieszczady", *Lokalna Strategia Rozwoju 2023–2027/2029*; LGD „Zielone Bieszczady", *Okres programowania 2023–2029.*

values effectively through digital channels, tourism products, and customer experience. The case further highlights a recurring barrier in rural tourism: limited digitalisation. Weak digital marketing skills, inadequate online booking capacity, and limited access to modern promotion tools can prevent otherwise attractive sustainable products from reaching wider markets.

This creates an important competence paradox. Local actors may possess strong knowledge of landscape, culture, food, or traditional practices but lack the digital and business competences needed to convert those resources into competitive tourism products. Renewable-energy-oriented lodging in the Bieszczady Mountains provides a more enterprise-level illustration of sustainable hospitality. The model combines solar energy, sustainable construction, composting, local sourcing, and low-waste operations with guest-experience design and destination branding. Its significance lies in demonstrating how environmental technologies can become part of the tourism product itself. Renewable-energy systems are not merely infrastructure reducing operational costs; they can also contribute to the identity of an eco-lodge and shape visitor expectations. This requires employees and owners to understand both the technical and communicative dimensions of sustainability. Energy systems, water management, waste reduction, and permaculture need to be integrated with hospitality, customer communication, and experience design.

The case also illustrates the importance of financial competences. Green transformation frequently requires initial investment, meaning that tourism entrepreneurs need access to finance and the ability to assess the economic implications of environmental technologies. For small enterprises, insufficient access to green finance may be as significant a barrier as a lack of environmental knowledge. The Bieszczady example therefore reinforces a broader conclusion: sustainable tourism entrepreneurship requires the simultaneous development of environmental, financial, operational, and marketing competences. Circular craft tourism in Łódź demonstrates how sustainability can be linked with cultural and industrial heritage. In this model, circular economy principles are combined with creative tourism, craft production, experiential learning, and digital commerce. The environmental dimension is visible in upcycling, waste reduction, and reuse of materials. However, the tourism value arises through the possibility of transforming these activities into visitor experiences. Craft workshops, live demonstrations, eco-design tours, and opportunities for direct interaction with producers create products that combine learning, culture, creativity, and sustainability. This requires artisans to develop new professional roles. Craft competence alone is insufficient when production becomes part of a tourism experience. Entrepreneurs need skills in interpretation, customer engagement, pricing, e-commerce, storytelling, event organisation, and digital promotion.

The Łódź case therefore illustrates how sustainable tourism can contribute to the revitalisation of post-industrial and creative urban economies. Environmental practices can reinforce rather than compete with heritage-based tourism when they are incorporated into experiential product design. The use of e-commerce is particularly important. It extends the economic relationship with visitors beyond the physical tourism experience and creates additional channels through which small producers can reach external markets. At the same time, the case exposes challenges related to

material supply, language accessibility, price sensitivity, and the capacity of small creative enterprises to professionalise tourism-related services. Green culinary trails in the Lubelskie region reveal a related mechanism in rural and agricultural contexts. Here, sustainable tourism is built around local food production, organic and environmentally responsible farming, regional cuisine, and farm-based visitor experiences. The integration of agriculture and tourism allows local products to become both economic goods and elements of tourism interpretation. Visitors do not merely consume food; they can learn how it is produced, understand its relationship with landscape and local culture, and participate in experiences connecting farms, gastronomy, and regional identity. The competence profile is therefore hybrid. Producers and tourism operators need knowledge of sustainable farming, sourcing, waste management, hospitality, storytelling, experience design, digital communication, and cooperation across local businesses. The concept of the culinary trail is particularly significant because the value proposition is collective rather than individual. A single farm or restaurant may offer an attractive product, but the tourism route depends on cooperation among multiple actors. This makes networking and cross-promotion critical entrepreneurial competences. Weak cooperation between enterprises can reduce the visibility and coherence of the tourism product even when individual participants offer high-quality experiences.

The Lubelskie case therefore demonstrates that sustainable tourism development requires relational competences: the ability to create shared products, coordinate schedules, exchange information, jointly promote the destination, and build a collective identity. Urban green tourism in Warsaw represents another scale of implementation.

In this context, sustainability is connected with green mobility, urban nature, alternative routes, digital applications, and the reinterpretation of the city beyond its conventional tourism attractions. Urban green routes can create opportunities to distribute visitors more widely across the city and increase awareness of urban ecosystems, parks, green infrastructure, and sustainable mobility. The development of such products requires route planning, eco-guiding, accessibility awareness, digital mapping, marketing, and the capacity to engage younger visitor groups. Gamification and app-based tools demonstrate how digitalisation can change the form of urban interpretation. The visitor is no longer only the recipient of information but may interact with routes, environmental indicators, challenges, or mobility data. This model is particularly relevant for younger tourism segments accustomed to mobile technologies and interactive forms of experience.

At the same time, technology does not remove the need for local participation. Urban routes interact with public space, neighbourhoods, mobility infrastructure, residents, and existing forms of land use. Citizen co-design and local consultation can therefore improve both social acceptance and the quality of tourism products. The Warsaw example highlights an important principle: sustainable urban tourism depends on understanding the city not only as a tourism product but also as a living environment for residents. Eco-kayaking in Pomerania illustrates the integration of nature-based tourism with environmental education and adventure entrepreneurship. In this model, river ecology, guiding, waste retrieval, wildlife protection, safety, and experiential tourism are closely interconnected. The tourism product creates direct contact with aquatic ecosystems while

simultaneously providing opportunities for environmental interpretation and conservation-oriented activity. The competence requirements extend beyond recreational guiding. Operators need knowledge of ecology, visitor safety, environmental regulations, changing weather conditions, and responsible behaviour in wildlife-sensitive areas. Entrepreneurial competence is equally important. Nature-based adventure tourism is strongly affected by seasonality, weather risk, market segmentation, and the need for multilingual promotion. This makes risk planning an essential business competence rather than merely an operational safety issue. The case also illustrates how environmental action can become part of the visitor experience. Waste collection, environmental observation, or low-impact equipment can transform sustainability from background infrastructure into a visible element of tourism participation. Across the seven Polish practices, several broader mechanisms can be identified.

Across the Polish cases, sustainable tourism transformation is closely connected with the mobilisation of local assets. Natural landscapes, agricultural production, crafts, urban green spaces, local cuisine, rivers, and cultural traditions provide the material basis for tourism products whose value depends on the way these resources are interpreted, organised, and communicated. Sustainability becomes economically meaningful when place-based resources are transformed into distinctive visitor experiences rather than treated only as environmental assets requiring protection. This process is frequently supported by intermediary institutions, including local action groups, municipalities, regional agencies, NGOs, educational institutions, and development organisations. These actors provide training, coordination, promotion, access to funding, and opportunities for cooperation, which is particularly important in environments dominated by small enterprises that may lack sufficient internal capacity to develop sustainability competences independently. Their intermediary role helps connect dispersed local actors with wider knowledge, markets, and support structures, enabling locally embedded tourism initiatives to participate in broader development processes.

Many of the analysed initiatives also demonstrate the importance of experiential entrepreneurship. Local resources are transformed into participatory tourism products through craft workshops, culinary experiences, nature-based activities, educational trails, urban green routes, and farm-based tourism. Sustainable tourism innovation therefore frequently emerges through experience design rather than through technological change alone. Digital tools nevertheless play an important enabling role. Booking systems, social media, online promotion, mapping applications, e-commerce, gamification, and digital route tools increase market visibility, facilitate access to dispersed attractions, and help small enterprises communicate the value of place-based tourism products. Their significance is especially pronounced in rural areas, where digital access can influence whether otherwise attractive products reach wider markets. At the same time, the Polish cases reveal a persistent digital divide. Rural entrepreneurs and small enterprises may possess valuable environmental, cultural, or experiential resources while lacking the infrastructure, digital competence, or organisational capacity required to market and distribute them effectively. Digitalisation therefore acts both as an opportunity for local tourism development and as a potential source of inequality between actors with different levels of technological capacity.

Cooperation and practice-based learning further shape the Polish model. Sustainable tourism products such as thematic routes, regional brands, local food networks, mobility systems, and territorial strategies depend on collaboration across organisational boundaries and cannot be developed effectively by isolated enterprises. This creates demand for competences in partnership building, negotiation, communication, project management, and shared product development. At the same time, competence development often takes place through workshops, mentoring, apprenticeships, peer learning, advisory services, and learning-by-doing rather than exclusively within formal educational institutions. Local enterprises, municipalities, NGOs, development agencies, and educational providers together form learning environments in which sustainability knowledge is connected with real operational and territorial problems. This has important implications for vocational education and training. VET institutions can contribute most effectively when they participate in local competence ecosystems, cooperate with enterprises and intermediary organisations, and connect learning with authentic challenges related to tourism products, digitalisation, environmental management, entrepreneurship, and destination development. VET providers can support sustainable tourism more effectively when they cooperate with local enterprises, municipalities, NGOs, and destination organisations around real development problems.

Instead of teaching sustainability only as a theoretical subject, training can be linked with local projects involving sustainable accommodation, regional food, mobility, guiding, digital promotion, circular economy, or environmental education.The Polish practices also reveal the need for hybrid competence profiles. A rural tourism entrepreneur may need knowledge of biodiversity, digital marketing, hospitality, local branding, and renewable energy. A craft producer may need circular-design competence alongside e-commerce and visitor engagement. An eco-guide may require ecological knowledge, safety competence, foreign-language communication, and entrepreneurship.

This makes rigid occupational boundaries increasingly difficult to maintain. The cases additionally reveal that financial and institutional capacity strongly influence whether green competences can be applied in practice. Training alone cannot solve problems related to lack of investment, weak digital connectivity, inadequate infrastructure, or fragmented governance. Sustainable tourism competence policies therefore need to be connected with broader support systems for entrepreneurship and regional development. The Polish evidence also suggests that sustainability can contribute to diversification and resilience.

Many of the practices create opportunities for off-season tourism, additional income streams, new target groups, or alternative destination narratives. This is particularly relevant in rural and nature-based destinations where tourism demand may otherwise be strongly seasonal. However, economic diversification should not be assumed automatically. Sustainable products need professional marketing, reliable quality, appropriate infrastructure, and the ability to reach relevant visitor segments.

The relationship between local authenticity and professionalisation is therefore critical. Tourism products rooted in local culture and resources derive part of their value from authenticity, but they still require competences in service design, digital communication, pricing, safety, and business

management. Professionalisation should consequently strengthen rather than replace local character. From the perspective of transferability, the Polish examples suggest that the most transferable elements are not the specific tourism products but the organisational mechanisms behind them. Local intermediary organisations, shared regional branding, practical competence development, cooperation among small enterprises, digital market access, and experiential product design can be adapted to different territorial contexts.

The individual examples remain strongly place-dependent. Bieszczady tourism depends on mountain landscapes and local culture; Łódź draws on creative and post-industrial identity; Lubelskie builds on agriculture and food; Pomerania uses aquatic environments; Warsaw relies on urban green infrastructure.The value of the Polish model therefore lies precisely in its capacity to turn territorial diversity into tourism diversity.

Taken together, the Polish practices illustrate sustainable tourism as a process of local resource activation supported by entrepreneurship, cooperation, and competence development. Their main strength lies in the capacity of relatively small-scale initiatives to combine environmental objectives with local development and tourism diversification.

Their main limitation lies in fragmentation. Access to finance, digital tools, professional training, infrastructure, and institutional support varies significantly between territories and actors.

The central lesson from the Polish material is therefore that community-based and place-based sustainable tourism requires strong connecting structures. Local resources alone do not create sustainable tourism systems. They need institutions capable of linking environmental knowledge, entrepreneurship, education, finance, digitalisation, and cooperation. From this perspective, the development of sustainable tourism competences in Poland should be understood not only as an educational challenge but also as a regional-development challenge. Skills become effective when they are embedded within local networks that enable individuals and enterprises to transform knowledge into viable, environmentally responsible tourism products.

2.2.5 Portugal

The Portuguese practices demonstrate how sustainable tourism can be developed through the interaction of certification, heritage protection, community participation, environmental management, and competence development. The analysed cases range from networks of historic villages and protected natural areas to luxury hospitality, rural eco-lodging, and regional capacity-building initiatives.

Although they differ considerably in organisational scale, the cases share a number of characteristics. Sustainability is generally linked with the preservation of territorial resources, while competence development is supported through workshops, certification processes, workplace learning, peer exchange, and cooperation between public authorities, tourism organisations, educational institutions, environmental actors, and local enterprises.

The practices considered include the Biosphere-certified Historic Villages of Portugal network, sustainability initiatives in luxury hospitality in Lisbon, Eco Lodge Cabreira, tourism development

associated with Peneda-Gerês National Park, and the Verde Sentido initiative. Together, they illustrate different mechanisms through which environmental knowledge and entrepreneurial capabilities can be incorporated into tourism development. The Historic Villages of Portugal provide an example of sustainability implemented at network and territorial level. Rather than focusing on a single tourism enterprise, the initiative connects municipalities, tourism organisations, educational and training institutions, public authorities, and European partners around the development and preservation of a group of historic rural destinations[41].

The importance of this model lies in the combination of heritage conservation with contemporary environmental management. Waste management, water and energy efficiency, renewable energy, biodiversity protection, responsible land use, sustainable mobility, and environmental communication become part of a broader strategy aimed at maintaining the attractiveness and viability of historic settlements.

Certification contributes to this process by providing a framework through which sustainability objectives can be translated into operational expectations. However, the value of certification extends beyond formal recognition. It can also create a shared language for local actors and help coordinate tourism development across multiple municipalities and businesses.

This requires competences that combine environmental and managerial knowledge. Tourism operators and local institutions need to understand resource efficiency, environmental standards, mobility, certification procedures, and sustainable service design.

At the same time, they need entrepreneurial and organisational capacities in marketing, product development, cooperation, innovation, and risk management.The case also demonstrates the importance of training adapted to different stakeholder groups. Municipal technicians, tourism providers, students, and local entrepreneurs require different forms of knowledge and different learning environments. Workshops, certification programmes, workplace learning, and technical training can therefore be understood as complementary elements of a territorial competence-development system. The inclusion of older populations and small local enterprises remains particularly important. Digital and green transitions may progress unevenly when some groups have limited access to training, technology, or specialist expertise. This illustrates a broader challenge for sustainable rural tourism: destination-level transformation requires mechanisms capable of involving actors with very different starting capacities. The Portuguese heritage-network model also demonstrates the potential role of environmental certification in strengthening destination identity.

Historic and rural destinations compete partly through authenticity, heritage, landscape, and local culture. Sustainability can reinforce this positioning when environmental practices are clearly connected with the preservation of the resources on which the tourism product depends.

[41] Aldeias Históricas de Portugal, *Biosphere Destination*; Eco Lodge Cabreira, official project website; Instituto da Conservação da Natureza e das Florestas (ICNF), materials concerning Peneda-Gerês National Park; Verde Sentido, official project platform.

Certification therefore becomes most meaningful when it supports substantive changes in destination management rather than functioning solely as a promotional label. The Lisbon luxury-hospitality case provides a contrasting organisational context. Large hotels operate with greater technical, financial, and managerial resources than most rural tourism enterprises, but they also face complex sustainability challenges associated with energy consumption, water use, waste, procurement, and customer expectations. In such organisations, environmental transformation requires coordinated action across multiple departments. Energy efficiency, waste reduction, responsible sourcing, water management, and environmental communication cannot be implemented effectively by a single sustainability specialist. They need to become part of operational routines across management, technical services, housekeeping, food and beverage, purchasing, and guest relations. This makes internal competence development particularly important.

Workshops, environmental-management procedures, certification support, audits, and knowledge exchange can help translate corporate sustainability objectives into everyday professional practices. The hospitality case also demonstrates the role of leadership. Environmental objectives are more likely to become durable when they are incorporated into management strategy, monitored consistently, and supported by senior decision-makers. At the same time, implementation requires the participation of employees. Sustainability therefore combines top-down strategic direction with bottom-up operational learning.Luxury hospitality presents an additional challenge because environmental measures need to be integrated without undermining perceptions of service quality.

This creates demand for competences in service innovation and customer communication. Employees need to understand how resource efficiency and responsible consumption can become part of a premium tourism experience rather than being perceived as restrictions placed on guests.

The case consequently illustrates a broader change in tourism entrepreneurship. Environmental responsibility can become part of brand positioning and value creation when it is linked with credible operational practices. Eco Lodge Cabreira represents a smaller-scale and more regenerative form of tourism development. The initiative combines accommodation with biodiversity protection, permaculture, waste management, rainwater harvesting, renewable energy, environmental communication, and community participation[42]. Its significance lies in the close relationship between environmental practice and the tourism experience itself. Visitors encounter sustainability not only through corporate communication but through buildings, land management, energy systems, food, landscape, and activities connected with the surrounding environment. This creates a distinctive competence profile. Operators need practical knowledge of sustainable land use, water management, composting, renewable energy, biodiversity, and environmental interpretation.

At the same time, they need entrepreneurial competences in business modelling, marketing, stakeholder engagement, experience design, and adaptation to changing market conditions. The case is particularly relevant for understanding informal and community-based learning. Small rural enterprises frequently lack access to specialised training institutions. Competences may therefore be

[42] Eco Lodge Cabreira, official website; ENFORCE, *Eco Lodge Cabreira*; FOOD-ZONE, *Eco Lodge Cabreira.*

developed through peer exchange, self-directed learning, voluntary participation, local networks, projects, and workplace experimentation. This learning model can be highly contextual and responsive to local conditions.

However, reliance on informal learning can create gaps in technical areas that require specialised expertise, including energy-system maintenance, environmental monitoring, water management, or formal certification. The Cabreira example therefore suggests that community-based learning needs to be complemented by access to specialist knowledge. Geographical isolation creates an additional challenge. Rural entrepreneurs may face limited access to trainers, digital infrastructure, finance, and professional networks. These constraints influence both environmental implementation and business development. The role of external partnerships is therefore important. Cooperation with local authorities, environmental organisations, project networks, mentors, and educational initiatives can expand the knowledge resources available to small enterprises. Peneda-Gerês National Park illustrates the particular requirements of sustainable tourism in protected natural areas.

Here, tourism depends directly on ecosystems whose degradation would undermine both conservation objectives and the tourism economy. Environmental competences therefore become central to professional practice. Biodiversity protection, sustainable land management, water and waste management, environmental interpretation, nature guiding, impact monitoring, and responsible visitor behaviour all contribute to the sustainable use of protected landscapes. However, environmental expertise alone is insufficient. Local entrepreneurs and destination actors also need the ability to create tourism products that generate income while respecting ecological limits. Nature guiding, birdwatching, wellness, local experiences, environmental education, and other niche forms of tourism can contribute to diversification when they are appropriately designed and managed. This creates a strong connection between conservation knowledge and entrepreneurship.

Protected-area tourism requires professionals capable of translating ecological characteristics into meaningful visitor experiences without encouraging forms of use that threaten the resource itself.

Nature-guiding education, environmental workshops, business development support, cooperation with universities and NGOs, and knowledge-exchange networks can strengthen the capacity of local tourism actors. The governance of the Peneda-Gerês National Park (PNPG) is organised through a formal co-management model intended to strengthen participatory, collaborative and territorially integrated management. The PNPG Co-management Plan for 2022–2027 brings together the Institute for Nature Conservation and Forests (ICNF), the five municipalities within the Park, the University of Minho, environmental non-governmental organisations, representatives of communal lands, regional agricultural authorities and ADERE Peneda-Gerês. The governance structure also includes a dedicated tourism working group composed of representatives of tourism enterprises operating in the municipalities of the Park. The model seeks to coordinate nature conservation with territorial development, tourism, public awareness, environmental education and communication, while strengthening cooperation between public authorities, local

actors, research and education institutions and economic stakeholders. The Peneda-Gerês case therefore illustrates protected-area governance as a multi-actor process in which conservation and tourism objectives cannot be managed effectively by a single institution[43].

Sustainable tourism development consequently depends on the ability to coordinate these actors and build sufficient trust around common objectives. This requires competences in facilitation, strategic planning, conflict management, stakeholder engagement, and long-term destination development. The challenge becomes particularly significant where local businesses have different levels of readiness. Some may already understand sustainability standards and nature-based tourism, whereas others may lack digital skills, business-planning capacity, or familiarity with environmental requirements.

The Verde Sentido initiative provides another perspective by focusing more explicitly on regional capacity building, local business networks, and tourism development connected with rural and wine-producing areas. The environmental competence requirements identified in this context include waste reduction, resource efficiency, biodiversity protection, sustainable land management, environmental interpretation, and certification[44].

At the entrepreneurial level, the emphasis shifts towards rural business modelling, cooperation within local networks, product development, marketing, innovation, and risk management. This combination is particularly important in enotourism and gastronomy-based tourism.

Wine landscapes and local food systems possess strong tourism potential, but transforming them into sustainable products requires cooperation among producers, tourism organisations, municipalities, guides, accommodation providers, and culinary businesses. Individual businesses may be unable to create a compelling destination experience independently. Routes, bundled experiences, shared marketing, common narratives, and local branding therefore require collective entrepreneurial capacity.

Peer learning and network-based training appear particularly relevant in tourism contexts characterised by a high proportion of family businesses and small operators. Such enterprises often differ considerably in terms of professional experience, managerial capacity, digital readiness, and access to formal training. Collaborative workshops, advisory services, mentoring, peer exchange, and joint product-development activities can help reduce these disparities by creating shared learning environments in which knowledge circulates between enterprises and common operational standards can gradually emerge. Digital competence constitutes an important enabling condition within this process. Regional tourism products increasingly depend on effective online visibility, booking and distribution systems, digital storytelling, and the capacity to communicate with visitors interested in rural, culinary, wine, nature-based, or slow-tourism experiences. The development of

[43] Instituto da Conservação da Natureza e das Florestas (ICNF), *Plano de Cogestão do Parque Nacional da Peneda-Gerês 2022–2027*; A. Oliveira et al., "Game Theory and Governance of Protected Areas – Peneda-Gerês National Park", *Cogent Social Sciences*, 9(1) (2023), Article 2171556, doi:10.1080/23311975.2023.2171556.

[44] Associação de Municípios do Douro e Tâmega and Associação Empresarial de Amarante, *Regulamento do Roteiro Enogastronómico Verde Sentido*; RURIS, *Projetos RURIS 2023 – Projeto Verde Sentido*; Associação de Municípios do Douro e Tâmega, *Verde Sentido*.

green tourism therefore increasingly requires the ability to connect environmental authenticity and territorial identity with professional forms of digital communication and market access.

Across the Portuguese practices, sustainability is closely associated with territorial identity and the preservation of place-based resources. Historic villages, protected landscapes, rural environments, local food systems, traditional production, and locally embedded forms of hospitality derive a significant part of their tourism value from the continued integrity of their environmental and cultural foundations. Sustainability consequently assumes a dual function: it serves environmental and social objectives while simultaneously protecting the resource base on which tourism products depend. This relationship is particularly visible in destinations where landscape quality, biodiversity, built heritage, local traditions, and community identity are central components of tourism attractiveness. Sustainable tourism management therefore cannot be separated from the long-term stewardship of territorial assets.

Certification constitutes another important mechanism through which sustainability practices can be institutionalised. Certification schemes may provide structured environmental requirements, external verification, market credibility, and common reference points for enterprises and destinations. Their effectiveness, however, depends on the availability of the competences required to interpret, implement, monitor, and maintain relevant standards. Certification should therefore not be treated as a self-sufficient instrument of transformation. Where enterprises lack appropriate knowledge, technical support, or organisational capacity, certification requirements may generate administrative compliance without producing substantial changes in operational practice. Training, advisory support, and continuous competence development are consequently necessary if certification is to function as a mechanism of organisational learning rather than merely as a formal label.

The Portuguese cases also underline the importance of participation and multi-actor governance. Municipalities, tourism organisations, environmental institutions, local enterprises, educational bodies, associations, and community actors repeatedly appear as participants in sustainability-oriented initiatives. This suggests that sustainable tourism is rarely produced through the isolated activity of individual organisations. Rather, it depends on coordination across institutional and sectoral boundaries. Intermediary organisations are particularly important in this respect. Destination networks, municipalities, protected-area authorities, tourism boards, NGOs, business associations, and educational partners can connect small enterprises with knowledge, training opportunities, certification systems, funding instruments, technical expertise, and wider markets. Their role becomes especially significant in rural and peripheral areas, where individual businesses may lack the scale or resources necessary to access such support independently.

These arrangements also reveal the importance of combining formal and informal forms of learning. Certification workshops, technical training programmes, mentoring, workplace learning, peer exchange, self-directed development, and community-based learning coexist across the analysed practices. Competence development in sustainable tourism should therefore be understood as an ecosystemic process rather than as the outcome of a single educational pathway. Vocational

education and training can play an important role within this ecosystem, but its contribution depends on the extent to which curricula and learning environments remain connected with enterprises, destination organisations, environmental institutions, local communities, and evolving territorial challenges. The interaction between formal education and workplace- or community-based learning is particularly important in sectors where sustainability competences need to be adapted continuously to changing technologies, standards, visitor expectations, regulatory requirements, and environmental conditions.

The Portuguese material further reinforces the importance of hybrid professional profiles. Contemporary tourism occupations increasingly require combinations of hospitality competence, environmental management, digital communication, entrepreneurship, stakeholder cooperation, certification literacy, and heritage or nature interpretation. The relative importance of these competences varies according to occupational and territorial context. A professional working within a protected area requires a different configuration of knowledge and skills from an employee in an urban hotel or an entrepreneur managing a rural eco-lodge. Green tourism competence should therefore not be conceptualised as a single universal skill set. It is more accurately understood as a context-dependent configuration of professional capabilities that combines environmental knowledge with occupational, digital, entrepreneurial, and relational competences.

At the same time, the cases reveal uneven implementation capacity across the tourism sector. Small enterprises, older workers, geographically isolated communities, and actors with limited digital connectivity or access to specialised support may encounter greater barriers to participation in sustainability initiatives. Without appropriate forms of training, finance, advisory support, and technological assistance, the green transition may therefore reproduce or intensify pre-existing inequalities between tourism actors. Implementation capacity becomes a critical condition of transition, because the formal availability of sustainability programmes does not guarantee equal capacity to participate in them. Policy and VET interventions consequently need to consider not only which competences are required, but also which actors have realistic access to the resources necessary to develop and apply them.

The Portuguese examples additionally demonstrate the close relationship between sustainability and entrepreneurship. Environmental practices are more likely to become durable when they contribute simultaneously to resource protection and the economic viability of tourism enterprises. Such synergies may emerge through stronger destination positioning, differentiated place-based products, nature-based experiences, heritage and culinary tourism, environmentally responsible accommodation, or improvements in resource efficiency. The entrepreneurial challenge lies in converting environmental responsibility into credible tourism value without reducing sustainability to a promotional narrative. This requires the capacity to align business development with measurable environmental practices, local identity, and long-term territorial interests.

From the perspective of transferability, the most significant lessons provided by the Portuguese cases concern underlying mechanisms rather than the replication of specific products or organisational solutions. Certification supported by training, participatory governance, intermediary

organisations, networked entrepreneurship, place-based product development, and combinations of formal and informal learning can be adapted to different destinations, but their institutional form should remain sensitive to territorial conditions. Historic villages, protected mountain landscapes, urban hotels, and rural eco-lodges operate within substantially different environmental, economic, and organisational contexts. Transferability should therefore be understood as the contextual adaptation of mechanisms rather than the direct reproduction of models[45].

Taken together, the Portuguese practices illustrate sustainable tourism as a process of connecting environmental stewardship, territorial development, entrepreneurship, and competence formation. Their principal strength lies in the interaction between local identity, certification, partnership structures, intermediary support, and continuous learning. Their principal challenge lies in ensuring that smaller, rural, less digitally prepared, and resource-constrained actors are able to participate meaningfully in the transition. The Portuguese material thus reinforces a broader conclusion emerging across the national cases: sustainable tourism practices are more likely to become durable when environmental knowledge is embedded within organisational and territorial systems that simultaneously support cooperation, entrepreneurship, training, digital capacity, and continuous professional learning[46].

2.2.6 Spain

The Spanish practices illustrate a model of sustainable tourism development in which environmental transformation is increasingly intertwined with digitalisation, certification, data-supported destination management, and cross-sectoral governance. The analysed examples encompass urban and coastal destinations, artificial-intelligence applications, digital visitor platforms, accommodation networks, and smart-destination systems. Despite substantial differences in scale, technological sophistication, and organisational structure, they reveal a common tendency to connect environmental objectives with technological, managerial, and entrepreneurial innovation. This convergence changes the meaning of both green and digital competence. Sustainability in tourism increasingly requires professionals not only to understand resource efficiency, emissions reduction, waste management, biodiversity protection, sustainable mobility, and environmental certification, but also to work with digital platforms, environmental data, smart-management systems, online communication, artificial intelligence, and visitor-flow analytics. Green and digital competences therefore become progressively interdependent rather than constituting separate domains of professional capability.

The cases considered include the sustainable-destination model developed in Gijón, the AI4ST initiative, the DTX digital platform, the sustainable accommodation network in Lanzarote, and the smart-destination approach implemented in Lloret de Mar. Taken together, they illustrate different configurations through which environmental, digital, managerial, and entrepreneurial capabilities

[45] F. Tiago, A. Gil, S. Stemberger and T. Borges-Tiago, "Digital Sustainability Communication in Tourism", *Journal of Innovation & Knowledge*, 6(1) (2021), pp. 27–34.
[46] S. Elhoushy, Y. Elzek and X. Font, "Sustainable Tourism Certification: A Systematic Literature Review and Suggested Ways Forward", *Journal of Sustainable Tourism*, 34(2) (2026), pp. 355–381.

can be combined within tourism systems. Gijón represents a particularly integrated destination-level example, connecting environmental sustainability with digital transformation, accessibility, service quality, certification, and business development within a broader destination-management framework. The analytical significance of this approach lies in the fact that sustainability is not positioned as an autonomous environmental programme but becomes connected with competitiveness, visitor experience, accessibility, urban management, and the innovative capacity of tourism enterprises[47].

Such integration produces multidimensional competence requirements. Tourism professionals need operational knowledge of energy efficiency, waste management, sustainable mobility, biodiversity, carbon-footprint measurement, circular-economy practices, and relevant environmental standards. At the same time, they increasingly require the ability to understand certification systems and use digital tools for resource management, monitoring, communication, and organisational improvement. The gaps identified in the material demonstrate that the formal adoption of sustainability objectives does not necessarily imply the organisational capacity to implement them. Carbon accounting, circular-economy instruments, environmental standards, and digital monitoring systems require forms of technical and analytical competence that go beyond general environmental awareness. Training therefore performs an important intermediary function between policy ambition and organisational practice. University cooperation, technical assistance, certification support, workshops, mentoring, and other forms of applied learning can help enterprises translate sustainability commitments into operational change.The Gijón example also demonstrates the importance of connecting green competence with entrepreneurial capability. Environmental improvement becomes economically and organisationally durable when it can be incorporated into viable business strategies through responsible branding, service innovation, sustainable business planning, customer communication, and risk management. This relationship is particularly significant for smaller enterprises. Micro-businesses may recognise the importance of sustainability while lacking the financial resources, technical expertise, organisational capacity, or staff time necessary to introduce certification systems, environmental monitoring, or advanced digital tools. Destination-level transformation therefore requires support structures capable of reducing disparities in implementation capacity between enterprises of different sizes and levels of technological maturity. Accessibility constitutes another important element of the Gijón model. Its integration with environmental and digital objectives broadens the concept of sustainable tourism beyond a narrow focus on ecological performance. Sustainability becomes a multidimensional destination-quality framework incorporating environmental, economic, technological, and social considerations. This interpretation is particularly relevant to competence development because it requires professionals to understand how different dimensions of destination performance interact rather than treating accessibility, digitalisation, environmental protection, and service quality as unrelated areas of

[47] SEGITTUR, *Smart Tourism Destinations*; Ayuntamiento de Gijón/Xixón, *Gijón/Xixón revalida el distintivo Destino Turístico Inteligente*; Ayuntamiento de Gijón/Xixón, *Plan de Sostenibilidad Turística en Destino: Gijón/Xixón, identidad, sostenibilidad y digitalización*; Barcelona Travel Hub, *AI4ST*; Identify Travel, *DTX – Destination Travel Experience*; Grupo de Alojamientos Sostenibles de Lanzarote; SEGITTUR, *Más de cuarenta destinos reciben el distintivo DTI en FITUR*, 23 January 2025.

expertise. The AI4ST case shifts the analysis towards the role of artificial intelligence in sustainable tourism. Its significance lies not simply in introducing AI into tourism operations but in examining how data-driven technologies can support environmental and managerial objectives. Potential applications include resource optimisation, environmental monitoring, visitor-management systems, recommendation tools, and services intended to encourage lower-impact tourism choices. These applications create a new set of competence requirements at the interface between tourism, sustainability, and digital technology. Tourism professionals require sufficient AI literacy to understand the capabilities and limitations of algorithmic systems, while technical specialists working in tourism contexts require an understanding of the environmental, organisational, and service-related problems that technology is intended to address. Data analysis, environmental monitoring, AI literacy, sustainability strategy, service design, and ethical judgement increasingly need to coexist either within professional profiles or across interdisciplinary teams.

The ethical dimension is particularly important. The growing use of artificial intelligence in tourism introduces questions concerning privacy, data governance, transparency, automated decision-making, bias, and the appropriate relationship between technological optimisation and human judgement. Sustainable digital transformation cannot therefore be evaluated exclusively in terms of technical efficiency. A system may contribute to improved resource management while simultaneously generating new social, ethical, or governance challenges. Responsible AI competence should consequently be incorporated into the wider architecture of sustainable tourism competence wherever algorithmic systems influence visitor services, destination management, organisational decision-making, or resource allocation.

The AI4ST case also reveals a recurring implementation problem: enterprises and destinations differ substantially in their level of digital maturity. Small tourism providers may have limited infrastructure, restricted investment capacity, insufficient technological confidence, or a shortage of staff able to work with advanced data systems. Technological innovation can therefore widen rather than reduce inequalities when adoption progresses more rapidly than competence development. This strengthens the case for combining technological implementation with hands-on training, mentoring, accessible advisory services, and differentiated forms of support. Entrepreneurial judgement is equally important because organisations must be capable of identifying where artificial intelligence can generate meaningful professional or organisational value rather than adopting new technologies primarily because they are available. Data-supported decision-making, service redesign, risk management, and digital transformation become entrepreneurial competences when they influence business models, service configurations, and market positioning.

The DTX platform represents a different and comparatively accessible form of digital enablement for sustainable tourism. Rather than relying primarily on advanced analytical systems, it connects digital visitor communication with local mobility, cultural and natural heritage, sustainability-oriented information, and visitor engagement. One potential contribution of digitalisation in this context lies in replacing or reducing certain forms of printed information and allowing visitor content to be updated and distributed electronically. Its more significant potential,

however, lies in the capacity of digital communication to influence the visitor journey. Information concerning walking routes, local experiences, biodiversity, heritage resources, and environmentally responsible choices can be incorporated into digital visitor interfaces, making storytelling and content design part of destination-management practice.

This creates competence requirements that are often underestimated in conventional tourism education. Environmental knowledge alone is insufficient if tourism professionals cannot translate it into communication that is understandable, credible, relevant, and engaging for visitors. Digital storytelling, content design, customer-journey planning, basic data interpretation, and digital-service management therefore become components of a wider sustainability competence. The DTX case also illustrates the importance of technological proportionality and usability. Highly complex systems may constitute substantial barriers for smaller businesses, particularly where technical infrastructure and specialised personnel are limited. More accessible digital solutions may consequently achieve wider diffusion and practical use. Technological sophistication should therefore not be equated automatically with organisational effectiveness. The appropriate level of technology depends on the problem being addressed, available resources, organisational capacity, user competence, and the long-term requirements associated with operation and maintenance.

The sustainable accommodation network in Lanzarote provides a different model, centred on cooperation between tourism enterprises operating within an environmentally sensitive island destination. Island tourism creates a particularly visible relationship between environmental sustainability and tourism operations because water availability, waste generation, energy consumption, biodiversity, transport, land use, and tourism intensity are closely interconnected. Environmental pressures experienced by accommodation providers are therefore simultaneously organisational and destination-wide. No individual establishment can fully address problems that originate within wider territorial systems.

In this context, network-based learning becomes particularly relevant. Hotels and smaller accommodation providers can exchange experience, participate in shared workshops, access support connected with sustainability standards and certification, and learn from practices implemented by other organisations operating under comparable environmental and market conditions. Peer learning can be especially valuable for small and family-run businesses because it complements formal training with observation, practical exchange, and contextualised knowledge. It may also reduce uncertainty concerning the costs, workload, customer reactions, and technical implications of adopting new environmental practices. Observing similar enterprises successfully implement sustainability measures can increase confidence in organisational change and reduce the perceived risks associated with innovation.

The competence requirements emerging from such cooperation extend across resource management, carbon-footprint calculation, renewable energy, biodiversity protection, environmental monitoring, certification, and communication with visitors. Once again, however, environmental and entrepreneurial dimensions are closely connected. Businesses must be able not only to improve their environmental performance but also to communicate it credibly, design low-

impact experiences, distinguish themselves within tourism markets, and align ecological practices with visitor expectations. This places particular importance on credible sustainability communication. Destinations with strong incentives to position themselves as environmentally responsible also face risks associated with unsupported or exaggerated environmental claims. Certification and forms of peer accountability may contribute to credibility, although neither can substitute for substantive environmental performance.

The Lanzarote case simultaneously illustrates the structural constraints experienced by smaller tourism enterprises. Investment limitations, administrative requirements, technical complexity, and unequal rates of adoption may slow the diffusion of sustainability practices throughout business networks. Collective structures therefore need to provide more than inspiration and opportunities for knowledge exchange. Their capacity to facilitate access to technical advice, training, finance, certification support, and other implementation resources is equally important. Network participation becomes most valuable when it strengthens the practical capacity of enterprises to act rather than merely circulating information about sustainability objectives.

Lloret de Mar illustrates the smart-destination approach in which digital transformation and sustainability are incorporated directly into destination-management systems. Tourism intelligence, environmental monitoring, resource-efficiency measures, mobility management, certification, and visitor-flow analysis are brought together within a data-supported approach to tourism governance. The significance of this model lies in its treatment of data as an operational resource. Sustainable destination management increasingly depends on the capacity to understand what is occurring across the tourism system, rather than relying exclusively on general objectives or retrospective evaluation.

Energy and water consumption, waste generation, mobility, visitor concentration, environmental indicators, and tourism demand can potentially be monitored and interpreted in ways that support more targeted management interventions. This generates demand for a form of green digital literacy that combines environmental understanding with analytical capability. Destination professionals need not only to recognise relevant sustainability indicators but also to understand how data are generated, what they can and cannot demonstrate, and how evidence should inform organisational or policy decisions. The critical competence is therefore not data collection itself but data-informed judgement. Dashboards, indicators, and digital platforms provide limited value if organisations lack the analytical capacity to interpret patterns, identify meaningful changes, assess uncertainty, and translate information into action.

The Lloret de Mar case consequently highlights the increasing importance of tourism intelligence within sustainable destination management. Data analysis becomes connected with environmental management, strategic planning, digital transformation, service innovation, communication, and organisational coordination. This has significant implications for professional education because these competences have traditionally been distributed across distinct disciplinary or occupational areas. The smart-destination model instead requires professionals capable of

working across interfaces between tourism operations, technology, environmental management, and governance.

Institutional coordination is equally important. Digital destination infrastructure may involve public authorities, tourism organisations, accommodation providers, technology suppliers, national programmes, and external sources of financing. Sustainable transformation therefore depends on governance arrangements capable of coordinating data, knowledge, resources, and decisions across multiple actors. Strong institutional support may facilitate initial investment, but long-term effectiveness depends substantially on whether local enterprises possess sufficient capacity to participate in and benefit from the resulting system. SMEs remain a particularly important consideration. As environmental reporting systems, digital platforms, and destination-management technologies become more sophisticated, smaller organisations may find participation increasingly difficult because of limited staffing, technological competence, or financial resources. Smart destinations therefore require inclusive competence-development mechanisms if digital transformation is to strengthen rather than fragment tourism ecosystems.

Considered comparatively, the Spanish cases demonstrate an increasingly close convergence between green and digital transformations. Environmental management is becoming more dependent on digital technologies, while digital innovation is increasingly evaluated according to its capacity to contribute to broader sustainability objectives. This convergence challenges approaches that treat green and digital skills as autonomous curriculum categories. In professional practice, activities such as carbon-footprint monitoring, smart mobility management, visitor-flow analysis, digital environmental communication, AI-supported resource management, and sustainability dashboards require the simultaneous mobilisation of environmental and digital capabilities.

Data constitute a central element of this convergence. Data-supported destination management reflects a movement from sustainability expressed primarily through intentions, policy commitments, or standards towards sustainability increasingly accompanied by measurement, monitoring, evaluation, and adaptive management. This transition nevertheless depends on analytical competence. Tourism organisations need to select appropriate indicators, understand methodological limitations, interpret changes over time, and connect evidence with management decisions. Datafication without interpretative capability risks producing extensive information without corresponding improvement in decision quality.

Certification performs a complementary function by supporting standardisation, external verification, market credibility, and organisational learning. Its effectiveness nevertheless depends on implementation capacity. Certification systems generate knowledge, monitoring, documentation, and organisational requirements that may affect smaller enterprises disproportionately. The value of certification therefore depends not only on the existence of standards but also on access to training, advisory support, technical knowledge, and organisational resources that enable enterprises to translate requirements into substantive operational practices.

The Spanish material also demonstrates that competence development increasingly takes place within networks and innovation ecosystems rather than exclusively within formal educational

institutions. Universities, public authorities, tourism organisations, enterprise networks, technology providers, certification bodies, and other intermediary actors repeatedly function as sources of knowledge, experimentation, and implementation support. This indicates that professional learning in sustainable tourism increasingly depends on interaction between formal education, workplace learning, technical assistance, peer exchange, and collaborative innovation. Vocational education should therefore be understood as one component of a broader competence ecosystem.

This ecosystemic perspective is particularly important because technological accessibility differs significantly between organisations. Innovative pilot projects may demonstrate what is technically possible, but systemic transformation requires solutions that can be adopted and maintained by businesses operating at different levels of digital maturity. Training and implementation support must consequently be adapted to organisational context. A micro-enterprise using a comparatively simple digital visitor-communication system has fundamentally different learning requirements from a destination authority managing integrated tourism-intelligence infrastructure. The relevant objective is therefore not uniform technological adoption but proportionate development of professional and organisational capabilities.

Ethics and trust constitute another increasingly important dimension of sustainable digital tourism. As data-intensive systems and artificial intelligence become more widely incorporated into tourism management, professionals require competence in privacy, data governance, responsible AI, transparency, and credible environmental communication. These concerns are not peripheral to technological transformation. They influence stakeholder participation, visitor trust, institutional legitimacy, and the credibility of sustainability initiatives. Green and digital competence therefore increasingly incorporates the capacity to exercise ethical and professional judgement under conditions in which technological efficiency, commercial interests, environmental objectives, and individual rights may not always align.

From the perspective of vocational education and training, the Spanish cases point towards increasingly hybrid and differentiated professional profiles. Tourism workers may need to combine environmental knowledge, occupational expertise, digital literacy, data interpretation, communication, entrepreneurial capability, and ethical judgement. Managerial roles require additional competence in strategic transformation, investment decisions, sustainability reporting, risk management, and stakeholder coordination, while destination-management functions require broader capabilities in governance, tourism intelligence, visitor-flow management, public-private cooperation, and the coordination of socio-technical systems. Sustainability competence should therefore be differentiated according to occupational role rather than delivered as a uniform set of skills. The learning needs of an accommodation employee, SME owner, digital content specialist, environmental professional, tourism entrepreneur, or destination manager cannot be addressed adequately through a single universal training module.

This differentiation also strengthens the importance of continuing professional development. Rapid technological change means that initial vocational education cannot provide a complete and permanently valid set of digital competences. Artificial intelligence, environmental-monitoring

technologies, data platforms, certification systems, and digital visitor services continue to evolve, requiring competence development to be conceived as a continuous process of upskilling, reskilling, experimentation, and professional learning. This creates opportunities for stronger cooperation between VET institutions, universities, employers, tourism organisations, and technology providers. Applied projects, workplace experimentation, mentoring, workshops, micro-learning, and collaborative innovation can complement formal qualifications and create more responsive pathways for competence development.

Entrepreneurship education must evolve accordingly. Sustainable tourism entrepreneurs increasingly make decisions that combine technology, data, environmental impact, ethics, investment, organisational risk, and the creation of new forms of customer value. Entrepreneurship can therefore no longer be conceptualised primarily in terms of business planning and market development. It increasingly involves the capacity to manage organisational transformation under conditions of technological, environmental, and market uncertainty. Entrepreneurial capability in sustainable tourism consequently includes the ability to evaluate competing technological options, recognise environmental constraints, mobilise external expertise, interpret data, communicate sustainability credibly, and determine how innovation contributes to both economic viability and wider destination objectives.

From the perspective of transferability, the Spanish material indicates that the most valuable transferable elements are not individual technological products but the mechanisms through which technological and environmental change are governed. Integrated destination governance, green-digital competence development, shared data infrastructures, certification support, network-based learning, continuing professional development, and technological solutions calibrated to different levels of organisational maturity can inform transformation in other contexts. Specific AI systems, visitor platforms, dashboards, or certification tools should not, however, be treated as universally transferable solutions. Their effectiveness depends on local infrastructure, institutional capacity, regulatory conditions, data availability and quality, financial resources, professional competence, and user readiness. Transferability should therefore be understood as the contextual adaptation of mechanisms rather than the replication of particular technologies

Taken together, the Spanish practices illustrate a broader movement from sustainability based primarily on individual environmental interventions towards sustainability embedded in interconnected technological, organisational, and governance infrastructures. The green transition of tourism increasingly depends on the capacity of professionals and institutions to manage information, technology, cooperation, and organisational change. Environmental expertise remains indispensable, but it is no longer sufficient on its own. Sustainable tourism increasingly requires the capacity to convert environmental knowledge into data-supported decisions, appropriate digital services, credible communication, entrepreneurial responses, and coordinated destination-level action. The Spanish material therefore adds an important dimension to the comparative analysis: sustainability competence is becoming increasingly socio-technical. It emerges from the interaction

of environmental knowledge, digital technologies, organisational and entrepreneurial capabilities, institutional governance, and human judgement rather than from any single category of skills.

2.3 Case Studies of Sustainable and Technology-Enhanced VET in Tourism

The transition towards more sustainable and digitally enabled forms of tourism has significant implications for vocational education and training. Emerging environmental standards, changing business models, increasingly data-intensive destination-management systems, immersive technologies, and more complex visitor expectations are transforming not only individual occupational tasks but also the organisation of tourism work itself. VET systems are therefore required to respond to a broader process of occupational restructuring in which environmental responsibility, digitalisation, entrepreneurship, communication, and professional judgement increasingly intersect.

The case studies examined in this section provide an empirical basis for analysing how these transformations are translated into educational and training practices. Whereas the preceding analysis focused primarily on sustainable tourism practices and the mechanisms through which competences are developed within enterprises, destinations, networks, and territorial systems, the present section shifts attention more explicitly towards vocational learning, pedagogical innovation, and the institutional conditions that enable emerging competences to be developed. The analytical focus consequently moves from sustainability practices as such towards the educational processes through which professionals acquire the capacity to interpret, implement, and adapt them.

The analysis draws on cases identified in Germany, Greece, Italy, Poland, Portugal, and Spain through desk research, national and sectoral mapping, and contributions from organisations familiar with the tourism and vocational education ecosystems of the respective countries. The cases represent diverse institutional, territorial, technological, economic, and educational settings. Their value therefore lies not in their representativeness of entire national systems, but in their capacity to illuminate different mechanisms through which sustainability-oriented and technology-supported learning can emerge under varying conditions. The purpose of the comparative analysis is consequently not to identify a single optimal model of tourism VET, but to examine how different educational providers, tourism organisations, public institutions, enterprises, and intermediary actors respond to changing competence requirements.

Particular attention is given to the interaction between green, digital, entrepreneurial, and transversal competences. Sustainable tourism increasingly requires combinations of environmental management, resource efficiency, sustainable mobility, biodiversity awareness, circular-economy practices, sustainable entrepreneurship, digital literacy, data use, communication, collaboration, customer engagement, and the ability to work effectively across disciplinary and organisational boundaries. These competence domains are analytically distinguishable but increasingly difficult to separate in professional practice. Tourism occupations are becoming more hybrid, and the capacity

to integrate different forms of knowledge is becoming at least as important as mastery of individual technical skills.

Digital and immersive technologies constitute an important dimension of this transformation. Extended Reality technologies, including Virtual Reality, Augmented Reality, and related forms of immersive simulation, are examined where they contribute to vocational training, heritage interpretation, environmental education, visitor-experience design, or the simulation of professional situations. Their relevance, however, does not derive primarily from technological novelty. Immersive environments may allow learners to encounter situations that would be difficult, expensive, environmentally sensitive, unsafe, or otherwise impractical to reproduce within conventional educational settings. They can potentially support procedural learning, spatial understanding, professional decision-making, visitor-management competence, environmental awareness, communication, and the rehearsal of complex occupational situations.

The educational value of such technologies nevertheless depends on pedagogical integration. Access to immersive equipment does not in itself generate improved learning. Educational additionality emerges when technological affordances are aligned with clearly defined learning objectives, appropriate instructional design, educator competence, learner needs, assessment, accessibility, and opportunities for reflection. Equally important is the relationship between simulation and authentic professional practice. Immersive environments can support preparation, rehearsal, experimentation, or reflection, but they should not be assumed to substitute automatically for workplace learning. Their contribution is strongest when simulated experience is deliberately connected with real occupational tasks, organisational conditions, and professional judgement.

The cases are therefore analysed not only in terms of the technologies or sustainability measures they incorporate, but also in terms of the learning processes they make possible. A central analytical question concerns the relationship between educational provision and the actual operating conditions of tourism organisations and destinations. Sustainability-related competences are strongly contextual and practice-oriented. Environmental management, sustainable hospitality, guiding, resource efficiency, visitor communication, destination management, and heritage interpretation cannot be developed fully as abstract knowledge domains because their application depends on concrete organisational, territorial, social, and environmental circumstances.

Work-based and experiential learning consequently occupy an important position within the analysis. Cooperation with tourism enterprises, protected areas, destination-management organisations, local authorities, technology providers, NGOs, cultural institutions, and community actors can expose learners to authentic professional problems and sustainability challenges. Such cooperation also allows VET institutions to remain connected with changes in occupational practice. Tourism transformation proceeds at different speeds across destinations and subsectors, while formal qualification frameworks and curricula are often revised more slowly. Partnership-based learning may therefore function as a mechanism of adaptive responsiveness, enabling educational

provision to engage with emerging competence needs before these become fully institutionalised within formal qualification systems.

This perspective also changes the way curriculum integration is understood. Sustainability and digitalisation may be introduced through dedicated modules, but they may also be embedded across occupational subjects, workplace learning, project-based education, interdisciplinary assignments, and simulated professional situations. The evidence examined in this study increasingly supports an integrated approach. Contemporary tourism work frequently requires environmental and digital capabilities to be mobilised simultaneously. Environmental performance may be monitored through digital systems, visitor flows analysed using data platforms, sustainable mobility supported through digital route-planning tools, heritage interpreted through immersive technologies, and certification processes managed through digital documentation and reporting.

The resulting competence challenge is therefore not simply to increase the volume of environmental or technological content within existing curricula. It is to develop learners' capacity to combine different forms of knowledge and to exercise professional judgement when solving authentic occupational problems. The relevant educational objective is integrative capability rather than the accumulation of disconnected skill categories. A learner should not merely know what sustainability means, understand how a digital system operates, or recognise an entrepreneurial opportunity in isolation. Professional competence increasingly requires the ability to bring these dimensions together when making decisions in contexts characterised by competing objectives, incomplete information, resource constraints, and diverse stakeholder expectations.

Entrepreneurial competence forms an important part of this capability. The green and digital transformation of tourism is generating new products, services, business models, forms of cooperation, and market expectations. Tourism professionals increasingly need to recognise emerging opportunities, redesign services, communicate new forms of value, cooperate across organisational boundaries, and manage uncertainty associated with technological and environmental change. Entrepreneurship education in tourism should therefore extend beyond conventional business planning and market analysis. It increasingly needs to address sustainable value creation, innovation, resource limitations, stakeholder relations, environmental and social consequences, technology choices, and the responsible management of transformation.

Transversal competences are equally important because technical knowledge rarely produces professional capability in isolation. Communication, teamwork, adaptability, problem solving, intercultural competence, ethical judgement, stakeholder coordination, and the capacity for continuous learning affect whether green and digital skills can be applied effectively in real professional environments. The analytical approach adopted in this section therefore treats competence as multidimensional. Rather than focusing exclusively on discrete technical skills, it examines configurations of knowledge, practical ability, judgement, attitudes, relational capability, and professional agency.

Educational innovation is also shaped by institutional conditions. Its success cannot be attributed solely to individual teachers or motivated learners. Curriculum flexibility, infrastructure,

access to technology, staff development, organisational leadership, funding, employer relationships, technical support, and the ability of VET institutions to cooperate with actors outside the education system all affect whether new educational approaches can move beyond temporary experimentation. The distinction between access to technology and institutional capacity is especially important. An institution may acquire equipment without possessing the pedagogical, organisational, or technical capability required to integrate it sustainably into teaching practice.

Intermediary organisations and cross-sectoral partnerships can play a significant role in addressing these limitations. Tourism associations, destination-management organisations, universities, local authorities, technology companies, environmental organisations, certification bodies, and sectoral networks may provide knowledge, equipment, professional development, access to workplaces, specialist expertise, or implementation support that individual VET providers would struggle to maintain internally. Their contribution is especially important in emerging competence areas that cross established disciplinary boundaries.

XR provides a clear example of this dependence on interdisciplinary cooperation. Effective immersive learning may require contributions from vocational educators, tourism professionals, instructional designers, software developers, heritage specialists, accessibility experts, and environmental professionals. Comparable arrangements may be necessary in sustainability reporting, biodiversity interpretation, smart-destination management, circular-economy applications, energy management, or data-supported tourism governance. The capacity to cooperate across professional boundaries should therefore be considered part of the institutional as well as the individual competence architecture of contemporary VET.

Transferability constitutes another central analytical dimension. It is not understood here as the direct reproduction of a programme, platform, or institutional arrangement in another country or educational system. Educational practices remain embedded in specific qualification structures, labour markets, institutional arrangements, technological infrastructures, funding systems, and tourism environments. The more useful analytical question concerns which underlying mechanisms can be adapted across contexts. Project-based learning, workplace collaboration, educator upskilling, shared technological infrastructure, modular curriculum design, simulation-based learning, interdisciplinary teaching, cooperation with destination organisations, and continuous dialogue with employers may possess greater transfer potential than the specific technologies or organisational forms through which they were originally implemented.

Transferability should consequently be understood as contextual adaptation. A pedagogical mechanism that functions effectively in one environment may require substantial modification elsewhere because infrastructure, teacher competence, employer engagement, institutional autonomy, or financial resources differ. The relevant unit of transfer is therefore the mechanism rather than the model in its complete organisational form. This distinction reduces the risk of treating successful initiatives as universally reproducible solutions and shifts analytical attention towards the conditions that make particular practices viable.

The six-country perspective also makes visible differences in institutional maturity and implementation capacity. Some contexts possess relatively well-developed sustainability standards, employer networks, technological infrastructure, and institutional partnerships, whereas others rely more heavily on temporary projects, local initiatives, external funding, or individual institutional actors. These differences influence which educational models can be implemented and sustained. They also draw attention to scalability. A pilot project may demonstrate pedagogical potential without providing evidence that it can be embedded across a wider VET system. Costs, infrastructure, staff competence, maintenance requirements, curriculum rigidity, procurement procedures, and regulatory constraints may all limit expansion beyond the initial implementation setting.

For this reason, the analysis distinguishes between innovation activity and sustained institutional capability. The existence of an innovative project demonstrates that experimentation is possible, but it does not necessarily indicate that an organisation or system possesses the capacity to reproduce, adapt, maintain, and improve the innovation over time. Long-term transformation requires institutional learning, staff development, stable organisational arrangements, access to technical expertise, and mechanisms through which experience can be retained after temporary funding or external project support has ended.

The cases are retained under their original names where this is necessary to identify particular initiatives and maintain correspondence with source materials. Their analytical role, however, is not primarily descriptive. Each case is treated as evidence of a broader educational, technological, organisational, or institutional mechanism. The analysis therefore considers the problem addressed by the initiative, the actors involved, the competences required or developed, the learning processes employed, the role assigned to technology, implementation barriers, and the conditions influencing continuity, scalability, and transferability.

This approach allows the analysis to move beyond a catalogue of educational initiatives towards a comparative understanding of how tourism VET responds to green and digital transformation. The cases reveal substantial diversity in educational responses, but they also allow recurrent mechanisms to be identified across institutional and national contexts. They provide empirical material for examining how curriculum design can become more closely connected with sustainable tourism development, technological innovation, occupational change, and the evolving organisation of work.

Taken together, the cases support a broader interpretation of vocational education as part of the transition infrastructure of the tourism sector. VET does not merely respond retrospectively to labour-market changes once new technologies and sustainability practices have become established. Through cooperation with enterprises, destinations, public institutions, technology providers, environmental organisations, and other stakeholders, it can participate in the diffusion of emerging practices, the translation of innovation into occupational competence, and the development of professional capabilities required for transformation. Its contribution therefore lies not only in preparing individuals for existing jobs but also in strengthening the capacity of tourism systems to adapt to environmental, technological, and organisational change.

The analytical importance of the case studies consequently lies less in identifying examples that should be copied than in revealing the conditions under which new tourism competences can be developed, institutionalised, and translated into professional practice. The central question is not which technology, programme, or educational model should be universally adopted, but how VET can develop the adaptive capacity required to connect changing occupational practices with meaningful learning. From this perspective, sustainable and technology-enhanced tourism education becomes part of a broader process through which vocational systems learn with, and contribute to shaping, the green and digital transitions

2.3.1 Germany

The German cases illustrate a diverse set of pathways through which Extended Reality can be integrated with tourism education, cultural and environmental interpretation, visitor management, and professional competence development. The analysed examples encompass heritage attractions, museums, protected natural areas, urban tourism, UNESCO-related heritage contexts, and training initiatives combining digitalisation with sustainability and entrepreneurship. Considered collectively, they suggest that the educational significance of XR extends beyond the production of visually engaging visitor experiences. Immersive technologies may function as tools for interpretation, simulation, environmental education, accessibility, professional training, and destination management. Their effective application, however, depends on competences that combine tourism knowledge with digital storytelling, content design, user-experience awareness, environmental or cultural expertise, and the capacity to cooperate across disciplinary and organisational boundaries. The German material therefore supports an interpretation of XR not as an autonomous technological innovation but as an element within a broader competence ecosystem.

One of the clearest applications concerns cultural heritage interpretation. TimeRide Cologne demonstrates how immersive virtual environments can reconstruct historical urban settings and provide visitors with access to representations of places and social environments that no longer exist in their original form. The educational value of such experiences depends substantially on the quality of historical interpretation and narrative design. Historical knowledge must be translated into a coherent and credible visitor experience, while visual design and interaction should reinforce rather than displace interpretative objectives. This creates a hybrid competence profile in which heritage professionals require knowledge of digital communication and immersive mediation, while designers and developers need sufficient understanding of historical context, audience diversity, and tourism environments. Digital storytelling consequently becomes a boundary-spanning competence connecting cultural interpretation with immersive technology.

The case also draws attention to the operational dimension of immersive heritage tourism. XR-supported visitor experiences require competence not only during the development of digital content but also throughout service delivery. Staff may need to assist visitors with equipment, respond to usability problems, support navigation, and manage the practical requirements associated with changing hardware and software environments. Accessibility forms an integral part of this competence. Users differ in digital confidence, sensory capabilities, familiarity with immersive

interfaces, and tolerance of particular devices. The effectiveness of technological innovation therefore depends partly on whether different visitor groups can participate meaningfully. Inclusive design and visitor facilitation should consequently be treated as core components of XR competence rather than as secondary technical considerations.

The Bavarian Forest National Park case illustrates a different relationship between immersive technology and tourism learning. Here, digital and 360-degree experiences are connected with environmental education and biodiversity interpretation. Their potential significance lies in the possibility of complementing direct encounters with nature by providing mediated access to ecological phenomena or environments that may be difficult to observe directly. This is particularly relevant in protected areas, where tourism and education must operate within ecological constraints. The relationship between access and conservation therefore becomes an important design problem. Digital representations may create additional interpretative opportunities without requiring unrestricted physical access to every location, but their contribution to conservation should not be assumed automatically. Their value depends on how they are integrated with environmental interpretation, visitor management, and broader conservation objectives.

The competence requirements associated with such applications differ from those involved in historical reconstruction. Environmental knowledge, scientific communication, ecological interpretation, digital-content development, and visitor engagement need to be combined within a coherent educational experience. The resulting process is inherently interdisciplinary. Cooperation between park staff, educators, researchers, and technology specialists can become necessary because no single professional group is likely to possess all the expertise required to design environmentally credible and pedagogically meaningful immersive content. From a VET perspective, this highlights the importance of boundary-spanning competence and collaborative professional practice.

The same case also illustrates the reskilling implications of technological change. Rangers and environmental educators accustomed to conventional forms of interpretation may increasingly need competence in digital communication, immersive facilitation, and the integration of XR resources into established educational activities. Digital transformation therefore does not merely generate new occupations. It also modifies existing professional roles and creates new competence requirements within established tourism, conservation, and visitor-service occupations.

The Deutsches Museum provides another example of XR as an educational technology, this time within a science and museum environment. Virtual and augmented reality can support the interpretation of scientific processes, inventions, and phenomena that are difficult to communicate through static displays alone. The central educational challenge lies in translating specialist knowledge into interactive representations that visitors can understand, explore, and contextualise. Science communication therefore becomes closely connected with immersive-design competence. Museum professionals may require greater confidence in facilitating digital experiences, while designers need to understand pedagogical objectives, visitor diversity, accessibility, and the cognitive implications of interaction design.

This case also illustrates the potential value of design-oriented cooperation with universities and research institutions. When technology development and educational design are pursued collaboratively, technical experimentation can be aligned more closely with pedagogical objectives. From the perspective of vocational education, the significance of this model lies in demonstrating that effective XR implementation requires more than operational familiarity with devices. Professionals need to understand how users learn, how information should be structured, how interaction affects attention and comprehension, and how immersive activities relate to broader educational aims.

The Fraunhofer VR CityTour demonstrator shifts attention towards immersive urban environments and the integration of VR with voice-based interaction. In this context, the competence profile is more strongly technological and involves three-dimensional modelling, virtual-environment design, user-experience design, project management, and the integration of AI-supported interaction mechanisms. Nevertheless, these competences remain relevant to tourism because virtual representations of cities require decisions concerning which places are selected, how they are represented, how users navigate them, and how technological interaction supports the tourism narrative. Technical design therefore has direct consequences for cultural interpretation and visitor experience.

The case further illustrates the importance of applied development processes and knowledge exchange between research institutions and technology partners. Collaborative workshops, prototyping, and early-stage testing can function as competence-development mechanisms because participants learn through solving concrete implementation problems. Such forms of experiential learning are particularly valuable in rapidly evolving technological fields where standardised curricula may lag behind practice. User testing assumes particular importance because immersive tourism products are highly dependent on usability, interaction design, comfort, and system stability. Technical feasibility alone does not ensure a meaningful visitor experience. User-experience competence therefore becomes a mediating capability between technological development and tourism-service quality.

The Bamberg case extends the analysis towards heritage destinations facing visitor-management and conservation pressures. Digital technologies in this context are relevant not only to interpretation but also to broader questions of visitor guidance, spatial distribution, heritage protection, and destination governance. Highly visited historic areas often experience tensions between accessibility, conservation, residents' quality of life, and tourism pressure. Digital information and immersive interpretation may contribute to strategies that encourage visitors to engage with a wider range of places and narratives, although such effects require empirical assessment rather than assumption. Technology should therefore be understood as one component of a broader visitor-management system rather than as an autonomous solution to overtourism or spatial concentration.

This type of application requires competences that extend beyond immersive storytelling. Tourism professionals need to understand visitor flows, heritage constraints, destination

management, community interests, and digital communication. The Bamberg material also highlights the importance of collaborative and participatory content development. Historians, tourism professionals, public institutions, technology specialists, researchers, and local stakeholders may contribute different forms of knowledge to the design of interpretation and visitor guidance. Such cooperation can increase contextual relevance and improve the legitimacy of technological interventions.

Cooperation itself can be understood as a competence-development process. Participants need to communicate across disciplinary and institutional boundaries, negotiate competing priorities, and translate specialist knowledge into shared design decisions. This strengthens the relevance of interdisciplinary project-based learning for tourism education. It also demonstrates why digital literacy among heritage professionals matters. Organisational resistance may emerge when employees lack confidence in digital tools or cannot see how technological applications relate to recognised professional goals. Staff development is therefore more effective when technological learning is linked explicitly with conservation, interpretation, accessibility, or visitor-management problems rather than presented as an abstract requirement for digital modernisation.

The social and labour-market dimensions of technology-enhanced tourism education broaden the analysis further. Training programmes that combine sustainable tourism, intercultural communication, entrepreneurship, and immersive-media competence illustrate how green and digital learning can also support labour-market participation. The relevant competence profiles are characteristically hybrid, combining knowledge of low-impact tourism, customer service, environmental management, communication, entrepreneurship, digital media, and emerging technologies. Such programmes demonstrate that technology-enhanced VET can potentially address several dimensions of transformation simultaneously: sustainability, digitalisation, entrepreneurship, and inclusion.

Their effectiveness, however, depends on educational conditions extending beyond curriculum content. Language proficiency, access to equipment, digital literacy, mentoring, caring responsibilities, and the organisation of training can all affect participation. Accessibility should therefore be understood in a broader institutional sense. It concerns not only whether an XR interface can technically be used by diverse learners, but also whether learners are able to enter, remain in, and benefit from the educational process. Inclusive VET consequently requires attention to training formats, learner support, language needs, equipment access, and wider social circumstances.

Across the German material, interdisciplinary learning emerges as a recurrent mechanism. Effective XR applications require interaction between tourism professionals, educators, historians, environmental specialists, researchers, designers, software developers, and destination organisations. Immersive tourism education can therefore be difficult to accommodate within narrowly separated disciplinary structures. Learners increasingly need opportunities to work across professional boundaries and to understand how different forms of expertise contribute to a shared tourism or educational problem.

Project-based and problem-based learning are particularly well suited to this requirement. The cases involve concrete challenges such as reconstructing historical environments, interpreting biodiversity, representing urban spaces, supporting visitor management, or designing more inclusive tourism experiences. Such problems provide contexts in which technical, environmental, cultural, communicative, and entrepreneurial competences can be developed simultaneously. The educational unit becomes the professional problem rather than the disciplinary category.

Partnership-based competence development constitutes a related mechanism. Universities, research institutes, museums, protected areas, tourism organisations, public authorities, and technology providers can supply forms of knowledge, equipment, infrastructure, workplace access, and specialist expertise that individual VET providers may not be able to maintain independently. This is particularly important for emerging technologies with high implementation and maintenance requirements. Shared infrastructure and collaborative expertise may therefore provide a more sustainable model than expecting every educational institution to develop complete technological capacity internally.

Educator and staff upskilling is equally important. XR implementation can alter established occupational roles: museum employees become facilitators of immersive experiences, environmental educators integrate digital content with ecological interpretation, tourism staff support visitors using digital devices, and heritage professionals increasingly engage with digitally mediated visitor management. The green and digital transitions consequently require not only the education of new labour-market entrants but also continuing professional development for the existing workforce.

The interaction between sustainability and digitalisation is another recurring theme, but it requires careful interpretation. XR may potentially support environmental education, alternative access, heritage interpretation, visitor management, and reduced physical pressure on particular locations. None of these outcomes follows automatically from the use of immersive technology. XR infrastructures themselves require devices, energy, connectivity, maintenance, software updates, and replacement cycles. Their sustainability contribution should therefore be evaluated in relation to specific educational, social, or destination-management outcomes rather than inferred from their digital character.

This distinction has direct pedagogical significance. Tourism learners should not be encouraged to equate technological innovation with sustainability. They require the capacity to evaluate whether a given technological intervention actually addresses an environmental, social, educational, or organisational problem and whether its benefits are proportionate to its costs and implementation requirements. Such judgement may be understood as an emerging form of green-digital competence.

Accessibility and inclusion constitute a further cross-cutting dimension. Usability limitations, language needs, differences in technological confidence, unequal access to equipment, and broader digital divides can affect both visitors and learners. Inclusive XR competence therefore needs to encompass user diversity from the beginning of the design and facilitation process. Technical

knowledge should be accompanied by user-centred design, communication competence, accessibility awareness, and ethical judgement.

Digital storytelling also appears consistently across the German cases. Whether the subject concerns historical Cologne, biodiversity in a protected area, scientific knowledge in a museum, urban heritage, or local narratives, immersive environments require content that makes the technological representation intelligible and meaningful. Storytelling connects technology with tourism interpretation by combining cultural, environmental, educational, and communicative knowledge. It therefore constitutes an important interface competence through which digital environments become structured visitor and learning experiences.

From the perspective of curriculum design, the German material supports an integrated rather than modular interpretation of green and digital competence. Teaching the technical operation of XR independently from tourism interpretation would provide only a partial competence base. Equally, teaching sustainability principles without developing the ability to communicate and operationalise them through contemporary digital environments may leave learners insufficiently prepared for emerging professional practice. A more integrated curriculum would connect technological learning with concrete tourism challenges. Learners might, for example, design an immersive biodiversity interpretation activity, develop a heritage narrative, analyse a digital visitor-management concept, or assess the accessibility and sustainability implications of an existing immersive experience. Such tasks create opportunities for environmental, digital, entrepreneurial, communicative, and transversal competences to develop in combination[48].

The cases also support the use of simulation as a component of vocational learning. Immersive environments can provide access to situations that would otherwise be difficult to reproduce within conventional educational settings, including reconstructed historical environments, protected ecosystems, complex visitor settings, and technologically mediated professional situations. Simulation should nevertheless complement rather than substitute for authentic workplace learning. XR can support preparation, rehearsal, experimentation, interpretation, or reflection, while professional competence continues to depend on engagement with real visitors, organisations, destinations, and workplace constraints. The relationship between immersive simulation and work-based learning therefore needs to be deliberately designed.

From the perspective of transferability, the most durable lessons concern pedagogical and organisational mechanisms rather than particular devices, platforms, or software solutions. Specific technologies are likely to change rapidly and may become obsolete. More transferable mechanisms include interdisciplinary co-creation, university–industry cooperation, project-based learning, educator upskilling, user testing, accessibility-oriented design, shared technical capacity, and the integration of immersive tools with clearly defined tourism and sustainability problems. This distinction is particularly important for VET. Curricula organised around individual products or

[48] E. H. Pratisto, N. Thompson and V. Potdar, “Immersive Technologies for Tourism: A Systematic Review”, *Information Technology & Tourism*, 24 (2022), pp. 181–219.

headsets risk rapid obsolescence, whereas curricula focused on immersive-content design, storytelling, user experience, environmental interpretation, ethical technology use, collaborative problem solving, and critical evaluation are more likely to remain relevant as technological platforms evolve.

The German cases consequently suggest that XR competence should be conceptualised at a level substantially higher than device operation. It encompasses the capacity to identify appropriate applications, define the problem that technology is intended to address, design meaningful content, collaborate across professional boundaries, support diverse users, evaluate educational and organisational effectiveness, and relate immersive experiences to wider tourism and sustainability objectives.

Taken together, the cases point towards a model of technology-enhanced tourism education in which digital tools are embedded within broader systems of interpretation, sustainability, professional learning, organisational capacity, and stakeholder cooperation. The central implication is that XR becomes educationally relevant when technological choice is subordinated to a clearly defined learning or tourism problem. Immersion is not an educational objective in itself. Its value lies in the extent to which it enables learners, professionals, or visitors to understand environments, histories, ecological systems, visitor contexts, or professional situations in ways that support informed, inclusive, and contextually appropriate tourism practice[49].

2.3.2 Greece

The Greek cases illustrate several pathways through which immersive technologies can intersect with tourism education, cultural heritage interpretation, hospitality training, entrepreneurship, and inclusive visitor engagement. The analysed material encompasses augmented heritage interpretation, immersive cultural storytelling, simulated hospitality operations, small-scale tourism entrepreneurship, and virtual environments intended to reproduce professional situations. Considered together, these examples are particularly relevant to vocational education because they position XR not merely as a visitor-facing technology but as a potential environment for occupational learning, professional rehearsal, interpretation, communication, and competence development.

A particularly visible application concerns digitally mediated cultural heritage interpretation. Cosmote Chronos demonstrates how augmented and virtual technologies can be used to relate archaeological remains to historically reconstructed representations, thereby making absent, damaged, or substantially transformed elements of heritage more intelligible to visitors. The educational significance of this approach lies in the relationship it creates between place and interpretation. Rather than encountering cultural heritage exclusively through written descriptions or conventional narration, visitors can engage with digital reconstructions embedded within or related to the physical environment.

[49] G. Makransky and G. B. Petersen, "The Cognitive Affective Model of Immersive Learning (CAMIL): A Theoretical Research-Based Model of Learning in Immersive Virtual Reality", *Educational Psychology Review*, 33 (2021), pp. 937–958.

The value of such experiences, however, depends less on technological sophistication than on the quality of interpretative design. Decisions concerning what is reconstructed, how uncertainty is communicated, how historical information is selected, and how digital content relates to the surviving physical site directly affect the meaning produced by the experience. XR-based heritage interpretation therefore generates competence requirements extending beyond technical operation. Digital storytelling, cultural mediation, visitor communication, historical interpretation, and content design need to be combined within an interdisciplinary process involving curators, educators, tourism professionals, technology providers, and digital-content specialists.

This interdisciplinary structure is itself significant from a VET perspective. Tourism professionals increasingly need the ability to communicate across professional boundaries and to understand how technological choices interact with visitor needs, cultural interpretation, and heritage-management objectives. The relevant competence is therefore not simply the ability to use an immersive application, but the capacity to participate intelligently in its design, adaptation, facilitation, and critical evaluation.

The introduction of immersive interpretation also changes the role of guides and educators. Their function increasingly includes mediating the relationship between physical heritage, digital representation, and visitor understanding. This requires technological confidence, but also pedagogical judgement concerning when an immersive intervention adds interpretative value and when more conventional forms of communication may remain preferable. In this sense, technology becomes one component of a wider interpretative repertoire rather than a substitute for professional mediation.

Accessibility constitutes an equally important condition of meaningful implementation. Mobile and immersive experiences depend on device compatibility, connectivity, interface design, linguistic accessibility, sensory requirements, and varying levels of user confidence. A technically advanced application may consequently remain educationally ineffective if particular visitor groups cannot use it comfortably or understand its interface. XR competence should therefore incorporate facilitation, user-centred design, and accessibility awareness alongside technical knowledge.

The hospitality-training material shifts attention more directly towards vocational simulation. Immersive environments can reproduce occupational situations such as reception procedures, customer complaints, housekeeping tasks, environmental routines, or other service-related scenarios before learners encounter comparable situations in the workplace. Their pedagogical potential lies in providing protected environments in which decisions can be practised, reconsidered, and repeated without exposing customers, learners, or businesses to the consequences of initial mistakes.

This function is particularly relevant to hospitality occupations, where competence depends not only on procedural knowledge but also on communication, timing, judgement, situational awareness, and the ability to respond under pressure. Simulation may therefore help reduce the distance between theoretical instruction and professional performance by enabling learners to rehearse occupational situations in conditions that retain some of the complexity and interdependence of workplace practice.

The sustainability dimension becomes particularly important when environmental procedures are incorporated into such simulations. Resource-conscious housekeeping, waste-management routines, energy-saving practices, sustainability-related customer communication, or environmental standards can be embedded within occupational scenarios rather than treated as separate theoretical content. This provides a useful illustration of embedded green learning, in which sustainability becomes part of professional decision-making rather than an autonomous subject detached from everyday hospitality operations.

Such integration has broader curriculum implications. When green skills are taught exclusively through separate modules, learners may acquire conceptual knowledge without necessarily developing the capacity to apply it during routine professional tasks. Simulation provides one mechanism through which environmental considerations can be incorporated into operational learning. A learner addressing a housekeeping problem, for example, may need simultaneously to consider customer expectations, resource consumption, service standards, environmental procedures, communication, and digital interaction. Competence consequently develops around the occupational problem rather than around isolated disciplinary categories.

The hospitality cases also highlight the role of teacher competence. Meaningful XR-based education requires educators to do considerably more than operate hardware or software. Teachers and trainers need to select appropriate scenarios, align immersive activities with curriculum outcomes, facilitate learner engagement and reflection, interpret performance, incorporate simulation into assessment, and decide when XR should be combined with other teaching methods. Educator upskilling therefore represents a condition of pedagogical integration rather than a supplementary technical activity.

This distinction is important because investment in technology does not in itself generate educational innovation. Hardware and software can remain marginal to teaching if educators lack confidence, pedagogical digital competence, or opportunities to experiment with new instructional approaches. Sustainable implementation therefore requires institutional as well as individual capability. Internal technology champions, specialist educators, peer support, and shared institutional expertise can help retain knowledge within educational organisations, reduce dependence on external providers, and support continuity once initial project funding or implementation assistance has ended.

The cultural interpretation material introduces a related mechanism through participatory storytelling and co-creation. Immersive content in museums and cultural centres may be developed with communities rather than simply produced for them. Such processes change the role of tourism and cultural professionals, who may become facilitators responsible for collecting narratives, negotiating representation, incorporating multiple perspectives, and translating local knowledge into digital experiences without reducing its complexity.

Co-creation therefore produces both pedagogical and ethical competence requirements. Professionals need to understand who has authority to represent particular cultural narratives, how different voices are included, and how technological mediation shapes the meaning visitors derive

from an experience. This is particularly important in immersive cultural tourism because digital reconstruction can create strong impressions of presence and authenticity even though the experience remains a designed and selective representation.

Critical digital literacy should therefore include recognition that XR does not reproduce culture, history, or place neutrally. It selects, frames, reconstructs, and mediates them. Emotional intensity and a sense of presence may strengthen visitor engagement, but neither should be equated automatically with learning. Effective cultural interpretation still requires context, explanation, intellectual coherence, and opportunities for reflection. The competence challenge consequently lies in designing immersive experiences that are both engaging and interpretatively responsible.

User diversity adds another dimension to this requirement. Digital-content competence in tourism should include the ability to anticipate differences in age, language, technological confidence, sensory capacity, prior experience, and cultural background. Accessibility is therefore not confined to technical interface design but forms part of the broader communicative and pedagogical quality of an immersive experience.

The small-island accommodation case shifts the analysis from institutional settings towards tourism entrepreneurship. This perspective is important because discussions of XR in tourism frequently concentrate on museums, major attractions, universities, or technologically advanced destinations. Small tourism enterprises face substantially different conditions. Their decisions concerning digital adoption are shaped by limited financial resources, restricted access to specialist staff, local infrastructure, maintenance requirements, and the need to connect technological investment directly with visitor experience and business viability.

In such contexts, relatively accessible technologies such as 360-degree content, mobile AR, digital storytelling, and interactive visitor guides may be more relevant than complex immersive infrastructures. The associated competence profile is correspondingly different. Small tourism entrepreneurs do not need to become advanced XR developers. More important is their ability to identify appropriate technologies, create or commission useful content, integrate digital tools into the visitor experience, assess costs and maintenance requirements, and evaluate whether a particular technological intervention contributes to business and destination objectives.

This capability may be understood as applied XR literacy for tourism entrepreneurship. Its central feature is technological judgement. The professional question is not whether an enterprise can adopt XR, but what degree of technological complexity is proportionate to the problem being addressed, the resources available, and the organisational capacity to maintain the solution over time. Excessively complex technologies may be financially unsustainable, difficult to update, or poorly aligned with local connectivity and infrastructure. Critical selection therefore becomes as important as technological enthusiasm.

Digital storytelling can also contribute to the visibility of local routes, gastronomy, cultural narratives, and lesser-known tourism resources. In destinations characterised by spatial concentration of visitor activity, such communication may help broaden the geographic scope of the

visitor experience. This potential should nevertheless be interpreted conditionally. Digital promotion does not automatically produce a more sustainable distribution of tourism flows, and directing visitors towards secondary locations can generate new pressures if infrastructure, carrying capacity, community interests, and environmental sensitivity are not considered. Digital visitor communication therefore needs to be integrated with destination-management judgement.

Small enterprises additionally face practical challenges associated with connectivity, content maintenance, outsourcing, intellectual property, platform dependence, and the continuing workload required to keep digital services relevant. Continuing training should therefore address not only the creation or operation of immersive content but also the organisational and managerial requirements associated with its lifecycle.

Virtual hotel simulation provides an especially useful example of the relationship between curriculum and workplace requirements. Learners may acquire theoretical knowledge of hotel operations without encountering the complexity, sequencing, pressure, and interdependence characteristic of real hospitality environments. A well-designed virtual hotel can reproduce selected operational relationships extending across reception, reservations, housekeeping, customer communication, environmental procedures, and unexpected events, allowing learners to understand how different functions interact.

Such systemic understanding is particularly important for sustainability because environmental performance in hospitality is rarely confined to one department. Energy use, water consumption, waste, procurement, customer communication, and environmental compliance result from numerous interconnected operational decisions. Simulation can therefore help learners perceive sustainability as part of hotel management rather than as a separate environmental responsibility.

Simulation may also support communication and decision-making competences by enabling learners to respond to complex situations under controlled conditions and to receive feedback before repeating or modifying their actions. This creates opportunities for reflective learning that are difficult to reproduce through lectures alone. However, educational validity depends on the authenticity of the scenarios. A simulation that substantially oversimplifies workflows or ignores organisational constraints may develop procedures that do not transfer effectively to employment.

Employer participation therefore becomes particularly important. Hotels, tourism associations, and other industry actors can help educational institutions identify authentic scenarios, recurrent operational problems, sustainability requirements, and realistic workflow dependencies. Educators, in turn, are responsible for ensuring that workplace situations are transformed into structured learning experiences rather than simply reproduced. This relationship provides a strong rationale for industry–VET co-design.

Immersive simulation should consequently be viewed as complementary to work-based learning rather than as its replacement. XR can prepare learners before workplace exposure by allowing them to encounter selected procedures and professional situations in advance. Following internships or other work-based experiences, simulation can also support reflection, consolidation, or practice of

situations that were not encountered directly. A particularly productive model therefore links classroom learning, simulation, and workplace experience within a deliberately structured learning sequence.

The institutional conditions of simulation are equally significant. Licensing costs, infrastructure requirements, staff confidence, platform dependence, technical support, and maintenance influence whether immersive learning remains a temporary pilot or becomes a sustainable component of educational provision. Scalability consequently depends not only on pedagogical effectiveness but also on ownership, financing, interoperability, institutional expertise, and the capacity to maintain technological resources over time.

This raises an important policy issue. Where immersive training depends exclusively on expensive commercial platforms, differences in institutional resources may translate into unequal access to innovation. Shared infrastructure, open educational content, regional technology centres, consortia, and jointly maintained simulation environments may therefore provide alternative implementation models. Their value lies not only in reducing cost but also in pooling expertise and making specialist support available to institutions that could not sustain it independently.

Viewed comparatively, the Greek cases reveal a set of interconnected educational and organisational mechanisms rather than a linear sequence of technological applications. Simulation-based vocational learning provides opportunities for safe rehearsal of occupational tasks, while curriculum integration ensures that immersive activities are linked to professional outcomes rather than introduced as isolated technological demonstrations. Teacher and trainer competence determines whether these environments become pedagogically meaningful, while co-creation connects learning with community knowledge, cultural interpretation, and collaborative practice. Technological proportionality ensures that adoption remains aligned with organisational resources and professional needs, whereas accessibility and inclusion determine whether technological availability translates into meaningful educational participation.

The interaction between green and digital competence is particularly significant. Hospitality scenarios demonstrate how environmental procedures can be embedded within digitally mediated occupational learning, requiring learners to integrate sustainability, communication, customer service, resource management, and technological interaction within the same professional task. This supports an integrated interpretation of curriculum modernisation. Adding separate modules labelled “sustainability” and “XR” risks maintaining artificial boundaries between competence areas that increasingly converge in practice.

A stronger approach would embed environmental and digital learning within authentic occupational problems. Learners might analyse resource-efficient hotel operations, respond to a sustainability-related customer complaint, design an accessible AR heritage interpretation activity, develop digital communication for a local tourism route, or assess the sustainability implications of

an immersive visitor experience. Such activities require knowledge to be mobilised in combination rather than reproduced in isolation[50].

Entrepreneurial competence is equally important in this context. Small tourism operators need to determine whether immersive technologies can meaningfully differentiate products, strengthen direct communication, expand interpretation, increase visibility of local experiences, or support particular destination objectives. This requires opportunity recognition, cost assessment, service design, storytelling, market judgement, and critical technology adoption. Entrepreneurship education should therefore encourage learners to ask not simply whether an XR application can be developed, but whether it addresses a meaningful tourism problem, for which users, at what cost, and with what environmental, social, accessibility, and organisational implications.

Partnerships constitute another recurrent condition of implementation. Telecommunications providers, cultural institutions, schools, universities, technology companies, tourism enterprises, and employers can provide access to equipment, specialist knowledge, authentic professional contexts, and technological expertise that individual VET institutions may lack. However, dependence on external partners also creates a potential vulnerability. Where technological knowledge remains entirely outside the education provider, implementation may weaken once external funding or project support ends. Educational institutions therefore require sufficient internal capability to maintain, adapt, and critically evaluate the tools they use.

Continuous professional development follows from the same logic. Technological change proceeds more rapidly than formal qualification structures, making it unrealistic to expect initial education to provide permanent competence in XR or related digital technologies. Peer learning, mentoring, short training formats, workplace experimentation, and cooperation with technology and tourism organisations therefore become components of institutional adaptation.

From the perspective of transferability, the most durable elements of the Greek cases are consequently pedagogical and organisational rather than technological. Specific applications, devices, and platforms are likely to change rapidly. More transferable mechanisms include simulation-based learning, employer co-design, teacher upskilling, community participation, interdisciplinary teamwork, gradual and proportionate technology adoption, and the integration of green objectives into authentic occupational scenarios.

This distinction has important implications for VET policy. Investment in equipment without corresponding investment in educators, curriculum development, organisational learning, maintenance capacity, and partnerships risks producing short-lived innovation. By contrast, investment in reusable pedagogical methods, institutional expertise, professional development, and collaborative implementation creates greater capacity to adapt to future technological change.

[50] G. Makransky and G. B. Petersen, “The Cognitive Affective Model of Immersive Learning (CAMIL): A Theoretical Research-Based Model of Learning in Immersive Virtual Reality”, *Educational Psychology Review*, 33 (2021), pp. 937–958; C. Silva, N. Zagalo and M. Vairinhos, “Towards Participatory Activities with Augmented Reality for Cultural Heritage: A Literature Review”, *Computers & Education: X Reality*, 3 (2023).

Taken together, the Greek cases illustrate a model in which XR can function as a bridge between curriculum and professional practice when it is embedded within authentic occupational problems. Its principal educational contribution lies not in replacing established forms of vocational learning, but in creating additional opportunities for rehearsal, experimentation, interpretation, co-creation, and reflection. Immersive technology should therefore not be conceptualised as a separate digital specialisation. It is more appropriately understood as one possible learning environment through which green, digital, entrepreneurial, communicative, and transversal competences can be developed in combination[51].

2.3.3 Italy

The Italian cases illustrate a particularly diverse relationship between Extended Reality, tourism, cultural heritage, environmental interpretation, and destination development. The analysed material encompasses digitally mediated heritage interpretation in Matera, immersive environmental education in Milan, augmented-reality storytelling in wine tourism, archaeological reconstruction at the Circo Massimo in Rome, mobile interpretation in Cilento, HBIM-to-XR integration for museum and heritage management, virtual destination representation in Apulia, and multisensory interpretation at the Cagli Museum. Despite differences in technological complexity and institutional setting, these cases share a common characteristic: XR is rarely introduced as an autonomous digital attraction. Instead, it operates at the interface between existing cultural or territorial resources, visitor interpretation, professional practice, and wider organisational objectives.

This relationship is significant because it changes the competence requirements associated with tourism digitalisation. Immersive technologies require considerably more than device operation or software familiarity. Their meaningful application depends on combinations of digital storytelling, cultural and environmental interpretation, user-experience design, accessibility awareness, digital asset management, project coordination, interdisciplinary cooperation, and the ability to assess whether a technological intervention corresponds to a genuine tourism, heritage, or educational problem. The Italian material therefore provides a particularly useful basis for conceptualising XR competence as an integrative professional capability rather than as a discrete technological specialisation.

The Matera material demonstrates the close relationship between digital interpretation and place-based tourism. In a city whose tourism identity is strongly connected with historic urban fabric, cultural heritage, and processes of urban and cultural revitalisation, immersive technologies can provide additional ways of interpreting historical narratives and making complex spatial transformations more intelligible to visitors. Their analytical significance lies not in demonstrating that XR itself produces urban regeneration, but in showing how digital interpretation can become embedded within a wider process of heritage valorisation and destination development.

[51] A. Huang, E. de la Mora Velasco and A. Haney, "Examining Instructional Technologies in Hospitality and Tourism Education: A Systematic Review of Literature", *Journal of Hospitality & Tourism Education*, 36(2) (2024), pp. 113–131.

Such applications may broaden the range of narratives and locations presented to visitors and can potentially increase the visibility of places outside the most familiar tourism itineraries. However, spatial or seasonal redistribution should not be treated as an automatic consequence of immersive interpretation. Whether digital content influences visitor movement depends on destination-management decisions, accessibility, transport, promotion, visitor preferences, and the capacity of less-visited areas to accommodate additional demand. XR should therefore be understood as one possible instrument within a wider territorial strategy rather than as an independent mechanism of tourism dispersal.

The competence implications are correspondingly broad. Tourism professionals involved in this type of intervention require knowledge of local heritage, visitor communication, interpretation, and destination management, while the production of immersive experiences may require digital-content creation, interaction design, marketing expertise, and cooperation with creative industries. These requirements demonstrate why XR projects frequently extend beyond the organisational boundaries of the tourism sector itself. Universities, municipalities, cultural institutions, technology companies, creative organisations, and tourism operators may all contribute different forms of expertise.

Interdisciplinary cooperation consequently becomes a professional competence in its own right. Tourism professionals need to formulate requirements for technical partners, interpret specialist information, participate in design decisions, and ensure that digital solutions remain aligned with cultural, visitor, and destination objectives. Technical specialists, in turn, require sufficient understanding of tourism contexts and heritage interpretation to avoid producing technologically sophisticated experiences that remain disconnected from place.

The Matera material also draws attention to the lifecycle of digital tourism products. Immersive content requires maintenance, revision, technical support, and periodic reinterpretation. Software and hardware evolve, historical knowledge may be refined, platforms become obsolete, and visitor expectations change. Sustainable digital innovation therefore requires organisational capacity beyond the initial development phase. Funding a technological intervention is not equivalent to developing the institutional capability required to maintain it.

This distinction is particularly important for VET. Learners should be encouraged to understand digital innovation as a lifecycle involving needs analysis, development, implementation, evaluation, maintenance, updating, and eventual replacement or migration. Competence in digital tourism consequently includes the capacity to anticipate long-term resource requirements rather than focusing exclusively on initial creation.

The Milan material extends the analysis towards urban ecology and environmental interpretation. Immersive experiences associated with urban green spaces demonstrate how XR can be used to communicate biodiversity, climate change, human impacts on natural systems, and other ecological processes within a metropolitan context. This expands the conventional scope of urban tourism interpretation, which often privileges architecture, cultural heritage, events, commerce, and built environments while ecological processes remain comparatively less visible within the visitor narrative.

Digital mediation can help make urban nature more legible by drawing attention to parks, biodiversity, ecological relationships, and environmental change. Its educational value depends, however, on the accuracy and intelligibility of environmental communication. Technological expertise alone is therefore insufficient. Professionals need to understand environmental processes well enough to translate specialist knowledge into accessible content without oversimplifying the underlying science.

Environmental storytelling emerges in this context as an important interface competence. It requires the integration of ecological knowledge, communication, narrative design, visitor understanding, and digital-media production. Where experiences concern future urban environments or the changing function of green spaces, participatory approaches may provide additional value by incorporating knowledge about how residents experience, use, or interpret those environments. Co-design can therefore transform digital-content development into a collaborative learning process rather than a purely technical activity.

The wine-tourism material illustrates a different relationship between place, product, and digital interpretation. Augmented and multimedia content associated with wine can extend interpretation beyond the vineyard or tasting environment, connecting products with narratives concerning landscape, heritage, production, local identity, and destination culture. Digital mediation thereby becomes distributed across the visitor journey rather than being confined to a single physical tourism attraction[52].

For wine-tourism professionals, this produces hybrid competence requirements. Product knowledge, hospitality, and customer service increasingly intersect with digital storytelling, content management, brand communication, and visitor-experience design. Where sustainability narratives are incorporated, professionals also need to ensure that environmental claims remain proportionate, evidence-based, and consistent with actual practices.

The case is particularly useful for examining the relationship between tradition and technological innovation. Heritage-based tourism products often derive value from continuity, authenticity, and established cultural identity. Introducing AR or other digital mediation therefore requires curatorial judgement. The professional challenge is not simply to add technological features, but to determine which aspects of the tourism narrative genuinely benefit from digital interpretation and which are better communicated through physical place, interpersonal interaction, material culture, or traditional forms of storytelling.

The Circo Massimo Experience provides a more complex example of immersive heritage interpretation. Augmented and virtual reconstruction enables visitors to relate surviving archaeological remains to digitally reconstructed representations of structures, spatial configurations, and activities that are no longer directly visible. XR consequently functions as a

[52] Frescobaldi, *Augmented Reality: A Unique Journey*; Frescobaldi, *Explore Frescobaldi's World*.

mediating layer between fragmentary physical evidence and the visitor's understanding of the historical environment[53].

This capacity is particularly significant in archaeological tourism because surviving remains frequently provide only partial information about former scale, spatial relationships, architectural form, or everyday use. Digital reconstruction can make these dimensions more legible, but its interpretative power creates a corresponding professional responsibility. Visually convincing reconstruction may appear authoritative even where aspects of the representation involve scholarly interpretation, uncertainty, or hypothetical reconstruction.

Critical digital heritage competence should therefore include the capacity to distinguish between documented evidence, reconstruction, hypothesis, and narrative choice. Immersive representation should not encourage visitors to perceive a digital reconstruction as a neutral or definitive reproduction of the past. Tourism professionals, curators, historians, and developers require sufficient interpretative literacy to communicate uncertainty and to understand how visualisation influences perceived authenticity.

The Circo Massimo case also draws attention to facilitation. Visitors using immersive devices within an archaeological environment may require assistance with equipment, orientation, safety, accessibility, and interpretation. Occupational roles consequently extend beyond conventional guiding. Staff working with immersive heritage systems may require digital confidence, basic troubleshooting capability, visitor-flow awareness, accessibility competence, and the ability to move between digital and conventional modes of interpretation.

These requirements contribute to the development of hybrid occupational profiles within cultural tourism. Heritage professionals increasingly operate at the interface between visitors, physical sites, digital systems, and specialist technological providers. Their role is not necessarily to develop complex technologies independently, but to possess sufficient competence to facilitate their use, evaluate their contribution, and ensure consistency between technological outputs and interpretative objectives.

The case also demonstrates the significance of public–private and interdisciplinary cooperation. Complex immersive heritage projects may require technical expertise that cultural institutions do not maintain internally. External technology providers can supply specialised development capabilities, but the outsourcing of technological production does not remove the need for internal institutional competence. Cultural institutions require sufficient expertise to define objectives, supervise content, assess historical accuracy, evaluate technological decisions, and retain responsibility for the quality of interpretation.

This distinction is important for digital governance. Outsourcing technical implementation should not become outsourcing of curatorial or interpretative authority. Institutions need enough

[53] Roma Capitale, Sovrintendenza Capitolina ai Beni Culturali, *Circo Maximo Experience*, 29 May 2019.

internal capability to act as informed commissioners and evaluators of external technological services.

The WonderCilento material shifts attention from concentrated archaeological attractions towards digitally mediated interpretation across a dispersed natural and cultural landscape. Mobile and augmented interpretation can accompany visitors through geographically distributed environments and connect environmental, archaeological, and cultural resources within a coherent visitor narrative[54].

This creates a different relationship between technology and destination space. Rather than drawing visitors into a purpose-built immersive attraction, digital interpretation becomes integrated with movement through the landscape. The associated competence profile combines route design, environmental and cultural interpretation, digital storytelling, visitor communication, and destination knowledge.

Mobile interpretation may increase the visibility of lesser-known places and potentially contribute to broader spatial distribution of visitor activity. Such effects should nevertheless be interpreted conditionally. Promoting previously less-visited locations may reduce pressure on established hotspots, but it can also transfer pressure to environmentally or socially sensitive places that are not prepared for additional visitation. Digital dispersal therefore needs to be connected with knowledge of carrying capacity, infrastructure, accessibility, ecological sensitivity, and community interests.

This relationship illustrates the increasing convergence of digital-content production and destination management. Decisions about what is made visible through an application can influence tourism attention and potentially visitor behaviour. Digital storytelling therefore has spatial consequences and should be accompanied by destination-management judgement.

Rural and protected environments also raise specific implementation questions. Connectivity, device performance, content maintenance, and changes in environmental conditions may limit the reliability of mobile interpretation. Appropriate technological design may therefore favour lightweight solutions, offline functionality, and manageable content structures rather than maximal technological sophistication. Technological appropriateness is again more important than novelty.

The HBIM-to-XR framework introduces a more advanced form of digital heritage infrastructure. Historic Building Information Modelling enables architectural and heritage assets to be represented through structured digital information that can support documentation, conservation, research, management, planning, and interpretation. When such models are connected with XR environments, the same digital asset can potentially serve both specialist heritage-management purposes and public-facing educational or tourism applications[55].

[54] Wonderlab srl, *Wonder Cilento: An Innovative Tourism in Augmented Reality*, Wonder Cilento, 2023.

[55] U. Ferretti, R. Quattrini and M. D'Alessio, "A Comprehensive HBIM to XR Framework for Museum Management and User Experience in Ducal Palace at Urbino", *Heritage*, 5(3) (2022), pp. 1551–1571.

This is analytically significant because it reduces the distinction between digital tourism content and heritage-management infrastructure. Digital representations may become multi-purpose assets that support conservation, documentation, curatorial practice, research, education, and visitor experience simultaneously.

The competence requirements are correspondingly interdisciplinary. Architectural knowledge, heritage management, data structures, digital modelling, XR development, curatorial interpretation, and user-experience design may all contribute to the same workflow. It would therefore be unrealistic to expect a conventional tourism professional to acquire specialist expertise across the entire technical pipeline.

A more useful distinction can be drawn between specialist digital competence and interface competence. Specialist professionals require advanced knowledge of modelling, programming, data structures, or technical implementation. Tourism and heritage professionals require sufficient understanding to formulate requirements, communicate with specialists, interpret outputs, recognise limitations, and integrate digital assets into visitor services and organisational objectives.

This interface competence is likely to become increasingly important as tourism organisations depend on technologies that are developed outside conventional tourism occupations. Professional capability therefore includes knowing how to work effectively with expertise one does not personally possess.

The HBIM case also raises the issue of institutional capacity. Sophisticated digital models require specialist knowledge, infrastructure, maintenance, software, staff time, and continuing financial resources. These requirements may create disproportionate challenges for smaller cultural institutions. Advanced digitalisation can therefore widen capacity differences if access to specialist expertise, infrastructure, and technical support remains highly uneven.

From a VET and policy perspective, this strengthens the rationale for shared-capacity models. University partnerships, collaborative digital heritage centres, regional technical services, shared infrastructure, and inter-institutional networks may allow smaller organisations to access specialist competence without reproducing the full technological capacity internally.

The Apulia metaverse case extends the analysis towards virtual destination representation. A digitally reconstructed urban environment can enable users to engage remotely with selected destination spaces, guides, and tourism services. Such platforms may support destination familiarisation, virtual exploration, tourism information, educational activity, and potentially pre-visit engagement.

The sustainability implications require particular caution. Virtual access should not automatically be presented as a substitute for physical travel or assumed to produce lower environmental impacts. Whether a metaverse platform changes travel behaviour depends on how users employ it. Virtual engagement may assist planning, extend access to individuals who cannot travel, or provide educational experiences independent of physical mobility. It may equally function as destination marketing that subsequently stimulates additional travel demand.

This ambiguity makes the case pedagogically valuable. Learners should be encouraged to evaluate sustainability claims associated with technological innovation rather than assuming that digitalisation is inherently environmentally beneficial. Critical green-digital judgement requires consideration of behavioural effects, infrastructure, energy requirements, user needs, and the wider system within which the technology is deployed.

Virtual destination platforms also create new competence demands in 3D content, user experience, storytelling, platform management, and hybrid service design. Once again, however, advanced programming should not be interpreted as a universal tourism skill. Tourism professionals require sufficient interface competence to define visitor needs, work with technical teams, evaluate user experiences, and maintain coherence between virtual and physical representations of the destination.

The Cagli Museum material introduces an important complementary perspective through inclusive and multisensory interpretation. Here, innovation is not defined exclusively by visual immersion or technological complexity. Tactile elements, digital replicas, interactive storytelling, and other multisensory strategies can widen access to cultural heritage and challenge assumptions that more advanced technology necessarily produces more inclusive experiences[56].

Accessibility becomes a criterion of design quality. The relevant question is not simply whether a technological application functions, but whether diverse users can participate meaningfully in the experience. This requires accessibility awareness, multisensory storytelling, participatory design, cultural interpretation, and cooperation with users whose needs may not correspond to assumptions embedded in conventional museum design.

Participation is especially important. Accessibility cannot be designed reliably only on behalf of users. People experiencing disability and other forms of access barrier can contribute to identifying problems, testing prototypes, and evaluating whether proposed solutions meaningfully improve participation. Inclusive XR development therefore becomes a form of participatory professional practice.

For VET, this has substantial implications. Accessibility should not be taught as a compliance requirement added after the primary design process has been completed. It should shape the definition of the visitor problem, technological selection, content design, testing, and evaluation from the beginning. A professional capable of producing technically sophisticated immersive content but unable to identify who might be excluded by the interface possesses only partial digital competence.

Considered comparatively, the Italian material reveals several closely connected mechanisms. Digital heritage interpretation functions as a recurring bridge between cultural resources and technological mediation, while digital reconstruction makes absent, fragmented, or difficult-to-

[56] P. Clini, R. Nespeca, U. Ferretti, F. Galazzi and M. Bernacchia, “Inclusive Museum Engagement: Multisensory Storytelling of Cagli Warriors’ Journey and the Via Flaminia Landscape Through Interactive Tactile Experiences and Digital Replicas”, *Heritage*, 8(2) (2025).

interpret environments more legible. Both mechanisms create significant educational opportunities but simultaneously raise questions of evidence, authenticity, curatorial responsibility, and representational authority.

Digital asset management adds another layer of competence. The HBIM example demonstrates that tourism professionals may increasingly interact with structured digital heritage resources rather than isolated multimedia products. Understanding metadata, interoperability, maintenance, data structures, and specialist workflows may therefore become relevant even for professionals who do not create those systems directly.

The cases also demonstrate a recurring relationship between digital mediation and destination space. Matera, Cilento, and comparable initiatives suggest that digital interpretation may be incorporated into attempts to diversify visitor experiences spatially or temporally. Such effects should not be inferred from technology alone. They depend on destination governance, visitor behaviour, infrastructure, carrying capacity, environmental conditions, and community interests. XR needs to be embedded within wider destination-management systems if it is to contribute meaningfully to such objectives.

Co-creation similarly appears as a cross-cutting mechanism. Cultural institutions, researchers, technology providers, guides, destination organisations, local communities, and users may all contribute to immersive-content development. Such participation can strengthen contextual relevance but also introduces professional requirements in facilitation, negotiation, communication, and ethical judgement.

Accessibility constitutes another recurring theme. Although the Cagli example makes inclusive design particularly explicit, accessibility questions are also present in archaeological, museum, mobile, and destination applications. The Italian material consequently supports treating accessibility-by-design as a core dimension of XR competence rather than a specialist addition.

Technology lifecycle management is equally important. Immersive systems continue to generate competence and resource requirements after implementation. Content needs revision, equipment may require replacement, software changes, data must be managed, contracts and vendor relationships need oversight, and staff require continuing development. Innovation capacity should therefore be distinguished from the capacity to maintain innovation institutionally.

The cases further demonstrate that technological sophistication is not equivalent to tourism or educational value. The examples range from comparatively accessible storytelling applications to complex HBIM, mixed-reality, and metaverse environments. Their usefulness depends primarily on the quality of the problem–technology fit. A relatively simple intervention that addresses a clearly defined interpretative or accessibility problem may create greater value than a technically advanced system weakly aligned with user needs.

VET should therefore cultivate technological judgement. Learners need the capacity to determine which technological solution is proportionate to a given tourism problem, institutional

context, audience, resource base, and sustainability objective. This can be understood as responsible or appropriate technology adoption.

The Italian cases also reveal a particularly strong need for boundary-spanning competence. Technology-enhanced tourism increasingly operates at the intersection of tourism management, cultural heritage, environmental science, architecture, computer science, design, education, communication, and accessibility. No vocational programme can reasonably transform every tourism learner into a specialist in all these areas. The more realistic educational objective is to develop sufficient knowledge for effective collaboration across professional boundaries.

Boundary-spanning competence includes the ability to articulate tourism requirements to technical specialists, understand specialist information at a functional level, participate in multidisciplinary teams, recognise user and stakeholder needs, and connect technological possibilities with operational, cultural, educational, and sustainability objectives. Such capability is increasingly important precisely because innovation takes place between established occupational domains.

Critical digital literacy forms another essential component of this competence architecture. Immersive environments are designed representations rather than neutral reproductions of reality. Historical reconstructions contain interpretative choices. Virtual destinations reflect processes of selection. Digital heritage models incorporate assumptions and data structures. Sustainability claims associated with virtual tourism require empirical scrutiny. Accessibility depends on who has been included in the design process and who may still be excluded.

Professional competence therefore requires critical judgement alongside technological familiarity. Tourism learners should be able to question the evidentiary basis of reconstructions, assess the credibility of sustainability claims, evaluate accessibility implications, and identify where technological design shapes visitor understanding.

This has direct consequences for curriculum design. XR-related tourism education should not concentrate primarily on particular software packages or devices. Learning activities can instead be organised around authentic professional problems: evaluating a digital reconstruction, designing an accessible heritage route, assessing the sustainability implications of a virtual-destination platform, interpreting an HBIM resource for visitor use, or developing digital storytelling intended to communicate a lesser-known part of a destination responsibly. Such tasks integrate digital, cultural, environmental, entrepreneurial, communicative, and ethical competences within the same learning process.

Project-based learning is particularly compatible with this approach. Immersive tourism projects provide natural settings for multidisciplinary teamwork involving cultural institutions, destinations, technology companies, environmental organisations, universities, local communities, or accessibility groups. Such cooperation can expose learners to authentic professional constraints while giving partner organisations opportunities to experiment with emerging forms of interpretation.

Project-based learning nevertheless requires deliberate pedagogical design. Clear learning objectives, structured feedback, specialist support, opportunities for reflection, and appropriate assessment remain necessary. Without them, attention may shift towards the production of a technological artefact rather than the development of transferable professional competence.

Teacher and trainer development therefore becomes another condition of meaningful implementation. Educators do not need to become advanced XR engineers, but they require sufficient technological and pedagogical knowledge to supervise projects, select appropriate applications, evaluate learning, cooperate with external specialists, and identify ethical, accessibility, and sustainability implications.

Cultural and tourism institutions themselves can also function as learning environments. Museums, archaeological sites, vineyards, parks, historic cities, and protected landscapes provide contexts in which learners encounter real problems involving interpretation, conservation, visitor experience, digital transformation, and organisational capacity. Stronger cooperation between VET institutions and cultural organisations can therefore connect curriculum more closely with the complex conditions in which technology-enhanced tourism is actually implemented.

From a transferability perspective, the Italian cases again demonstrate that technologies themselves are less durable than the mechanisms through which they are selected, designed, governed, and used. Particular software, headsets, platforms, or digital models may change rapidly. More transferable principles include interdisciplinary co-creation, digital storytelling, responsible reconstruction, structured use of heritage data, accessibility-oriented design, lifecycle planning, continuing professional development, and the alignment of technological intervention with clearly defined tourism problems.

Transferability also depends on institutional capacity. A sophisticated HBIM-to-XR framework may be appropriate where specialist partners, digital infrastructure, and technical staff are available but unrealistic for a small local museum. Conversely, mobile interpretation, digital storytelling, or multisensory approaches may provide more proportionate pathways for organisations with limited resources. Transfer should therefore be assessed in relation to staffing, funding, infrastructure, audience needs, organisational readiness, and strategic objectives rather than technological desirability alone.

Taken together, the Italian cases illustrate an increasingly sophisticated relationship between tourism, cultural heritage, environmental interpretation, and digital technology. XR is not merely generating additional visitor attractions. It is becoming involved in how cultural and territorial assets are documented, interpreted, mediated, managed, communicated, and incorporated into destination strategies. This transformation alters professional competence requirements.

The central lesson from the Italian material is therefore that XR competence in tourism should be understood as a form of integrative professional capability. It combines domain knowledge, digital literacy, interpretative competence, accessibility awareness, collaboration, ethical and critical judgement, technological proportionality, and the capacity to work effectively with specialist

expertise. From a VET perspective, the objective should not be to train learners in individual digital tools that may rapidly become obsolete. It should be to prepare professionals capable of participating intelligently in the design, evaluation, governance, and adaptation of technology-enhanced tourism environments as technologies, visitor needs, and sustainability requirements continue to evolve[57].

2.3.4 Poland

Across the analysed examples, XR-supported tourism is used primarily to extend interpretation, mediate access to natural and cultural resources, support guiding, and create hybrid forms of visitor experience, with the Polish material offering a particularly clear illustration of this pattern. The analysed material encompasses protected natural areas, historic sites, cultural and religious routes, museums, regional heritage destinations, and technology providers developing immersive content for tourism and education. This diversity is analytically significant because it demonstrates that the potential relevance of XR is not confined to technologically advanced urban institutions. Immersive and digitally mediated interpretation may also be introduced in rural, protected, seasonal, and spatially dispersed tourism environments, although the conditions for implementation differ substantially across these contexts[58].

The Polish material therefore directs attention away from technological sophistication as the principal measure of innovation and towards the relationship between technology, place, users, and professional mediation. Across the cases, recurring competence requirements concern the integration of domain knowledge with digital interpretation, the ability to adapt technological solutions to heterogeneous visitor groups, the maintenance of meaningful non-digital alternatives, and the capacity to operate technologies under infrastructural and environmental constraints. A further recurring principle is that digital tools tend to be most valuable when they complement rather than displace human interpretation.

The Białowieża material provides an example of augmented interpretation in a protected natural environment. In this context, AR is associated with biodiversity communication and nature storytelling within an ecologically sensitive tourism setting. Such applications are particularly relevant because tourism in protected landscapes requires continuous negotiation between visitor access, environmental education, and conservation objectives. Digital overlays can potentially provide additional information about species, habitats, ecological processes, or landscape characteristics without requiring extensive physical interpretative infrastructure throughout a protected area[59].

Their educational value nevertheless remains dependent on professional mediation. Ecological knowledge cannot be replaced by an application. Guides and environmental educators retain

[57] C. Innocente, L. Ulrich, S. Moos and E. Vezzetti, "A Framework Study on the Use of Immersive XR Technologies in the Cultural Heritage Domain", *Journal of Cultural Heritage*, 62 (2023), pp. 268–283

[58] R. Mazur and L. Walaszczyk, "Transversal Competencies for Future Tourism Graduates: Stakeholder Alignment and Curriculum Innovation in European VET", *Research Square*

[59] A. Kolasińska, "Wykorzystanie nowych technologii cyfrowych w ramach ekspozycji przyrodniczych funkcjonujących w polskich parkach narodowych", *Turystyka Kulturowa*, No. 6 (2019), pp. 19–33.

responsibility for explaining relationships within ecosystems, responding to visitor questions, adapting communication to local and seasonal conditions, and contextualising information generated through digital interfaces. AR should therefore be understood as an additional interpretative layer rather than as a substitute for environmental expertise or interpersonal communication.

This produces a hybrid competence profile combining biodiversity knowledge, environmental storytelling, digital navigation, visitor communication, and sufficient technological confidence to facilitate basic use and respond to common operational problems. The professional role becomes one of mediation between ecological knowledge, the visitor, the physical landscape, and the digital layer through which additional information is communicated.

The same context highlights the importance of user onboarding and differentiated access. Visitors vary considerably in their familiarity with digital interfaces, their confidence in using mobile applications, and their preferences concerning the degree of technological mediation. An interface that appears intuitive to digitally experienced visitors may create barriers for other groups. Inclusive tourism practice should therefore avoid treating digital adoption as equivalent to universal digital participation.

This supports the concept of blended interpretation. Digital content can coexist with personal guiding, printed materials, conventional signage, and face-to-face communication, allowing visitors to engage with a destination through different combinations of media. From a VET perspective, competence therefore concerns not only the ability to use AR but also the ability to decide how digital and non-digital modes of interpretation should be combined for different audiences and situations.

The Słowiński National Park material develops this contextual perspective further by drawing attention to wearable technologies and eco-guiding. Technologies such as smart glasses potentially enable guides to access contextual information while remaining engaged with visitors and the surrounding landscape. Unlike smartphone-based applications, wearable solutions can become more directly integrated into the guiding process. Their professional value, however, depends on their performance under actual field conditions rather than in controlled technological environments[60].

This distinction is particularly important in natural tourism settings. Battery capacity, weather, moisture, sand, connectivity, visibility, device durability, and ease of maintenance can determine whether an otherwise sophisticated application remains usable in everyday professional practice. Digital competence in sustainable tourism should therefore include the capacity to assess operational suitability. A technology that functions effectively in a museum, classroom, or laboratory may be inappropriate in a remote coastal or forest environment.

Technology selection consequently becomes an exercise in professional judgement. The relevant question is not whether a particular device represents an advanced technological solution, but whether it can operate reliably within the environmental, organisational, and visitor-service

[60] Słowiński National Park, official educational and museum materials.

conditions of the destination. This principle may be described as context-sensitive technology adoption.

Professional users should also participate in this assessment. Guides and environmental educators possess experiential knowledge concerning visitor behaviour, route conditions, environmental constraints, seasonal variation, and common operational problems. Their involvement in technology design and testing can therefore improve usability and implementation quality. They should not be conceptualised merely as end users of innovation developed elsewhere, but as potential co-designers able to translate workplace realities into technological requirements.

The Malbork material shifts the analysis towards digitally mediated historical interpretation. Immersive reconstruction can provide additional ways of engaging with architectural environments, historical periods, or interpretative scenarios that cannot be experienced directly through surviving physical fabric. Such applications may improve the legibility of complex heritage environments by making spatial relationships, historical phases, and absent elements more intelligible[61].

At the same time, immersive reconstruction introduces questions of interpretative responsibility. Virtual historical environments are designed representations. Decisions concerning architecture, objects, people, sound, movement, colour, and narrative emphasis reflect choices made during reconstruction. Digital heritage competence therefore requires an understanding of the distinction between documented evidence, scholarly interpretation, hypothesis, and creative representation.

The greater the visual persuasiveness of a virtual environment, the more important this distinction becomes. Visitors may experience digitally reconstructed spaces as authoritative precisely because of their apparent realism. Heritage professionals therefore require the capacity to communicate uncertainty and avoid presenting hypothetical or contested elements as established historical fact. Critical digital literacy becomes inseparable from historical interpretation.

Accessibility also needs to be incorporated at the beginning of the design process. Immersive installations within historic buildings may create barriers associated with physical circulation, equipment, sensory requirements, interface design, or cognitive load. Universal and inclusive design should therefore not be introduced only after the principal technological solution has been developed. From a VET perspective, heritage-oriented XR competence needs to integrate storytelling, accessibility, visitor facilitation, historical interpretation, and critical evaluation of digital content.

The Zakopane material introduces another potential function of immersive media: extending access to place-based cultural heritage beyond the temporal and spatial limits of conventional visitation. Digital and 360-degree content can provide alternative forms of engagement with

[61] Muzeum Zamkowe w Malborku, *Skarby Zamkowych Kolekcji*; Muzeum Zamkowe w Malborku, *Kulisy działań digitalizacji 3D w Muzeum Zamkowym w Malborku*, 2026; *Wirtualna rekonstrukcja oraz jej multimedialna prezentacja w ochronie obiektów zabytkowych*, Cracow University of Technology Repository.

mountain culture, regional art, architecture, and local narratives before, after, or independently of physical presence at the destination[62].

Such possibilities are relevant to destinations characterised by strong seasonality, but their sustainability implications should be treated cautiously. Remote or virtual access does not automatically substitute for physical travel and should not be assumed to generate environmental savings. Digital content may replace certain forms of visitation, but it can equally stimulate interest in subsequent travel. Its environmental consequences therefore depend on actual user behaviour.

More defensible benefits concern access, education, interpretation, destination communication, and potential diversification of tourism products. Digital experiences can extend the temporal availability of cultural content and provide opportunities for engagement beyond peak tourism periods without implying that the technology itself resolves the structural problem of seasonality.

The same case highlights the relationship between local cultural expertise and digital-production competence. Artists, heritage interpreters, cultural organisations, tourism actors, and technology specialists may possess different but complementary forms of knowledge. Local actors can understand cultural meaning, authenticity, traditions, and place-specific narratives while lacking advanced digital-production skills. Technology professionals may possess sophisticated technical competence without comparable familiarity with the cultural significance of the content they are representing.

Effective digital heritage production therefore depends on collaboration across these knowledge domains. This creates opportunities for project-based learning in which tourism learners cooperate with local artists, guides, cultural institutions, or destination organisations to develop digital narratives while simultaneously engaging with copyright, representation, destination identity, audience design, and technological limitations.

The Częstochowa material broadens this discussion through the context of religious and pilgrimage tourism. This environment is particularly useful for examining differentiated technology adoption because visitors may vary substantially in age, motivation, cultural background, technological confidence, and expectations regarding the tourism or religious experience. Digital augmentation may enrich interpretation for some visitors while remaining irrelevant or undesirable for others.

This supports the principle of optional digital augmentation. Technology need not become compulsory in order to create value. A well-designed visitor service can allow meaningful choice between personal guiding, written interpretation, digital content, or hybrid forms combining several channels. Tourism digitalisation should therefore not be based on the assumption that all visitors require or prefer the same intensity of technological mediation.

[62] Municipality of Zakopane and Zakopane Cultural Centre, “Mapa panoramiczna Zakopanego – nowoczesny przewodnik po mieście”, 25 January 2021; Tatra Museum in Zakopane, “Wirtualny spacer”.

The competence implications extend towards multichannel visitor-experience management. Professionals need to understand how different visitor groups interact with technology and how interpretative coherence can be maintained across digital and non-digital formats. The objective is not technological uniformity but equivalent access to meaningful interpretation through different pathways.

Multilingual interpretation is part of the same competence. Digital tools can widen access for international visitors, but meaningful localisation requires more than literal translation. Religious, cultural, historical, or place-specific concepts may need additional explanation when audiences possess different background knowledge. Digital multilingualism should therefore be understood as an interpretative competence rather than merely a technical localisation task[63].

The POLIN Museum material represents a more institutionally developed context in which digital media interact with historical education, museum interpretation, and accessibility. Virtual and augmented forms of interpretation can potentially support engagement with historical places, events, and experiences that cannot be represented fully through physical exhibitions alone. Their educational significance nevertheless depends on integration with the wider museum narrative[64].

Technology should not function as an isolated attraction detached from curatorial and educational objectives. Its value lies in supporting historical understanding, reflection, interpretation, or access. This requires cooperation between educators, curators, visitor-service professionals, and technology specialists and reinforces the need for institutional competence extending beyond the acquisition of technological equipment.

Museum digitalisation also has a lifecycle dimension. Content, devices, software, security requirements, interfaces, and user expectations evolve over time. Institutions therefore need the capacity to supervise updates, assess technological relevance, troubleshoot operational problems, revise content, and determine whether an immersive experience continues to contribute to educational objectives.

This again demonstrates why technology acquisition should not be equated with digital capability. Institutional capability involves the ability to operate, evaluate, maintain, adapt, and eventually replace technological resources. From a VET perspective, museum environments can provide valuable contexts for project- and work-based learning. Learners in tourism, heritage, culture, design, or digital media can participate in content development, visitor testing, accessibility assessment, or evaluation of educational experiences, thereby engaging with authentic institutional challenges.

[63] Municipality of Częstochowa, *Mobilny Przewodnik po Częstochowie*; Jasna Góra, *Wirtualny spacer*; Jasna Góra Information Centre, visitor and guided-tour information; M. Ingaldi, "Balancing Tourism and Community Well-Being: Evaluating Pilgrimage Services in Częstochowa", *System Safety: Human – Technical Facility – Environment*, 6(1) (2024), pp. 339–349.

[64] POLIN Museum of the History of Polish Jews, *Touring with Audio Guides – Virtual Tour*; POLIN Museum, *Educational Programme for Schools 2026–2027*; POLIN Museum, *Accessible Museum*; POLIN Museum, *Virtual Exhibitions*; POLIN Museum, *Zwiedź dawną żydowską Warszawę bez wychodzenia z domu*.

The CinematicVR material shifts the analytical focus towards the supply side of tourism digitalisation. Technology companies and creative-digital organisations occupy an important position within emerging tourism XR ecosystems because many tourism enterprises, destinations, and cultural institutions lack the resources or specialist expertise required to develop immersive content internally.

This generates a professional interface between tourism and digital creative industries. The resulting competence gap should not be understood simply as a shortage of programmers or developers. Tourism systems increasingly require professionals capable of translating tourism objectives into technological requirements and technological possibilities into viable, interpretable, and contextually appropriate tourism products.

Such professionals perform a boundary-spanning function. Their value lies in possessing enough knowledge of tourism, visitor behaviour, interpretation, sustainability, digital content, and technology to facilitate cooperation between actors operating within different professional domains. They do not necessarily need to develop every technological component themselves. Their competence lies in articulating needs, coordinating expertise, evaluating outputs, and maintaining alignment between technology and tourism objectives.

Technology providers can also become partners in vocational education. Cooperation with XR companies can expose learners to current development environments, production processes, software practices, and real implementation problems. Such collaboration may allow VET providers to respond more rapidly to technological change than formal curriculum revision alone.

External partnerships nevertheless introduce institutional dependency risks. If technological competence remains entirely outside the educational institution, programmes may become difficult to maintain when funding or partnerships change. VET providers therefore require sufficient internal digital capability to act as informed partners, evaluate external proposals, and retain pedagogical control over technology-enhanced learning.

Virtual access represents another dimension of this discussion. Immersive technologies may provide access to natural or cultural resources for people unable to travel because of physical, geographical, financial, or other constraints and can also support educational uses beyond the destination itself. These accessibility benefits are more defensible than general claims that virtual tourism automatically reduces environmental impacts. Claims concerning carbon reduction require evidence that digital experience actually substitutes for physical travel rather than complementing or stimulating it.

This distinction reinforces a broader principle running through the Polish cases: digital access and environmental sustainability should not be conflated. Technological interventions need to be evaluated in relation to specific outcomes rather than treated as sustainable by virtue of being digital.

Viewed comparatively, the Polish material reveals a model of hybrid interpretation in which digital technologies function alongside human guiding, physical heritage, environmental education,

and conventional visitor communication. This is particularly appropriate where visitors differ significantly in their technological confidence, motivations, abilities, or preferences. Blended provision becomes both an accessibility strategy and a professional service model.

A closely related mechanism concerns mediated access. XR can provide alternative means of encountering reconstructed, sensitive, physically difficult, or geographically distant content. Access, however, is multidimensional. Physical accessibility does not guarantee digital accessibility; digital availability does not guarantee cognitive or linguistic accessibility; and online provision does not eliminate economic barriers associated with devices or connectivity. Inclusive XR competence therefore requires consideration of physical, sensory, linguistic, cognitive, technological, and economic dimensions of participation.

The diversity of Polish tourism environments also makes technological adaptation to place particularly important. Protected forests, coastal landscapes, castles, museums, religious routes, and mountain destinations present very different operational conditions. A technological solution appropriate to one environment may be unreliable, unnecessary, or inaccessible in another. Contextual judgement is therefore a central component of professional digital competence.

Digital interpretation of natural and cultural heritage creates another recurring interface between specialist knowledge and visitor communication. Environmental, historical, cultural, or religious expertise needs to be translated into accessible digital narratives. This process requires domain knowledge, storytelling, communication, user-centred design, and sufficient technological awareness to understand how the medium shapes the message.

Professional mediation between sectors becomes increasingly important for the same reason. Tourism organisations frequently depend on technology companies, museums, protected-area authorities, creative professionals, cultural institutions, educational providers, and local communities. Professionals capable of working productively across these boundaries are therefore increasingly valuable. Boundary-spanning competence becomes part of the occupational infrastructure of tourism digitalisation.

Infrastructure sensitivity further differentiates the Polish material. Connectivity, device cost, technical support, maintenance requirements, battery life, durability, internet availability, and access to specialist expertise influence whether immersive solutions can function reliably outside well-resourced institutional settings. Digital innovation in rural and natural destinations consequently cannot be analysed independently of regional infrastructure and organisational resources.

Inclusion through technological choice provides another important principle. Different visitors have different relationships with digital technology. Older visitors, religious tourists, people with disabilities, international audiences, school groups, and highly digitally confident users may require different forms of communication and support. Inclusive tourism therefore benefits from multiple interpretative channels rather than a single technologically standardised visitor journey.

These mechanisms broaden the meaning of tourism digital competence. Professionals do not necessarily need to become XR developers. A tourism employee may nevertheless need to explain an

immersive experience, support visitors encountering interface difficulties, assess basic accessibility issues, contribute domain content, or translate visitor feedback into requirements for developers. A guide may not design an AR application but may need to integrate it meaningfully into a tour. These capabilities can be conceptualised as functional XR competence.

Functional XR competence differs from specialist technological development. It concerns the capacity to use, facilitate, evaluate, mediate, and contextualise digital technologies within existing professional roles. This distinction is especially important for vocational education because most tourism learners will not become software engineers, while many may increasingly encounter digitally mediated services in everyday professional practice.

The Polish material consequently supports closer cooperation between VET providers and cultural, environmental, tourism, and technology organisations. Museums, national parks, historic sites, destination organisations, and technology companies can provide authentic environments for project-based learning. Learners can engage with biodiversity interpretation, digital heritage narratives, route design, accessibility audits, user testing, and evaluation of digital visitor services. Such projects allow green, digital, cultural, entrepreneurial, and communicative competences to develop around a shared professional problem.

Teacher and trainer competence remains essential within this model. Educators require sufficient understanding to supervise multidisciplinary projects, evaluate technological claims, recognise accessibility and sustainability implications, and help learners connect digital tools with actual tourism problems. Importantly, such competence also includes the ability to determine when XR is unnecessary.

This is a critical dimension of professional digital judgement. A conventional solution may sometimes be more accessible, reliable, affordable, pedagogically appropriate, or environmentally proportionate than an immersive one. Innovation should therefore be problem-driven rather than technology-driven. Learners should begin by identifying the visitor, educational, environmental, or organisational problem and only then consider whether a digital intervention provides meaningful additional value.

Lifecycle thinking constitutes another important competence. XR projects require content revision, software updates, equipment replacement, technical support, cybersecurity, accessibility review, and continuing organisational ownership. Without these capacities, successful pilots may become obsolete or unusable after initial funding or enthusiasm declines. VET should therefore address not only technology development and implementation but also maintenance, governance, cost, and long-term institutional responsibility.

From the perspective of transferability, the Polish cases reinforce the distinction between transferring technologies and transferring mechanisms. Specific devices, platforms, and applications may be poorly suited to other destinations. More durable principles include blended interpretation, visitor onboarding, professional co-design, multilingual and accessible communication, context-sensitive technology selection, collaboration with specialist providers, and project-based learning.

The material also indicates the value of incremental digitalisation. Smaller destinations and institutions do not necessarily require sophisticated immersive infrastructure at the outset. Mobile AR, 360-degree content, digital storytelling, guided digital overlays, and virtual educational resources may provide proportionate entry points. Organisations can begin with relatively manageable forms of digital interpretation, develop staff competence, evaluate visitor response, and progressively consider more complex technologies when a clearly defined need and sufficient implementation capacity exist.

Taken together, the Polish cases illustrate an approach to XR in tourism that is strongly dependent on mediation, context, accessibility, and professional judgement. Technology most often functions as a bridge between visitors and environmental or cultural resources rather than as an autonomous tourism product. Its effectiveness depends not simply on technological availability but on the capacity of professionals and institutions to determine when digital mediation is appropriate, how it should be integrated with human interpretation, which visitors can access it meaningfully, and whether it can be maintained under the actual infrastructural and organisational conditions of the destination.

From a VET perspective, the Polish material therefore supports a model based on functional, contextual, and inclusive XR competence. Learners should be prepared not only to operate digital technologies but also to evaluate their appropriateness, mediate their use, adapt them to diverse audiences, collaborate with specialist providers, and critically integrate them into tourism practice. The central competence is not technological proficiency in isolation, but the professional judgement required to connect technology with place, people, interpretation, accessibility, and sustainable organisational practice[65].

2.3.5 Portugal

The Portuguese cases illustrate a model of technology-enhanced tourism in which Extended Reality is closely connected with cultural heritage, educational innovation, regional cooperation, and digital access in historic and rural settings. The analysed examples range from international heritage projects and university-based education to immersive cultural tours, archaeological interpretation, and technology-supported historical itineraries. Considered collectively, they suggest that the relevance of XR extends beyond visitor-facing applications. Immersive technologies can also function as instruments of documentation, cultural mediation, professional learning, informal education, and competence development.

The Portuguese material is particularly valuable because it demonstrates that the educational and organisational significance of XR depends on its integration with wider systems of heritage interpretation and institutional cooperation. Technology does not operate independently of local knowledge, professional expertise, community participation, or organisational capacity. Its value emerges from the interaction between digital tools, cultural meaning, visitor needs, educational

[65] L. Walaszczyk and R. Mazur, "Risk Insights vs. Competences in Managing Multicultural Teams in Poland", *International Entrepreneurship Review*, 5(3) (2019), pp. 145–162.

objectives, and the institutional arrangements through which digital content is produced and maintained.

The iHERITAGE case provides a particularly useful example of this relationship. Immersive technologies are used not only in connection with monuments and physical heritage but also to support the interpretation of intangible cultural practices, gastronomy, local knowledge, and regional identity. This is especially significant in destinations where tourism value derives partly from living heritage rather than exclusively from built attractions. Cultural resources such as the Mediterranean Diet encompass food production, agricultural practices, social traditions, local knowledge, and community participation. Their digital mediation consequently requires more than technical content production[66].

Tourism professionals working in such environments require competence in cultural interpretation, storytelling, community engagement, heritage-sensitive communication, and sufficient environmental and territorial awareness to understand the wider context within which cultural practices exist. Immersive technology should therefore be regarded as one element of an interpretative process rather than as a substitute for cultural knowledge. The quality of digital representation depends on whether content reflects the significance attributed to heritage by the communities that maintain and reproduce it.

This makes co-creation particularly important. Local producers, cultural organisations, tourism enterprises, community actors, researchers, and technology providers possess different forms of knowledge that cannot easily be substituted for one another. Collaborative development can improve contextual accuracy and relevance while creating opportunities for mutual learning. From a VET perspective, this supports an interdisciplinary competence model in which tourism professionals learn to operate at the interface between culture, technology, community knowledge, sustainability, and visitor experience.

The iHERITAGE material also demonstrates the importance of participatory experimentation. Living-lab and workshop-based approaches move beyond a model in which completed technological products are delivered to passive users. Instead, stakeholders participate in defining problems, testing solutions, developing content, and evaluating outcomes. Such arrangements can function as experiential learning environments in which competence develops through engagement with authentic tourism and heritage challenges rather than through abstract instruction alone.

At the same time, participatory digital innovation can reveal underlying inequalities. Rural destinations and smaller tourism organisations may have limited infrastructure, uneven digital literacy, restricted access to specialist expertise, or insufficient organisational resources to participate fully in development processes. Digital inclusion therefore has both a technical and a

[66] iHERITAGE, *AR/VR Mediterranean Diet*, iHERITAGE: ICT Mediterranean Platform for UNESCO Cultural Heritage; UNESCO, *Mediterranean Diet*, Representative List of the Intangible Cultural Heritage of Humanity, inscribed in 2013.

participatory dimension. It concerns not only access to devices and connectivity but also the capacity of local actors to influence how their heritage is represented technologically.

The formal course in VR and AR applications in tourism introduces a different educational pathway by embedding immersive technologies directly within higher-education provision. Its significance lies in providing learners with structured exposure to XR concepts, tourism applications, hardware, software, development processes, and emerging implementation challenges. This moves digital competence development beyond occasional project participation towards formal curriculum integration.

The case supports an important distinction between digital fluency and specialist technological expertise. Tourism learners do not necessarily need to become professional XR developers. They do, however, require sufficient understanding to recognise appropriate applications, evaluate technological options, participate in experience design, identify usability problems, and cooperate effectively with specialised developers. The educational objective is therefore not universal technical specialisation but informed participation in technology-enhanced professional environments.

Practical engagement is particularly important in this regard. Immersive competence cannot be developed exclusively through lectures or conceptual descriptions. Learners need opportunities to interact with devices, explore interfaces, observe how content behaves, identify limitations, and understand the relationship between technical design and user experience. Active learning therefore becomes central to XR education.

Short or introductory courses nevertheless have limitations. Unequal prior digital competence, restricted access to equipment, limited instructional time, and differences in learner confidence can constrain the depth of competence development. This suggests the value of a layered model. Foundational XR literacy can be developed across a broad group of tourism learners, while more advanced content creation, technical production, or digital-experience management may require longer projects, specialist pathways, or cooperation with external organisations.

This layered approach also creates space for a more critical relationship between XR and sustainability. Teaching immersive technology in isolation risks producing a tool-centred curriculum. A stronger model requires learners to evaluate how digital applications relate to accessibility, visitor management, heritage protection, resource use, destination development, and institutional capacity. Digital competence should therefore be problem-oriented rather than tool-oriented.

The Virtual Reality Science Tour material provides another perspective by positioning immersive technologies as instruments of informal education and cultural-memory communication. VR and 360-degree content can create access to places, narratives, and historical contexts that may otherwise be geographically distant or difficult to experience directly. This illustrates the interpretative and educational potential of immersive media while also exposing the technical complexity hidden behind apparently simple visitor experiences.

High-resolution immersive content requires recording, editing, processing, storage, rendering, quality control, and continuing technical maintenance. The distinction between consuming

immersive media and producing it is therefore substantial. Tourism professionals who do not undertake advanced production themselves still require sufficient knowledge to estimate costs, formulate realistic project requirements, understand dependencies, and collaborate effectively with specialist production teams.

The same case highlights human factors. Motion sickness, headset discomfort, visual limitations, anxiety, cognitive overload, or unfamiliarity with immersive interfaces demonstrate that technological availability does not guarantee meaningful participation. User comfort should therefore be considered an integral component of XR competence. Professionals designing or facilitating immersive experiences need to understand that immersion is not universally comfortable or desirable.

Alternative formats, appropriate session duration, onboarding, opportunities to disengage, and attention to user responses become elements of responsible design. Educational quality cannot therefore be evaluated solely through engagement or technological novelty. A highly immersive experience may be ineffective if it creates discomfort, excludes particular users, or distracts from the intended learning objective.

The HOUDINI case introduces a further dimension by applying immersive and interactive technologies to sensitive archaeological heritage. AR, multilingual interpretation, voice-based interaction, digital storytelling, and visitor-management functions can help make fragile, dispersed, or visually subtle archaeological resources more intelligible to non-specialist audiences without requiring extensive physical intervention at the site.

The relationship between interpretation and conservation is therefore potentially important, but technology must remain subordinate to the heritage context. Digital characters, reconstructed environments, or interactive narratives should be consistent with archaeological evidence and should not transform culturally significant places into decontextualised entertainment environments.

This creates requirements in critical heritage literacy. Professionals need to distinguish between established evidence, scholarly interpretation, hypothesis, and creative reconstruction. They must also determine how uncertainty should be communicated and how technological interaction can support rather than simplify a complex cultural narrative. The competence challenge is consequently both epistemic and technical.

Multilingual and voice-based interfaces introduce additional complexity. Voice technologies may improve accessibility and create more natural forms of interaction, but language recognition, accents, translation quality, cultural context, and system reliability influence whether such interfaces are genuinely inclusive. Digital multilingualism therefore involves localisation, cultural adaptation, interaction design, and user testing rather than simple linguistic substitution.

The rural and archaeological context also highlights implementation capacity. Advanced XR applications can depend on connectivity, technical support, device availability, maintenance, and staff able to solve operational problems. Where these resources are limited, technologically

ambitious systems can become fragile. Modular and adaptable approaches may therefore be more appropriate than maximising technological complexity.

The Napoleonic Itineraries provide a different example because digital interpretation is distributed across a cultural route rather than concentrated in a single attraction. Historical routes depend on coordination among municipalities, heritage institutions, tourism enterprises, cultural organisations, and destination actors. Their coherence is therefore organisational as much as geographical.

Digital interpretation can help connect dispersed places within a shared narrative through augmented content, virtual experiences, games, or digitally supported guiding. Technology can facilitate continuity across locations, but it cannot substitute for governance. Successful cultural routes continue to depend on shared objectives, agreed interpretative principles, institutional cooperation, and consistent quality standards.

The use of game-based methods introduces a further educational issue. Historical games can increase engagement and provide alternative ways of approaching complex events, but gamification requires careful judgement where heritage is contested, traumatic, or historically complex. Creativity needs to be balanced with interpretative responsibility. Tourism learners should therefore understand both the pedagogical possibilities of gamification and the risks associated with oversimplification or trivialisation.

Viewed comparatively, the Portuguese material reveals a form of heritage-centred digital competence in which XR applications are repeatedly connected with cultural interpretation, archaeological heritage, memory, gastronomy, regional identity, and local narratives. Digital capability consequently needs to be combined with cultural, interpretative, and ethical competence.

Institutional and academic partnerships constitute another recurring mechanism. Universities, polytechnic institutions, municipalities, cultural organisations, tourism bodies, local communities, and international project consortia can provide expertise, equipment, funding, training, and opportunities for experimentation. Such partnerships create knowledge-transfer mechanisms between research and professional practice and can expand the implementation capacity of organisations that lack specialist resources internally.

Project-based capacity building nevertheless raises a problem of continuity. Workshops, living labs, collaborative development, and externally funded projects can create substantial competence during implementation, but that competence may weaken once project funding, external expertise, or temporary partnerships end. This creates a crucial distinction between project capacity and institutional capacity.

An organisation may successfully participate in an innovative XR project without possessing the internal capability to maintain, adapt, evaluate, or scale the resulting technology. Sustainable innovation therefore depends on whether knowledge is retained within institutions, staff continue to develop competence, organisational responsibilities are established, and technical resources remain accessible after formal project closure.

This distinction has direct implications for VET policy. Participation in innovation projects can provide valuable learning opportunities, but long-term transformation requires institutional learning. Educational providers need mechanisms for converting temporary project experience into curriculum knowledge, staff competence, reusable learning materials, and sustained cooperation with external actors.

The Portuguese cases also support modular technology adoption. The analysed material ranges from foundational VR/AR education and relatively accessible digital applications to more complex interactive archaeological environments. This diversity suggests that digital transformation should be calibrated to institutional and territorial capacity. Organisations may benefit from starting with manageable technological interventions and increasing complexity as professional competence and infrastructure develop.

Informal and non-formal learning are equally important. Virtual cultural tours, workshops, living labs, heritage projects, and community storytelling activities create learning environments outside conventional classrooms. This is particularly relevant to tourism because professional competence frequently develops through engagement with destinations, visitors, cultural resources, and local stakeholders.

These mechanisms also reinforce the importance of human factors and user experience. Immersive learning and visitor technologies need to accommodate not only different physical abilities or linguistic backgrounds but also differences in tolerance of immersive interfaces, technological confidence, and cognitive comfort. Accessibility should therefore encompass physiological, digital, linguistic, cognitive, and organisational dimensions.

A further implication concerns claims about the sustainability of virtual access. Immersive technologies may potentially reduce physical pressure on sensitive sites, extend cultural access, support education, or contribute to pre-visit planning. These possibilities are important, but they do not establish that XR reduces environmental impacts. Such claims require evidence concerning actual changes in travel or visitor behaviour. Digitalisation should therefore not be treated as inherently sustainable.

For VET, this distinction is particularly important because future professionals require the capacity to evaluate sustainability claims associated with technology rather than reproduce them uncritically. Critical green-digital judgement involves asking what problem is addressed, what behavioural effects are likely, what resources the technology itself requires, and whether environmental or social benefits can actually be demonstrated.

From the perspective of curriculum design, the Portuguese material supports a layered and integrated approach to XR competence. A foundational level should enable tourism learners to understand core concepts, potential applications, limitations, accessibility implications, and ethical issues. An applied professional level should enable them to integrate immersive technologies with guiding, heritage interpretation, visitor experience, communication, marketing, or destination

management. Specialist development competence can then encompass advanced modelling, programming, systems integration, and technical content production.

Such differentiation avoids the unrealistic expectation that all tourism professionals should become technical specialists while ensuring that non-specialist professionals retain sufficient digital fluency to participate effectively in technology-enhanced environments. It also reinforces the distinction between specialist competence and boundary-spanning or interface competence.

Authentic project work can support all three levels. Learners can participate in heritage documentation, visitor-narrative design, user testing, accessibility assessment, cultural interpretation, or evaluation of immersive applications. Such activities connect digital learning with real tourism and heritage problems and provide opportunities to integrate technological, cultural, environmental, communicative, and entrepreneurial competences.

Teacher competence remains central to this model. Educators require sufficient technological confidence to integrate emerging tools into curriculum, supervise collaborative projects, assess learning, and work productively with external specialists. Equally important is their ability to distinguish technological novelty from pedagogical value. The presence of immersive technology does not itself constitute educational innovation.

Cultural institutions and destinations can therefore function as extended learning environments for tourism VET. Museums, archaeological sites, cultural routes, rural communities, and heritage networks expose learners to authentic problems of interpretation, conservation, visitor management, accessibility, organisational capacity, and digital transformation. Sustained partnerships with such environments can strengthen the relevance of vocational learning.

From the perspective of transferability, the Portuguese cases again indicate that particular technological products are less durable than the mechanisms through which they are designed and implemented. Living-lab approaches, academic–industry cooperation, modular training, staff upskilling, community co-creation, heritage-sensitive storytelling, user testing, multilingual design, and layered digital competence development remain relevant even as individual platforms and devices change[67].

Taken together, the Portuguese cases position XR within a broader process of heritage valorisation, professional learning, and institutional capacity development. Immersive technology can expand opportunities for interpretation and access, but its long-term value depends on cultural credibility, accessibility, organisational continuity, and the competence of those who mediate between heritage, technology, communities, and visitors.

The central lesson from the Portuguese material is therefore that XR should be understood not only as a technological resource but also as a capacity-building environment. Projects can create opportunities for institutions, educators, professionals, communities, and learners to develop new

[67] Portugal 2020, *HOUDINI – Plataforma de conteúdos imersivos para património com história*, POCI-01-0247-FEDER-069902; Instituto Politécnico de Viana do Castelo, *HOUDINI*.

forms of cooperation and digital competence. From a VET perspective, the critical challenge is to ensure that knowledge generated through individual projects becomes embedded within organisations and remains adaptable as technologies, visitor expectations, and sustainability requirements continue to evolve.

2.3.6 Spain

The Spanish cases illustrate a model of XR-supported tourism in which accessibility, cultural and environmental interpretation, biodiversity communication, and visitor management intersect. The analysed examples encompass immersive access to physically constrained archaeological heritage, augmented interpretation of cultural destinations, digitally mediated engagement with marine biodiversity, virtual exploration of ecologically sensitive environments, and immersive documentation of temporary cultural and religious events. Considered collectively, these cases demonstrate that the relevance of XR extends beyond the enhancement of visitor experience. Digital and immersive technologies may also provide alternative forms of access where architectural, environmental, spatial, or temporal conditions constrain conventional visitation.

This gives the Spanish material a distinctive analytical profile. XR frequently operates at the intersection of inclusion and preservation. In some contexts, digital mediation can expand access to heritage that is physically inaccessible to particular users; in others, it can provide mediated encounters with environmentally sensitive spaces or cultural events that cannot be experienced continuously. The significance of these applications lies not in immersion itself but in the extent to which technology addresses a clearly defined barrier to participation, interpretation, or conservation.

The Cartagena case provides a particularly clear illustration of accessibility-driven technological design. The immersive system installed at the Punic Wall interpretation centre enables visitors with reduced mobility, including wheelchair users, to experience areas that cannot be accessed physically. The solution combines immersive Virtual Reality with three-dimensional documentation of the archaeological environment and an interface specifically adapted to wheelchair use.

The analytical importance of the case lies in the fact that technological development is organised around an identified accessibility problem. Rather than introducing VR as an additional attraction and considering accessibility retrospectively, the system uses immersive technology to create an alternative form of engagement with parts of the heritage environment that remain physically constrained. This provides a strong example of accessibility-by-design.

Such an approach has important implications for tourism competence. Professionals involved in technology-enhanced heritage interpretation need more than familiarity with immersive devices. They require an understanding of visitor diversity, accessible service provision, cultural interpretation, interface design, and the relationship between physical and digital barriers. Technological accessibility should therefore be treated as part of mainstream tourism-service design rather than as a specialist consideration relevant only to particular visitor groups.

The Cartagena case also demonstrates the interdisciplinary nature of inclusive technological development. Engineers and digital specialists contribute knowledge of system architecture,

photogrammetry, modelling and interface design; heritage professionals contribute archaeological and interpretative expertise; visitor-service staff understand operational requirements; and people with disabilities or organisations representing them can contribute knowledge of barriers that may otherwise remain invisible to designers.

Co-design consequently becomes a competence-development mechanism in its own right. Tourism professionals need to learn how to involve users in the design, testing and evaluation of services rather than attempting to infer their requirements without direct participation. Accessibility expertise is therefore partly relational and participatory.

Human mediation remains important even where the technological system has been designed inclusively. Staff need sufficient competence to introduce the experience, assist visitors, respond to differing support requirements and deal with basic technical difficulties. An accessible technology may become inaccessible in practice if service personnel are unable to facilitate its use. The case therefore highlights an important distinction between technological accessibility and service accessibility.

At the same time, virtual access should not automatically be treated as a substitute for physical accessibility. Where architectural barriers can reasonably be removed without compromising heritage values, technology should complement rather than replace efforts to enable direct participation. The professional question is therefore not simply whether VR can compensate for inaccessibility, but whether the digital alternative constitutes the most appropriate response to the barrier in question.

This issue has direct relevance to VET. Learners should be encouraged to evaluate whether technological intervention genuinely expands participation or merely transfers existing barriers into another medium. An immersive environment may overcome stairs or restricted circulation while simultaneously introducing difficulties related to interface complexity, vision, hearing, cognitive load, motion sensitivity, equipment use, or digital confidence.

The Natuverse case shifts attention from architectural accessibility towards the relationship between digital technology and environmental knowledge. Developed as a platform combining artificial intelligence, augmented reality, three-dimensional modelling and marine-biodiversity data, Natuverse connects immersive experience design with the identification, visualisation and communication of marine organisms. Its significance for tourism lies in demonstrating how environmental interpretation can increasingly depend on the interaction between scientific information and digital representation.

This creates a hybrid competence field between tourism, environmental science and technology. Tourism professionals do not need to become marine biologists or artificial-intelligence specialists, but they increasingly require sufficient environmental literacy to understand the significance of the information being communicated and sufficient digital literacy to collaborate effectively with scientific and technical specialists.

The process can be described as scientific mediation. Environmental information needs to retain sufficient scientific integrity while also becoming understandable and meaningful to non-specialist users. This involves choices about terminology, visualisation, narrative structure, scale, uncertainty and the relationship between educational content and visitor engagement.

Natuverse also illustrates an emerging relationship between tourism digitalisation and environmental data. The platform incorporates technological functions associated with species identification and classification alongside visitor-facing immersive applications. Digital tourism competence may therefore increasingly involve the ability to interpret data-oriented environmental technologies at a functional level rather than simply to operate consumer-facing applications.

This emerging capability can be understood as environmental-digital literacy. It combines sufficient knowledge of ecological processes to interpret environmental information responsibly with sufficient understanding of digital tools to recognise how data, artificial intelligence and immersive representation are used in environmental communication and decision-making.

The sustainability claims associated with such technologies nevertheless require careful treatment. Digital visualisation and virtual access can contribute to environmental education and may reduce the need for particular forms of physical interaction with sensitive environments, but these effects should be demonstrated rather than inferred. A digital application does not become environmentally sustainable solely because it represents biodiversity or uses virtual content.

The more defensible educational implication is therefore one of critical green-digital judgement. Tourism professionals should be capable of examining what environmental problem a technological intervention addresses, what evidence supports the claimed benefit, what material and organisational resources the system requires, and whether behavioural changes actually follow from its use.

The Sagunto case introduces another configuration by connecting Augmented Reality with cultural interpretation and smart-destination development. The tourism application combines geolocation, interactive information, three-dimensional content and thematic routes covering multiple heritage locations across the municipality. It therefore demonstrates how mobile AR can organise interpretation across a destination rather than around a single museum or attraction.

This form of digital mediation has potential destination-management implications because it can increase the visibility of heritage resources outside the most familiar visitor circuits and connect dispersed locations through thematic narratives. However, increased digital visibility should not be equated automatically with actual redistribution of visitor flows. Whether tourists change their routes depends on numerous factors beyond the application itself, including accessibility, transport, opening hours, perceived attractiveness, available services and established patterns of demand.

The case should therefore be interpreted as demonstrating the potential integration of AR with destination management rather than as evidence that AR itself reduces congestion or produces sustainable spatial redistribution. Digital content can support visitor dispersal strategies, but its effects depend on the wider governance system within which it operates.

The competence requirements extend accordingly beyond digital storytelling. Tourism professionals and destination managers need skills in cultural interpretation, project coordination, digital communication, visitor-experience design and increasingly the interpretation of tourism information and data. Technology becomes useful when professionals can connect digital content with actual destination-management decisions.

This relationship may be described as destination intelligence. Digital systems generate or organise information, but information only becomes useful when professionals can interpret it and decide whether communication, routes, promotional priorities, infrastructure, or visitor-management measures should be modified. Data availability is therefore not equivalent to management capability.

The sustainability implications of spatial diversification again require caution. Promoting lesser-known sites may reduce pressure on established attractions, but it can also transfer pressure to places with limited infrastructure or greater ecological or social sensitivity. Destination professionals therefore need to consider carrying capacity, local conditions, accessibility and heritage vulnerability when using digital technologies to influence visitor attention.

Mobile applications also introduce questions of digital inclusion. Their apparent accessibility can conceal dependence on compatible devices, connectivity, language, interface design and user confidence. Alternative interpretative channels remain important where visitors are unable or unwilling to use smartphone-based services. Inclusive digital destination management should consequently preserve multiple pathways to information and participation.

The Murciélagos Málaga case provides a particularly clear example of the intersection between immersive technology, biodiversity education and scientific communication. The initiative uses Virtual Reality, three-dimensional representations and related digital tools to enable users to encounter bats and cave environments that may be physically inaccessible or environmentally inappropriate for conventional visitation. The project connects scientific outreach with environmental education and the interpretation of sensitive habitats[68].

Its educational value lies not simply in displaying wildlife digitally. Bats are species around which misunderstanding, fear and negative cultural perceptions can occur, making communication and interpretation especially important. Environmental education in this context involves not only communicating biological information but also helping visitors understand ecological functions, conservation pressures and the broader significance of species within ecosystems.

This reinforces the concept of ecological storytelling. Scientific knowledge concerning habitat, behaviour, biodiversity and environmental pressures needs to be translated into narratives that remain accessible without distorting scientific meaning. Effective interpretation consequently

[68] Murciélagos Málaga, “Murciélagos Málaga: Digitalización del Patrimonio Natural y la Conservación de Especies Amenazadas”, 8 April 2025; Murciélagos Málaga, *MuMa VR – 3D Caves*, 2025.

depends on cooperation between conservation specialists, educators, digital creators and tourism professionals.

The technological production process itself is also interdisciplinary. Virtual representations of natural environments may depend on techniques such as three-dimensional scanning, modelling, photography, environmental observation and specialised scientific content. Tourism professionals do not need to acquire all of these technical competences. They do, however, require sufficient interface competence to formulate visitor needs, understand specialist contributions, evaluate outputs and integrate technological resources into coherent educational experiences.

Murciélagos Málaga is additionally relevant to the relationship between accessibility and conservation. Virtual environments can provide alternative access to spaces that are difficult to enter either because users face mobility or other access barriers or because the ecological characteristics of a site make physical visitation undesirable. This creates what may be conceptualised as dual-purpose mediated access.

The same technological intervention can therefore respond to two different constraints: the visitor's inability to enter a space and the environmental need to limit physical intrusion. These objectives should nevertheless be evaluated separately. A system designed primarily for conservation does not automatically meet accessibility requirements, while an immersive experience designed around engagement may fail to represent ecological information accurately.

The professional capability lies in recognising and balancing these objectives. Tourism technology becomes meaningful when accessibility, ecological integrity, educational purpose and visitor experience are considered simultaneously rather than sequentially.

The immersive documentation of Holy Week traditions in Murcia and Cartagena introduces another dimension: the digital mediation of intangible and event-based cultural heritage. Unlike permanent monuments, processions and comparable cultural practices occur at specific times and locations, depend on community participation and carry religious, social and cultural meanings that cannot be separated easily from the live event.

The development of immersive 360-degree recordings and VR applications creates reusable digital representations of such temporally limited experiences. In Cartagena, immersive audiovisual material recorded during Holy Week has been made available through Virtual Reality headsets, enabling users to experience selected moments from the processions outside their original spatial and temporal setting. Similar immersive approaches have been developed in Murcia.

This provides an example of temporal accessibility. Digital technologies can extend access not only across physical barriers but also across time. Individuals who cannot attend a live cultural event may encounter selected visual, spatial and auditory dimensions later through immersive documentation.

The distinction is relevant to tourism education because accessibility is often conceptualised primarily in physical terms. Digital technologies demonstrate that access can also be temporal, geographic, linguistic and informational. At the same time, digital documentation does not reproduce

the live event in its entirety. The social relationships, religious meaning, communal participation, atmosphere and embodied character of a procession cannot be assumed to transfer completely into an immersive representation.

This makes interpretative and ethical competence particularly important. Intangible cultural heritage is not simply audiovisual material available for technological reproduction. It is embedded within communities, identities and social practices. Decisions concerning what is recorded, selected, edited, contextualised and presented virtually affect how traditions are represented to audiences beyond the community itself.

Community participation should therefore form part of immersive heritage development. Cultural organisations, religious associations, local institutions and participants possess legitimate interests in how their practices are represented. Co-creation in this context is not merely an efficient design method but an element of responsible heritage mediation.

The competence requirements consequently include immersive-media documentation, storytelling, cultural interpretation, visitor facilitation, accessibility awareness and sensitivity to religious and community meanings. Professionals need to combine technological possibilities with an understanding of representational responsibility.

Immersive documentation may also provide additional access to highly concentrated cultural events, but claims concerning crowd reduction should remain cautious. The availability of a virtual representation does not demonstrate that users will substitute it for physical attendance. For some people the immersive experience may constitute an alternative; for others it may increase interest in attending the event in person.

The more defensible contribution therefore concerns additional access channels, cultural documentation, interpretation and reusable educational resources. Any claim regarding reductions in crowding or environmental pressure requires evidence of behavioural substitution.

Considered comparatively, the Spanish material places accessibility-by-design at the centre of technology-enhanced tourism. The Cartagena case makes this principle particularly explicit, but the same issue extends to mobile applications, environmentally sensitive experiences and virtual cultural events. Accessibility should be considered throughout the design process and should encompass physical ability, sensory requirements, interface usability, digital literacy, language, equipment access and staff support.

Closely connected with this is the broader concept of mediated access to constrained environments. XR can create alternative forms of engagement where access is limited by architectural barriers, environmental sensitivity, heritage fragility, geographic distance or the temporal nature of cultural events. Digital mediation consequently becomes a potential interface between inclusion and preservation.

Its value, however, depends on the quality of the mediation rather than on technological presence alone. The central professional question is whether the technology provides meaningful

additional access while respecting the cultural or environmental characteristics of the resource concerned.

Interdisciplinary co-design is therefore recurrent across the Spanish cases. Engineers, scientists, cultural professionals, educators, public authorities, technology developers, accessibility organisations, tourism professionals and local communities contribute different forms of knowledge. Their cooperation reinforces the importance of boundary-spanning competence for tourism professionals.

Such competence does not require expertise in every specialist field. It requires the ability to recognise when specialist knowledge is needed, formulate tourism and visitor requirements, understand relevant professional terminology, participate in collaborative design and assess whether the resulting technological solution remains aligned with its intended cultural, environmental or accessibility objective.

Environmental applications create an additional need for ecological and scientific mediation. The Natuverse and Murciélagos Málaga cases demonstrate that digital tourism increasingly intersects with biodiversity, environmental monitoring and scientific communication. Tourism professionals need enough ecological literacy to avoid misleading simplification and sufficient communication competence to translate specialist knowledge into meaningful visitor experiences.

This strengthens the case for collaboration between VET providers and universities, research institutions, conservation organisations and environmental professionals. Tourism education does not need to become environmental-science education, but learners increasingly require the capacity to work responsibly with scientific information where sustainability and biodiversity form part of tourism practice.

The Spanish material also links technology with destination management. The Sagunto case demonstrates how mobile and augmented content can become part of wider smart-destination systems and spatial interpretation strategies. Technology consequently moves beyond isolated attractions and becomes embedded within destination governance, communication and information management.

Intangible heritage digitisation adds another competence domain. Immersive documentation of Holy Week demonstrates how tourism technologies can preserve selected audiovisual dimensions of temporary cultural events and make them accessible beyond their original occurrence. This requires not only production competence but also community participation, ethical representation, contextualisation and long-term digital preservation[69].

Continuous professional development follows from these expanding requirements. XR platforms, devices, interfaces and production methods change rapidly, while accessibility expectations, digital standards and environmental knowledge also evolve. Initial occupational

[69] Ayuntamiento de Cartagena, “La Semana Santa de Cartagena podrá disfrutarse en realidad virtual a partir del año que viene”, 20 March 2023.

education therefore cannot provide permanent competence. Tourism organisations require continuing opportunities for staff to update technological, interpretative and user-service capabilities.

A particularly important lesson concerns the critical evaluation of substitution claims. Several forms of immersive tourism create plausible mechanisms through which physical pressure might be reduced: virtual access can offer alternatives to inaccessible heritage, environmentally sensitive habitats or highly concentrated events. Yet potential substitution should not be confused with demonstrated substitution.

This distinction represents an important dimension of sustainability literacy. Tourism professionals need to ask what evidence supports claims concerning reduced travel, lower site pressure or environmental benefit. They should be able to distinguish between technological potential, organisational intention and empirically demonstrated effect[70].

The Spanish cases therefore provide strong support for integrating accessibility into general tourism competence frameworks. As services become increasingly digital, technological solutions can remove certain barriers while simultaneously producing new ones. A virtual environment may overcome an architectural barrier yet introduce sensory, cognitive, financial or digital barriers. Inclusive tourism competence needs to encompass this multidimensional character of access.

Co-design with users is particularly important. Technologies intended for people with disabilities, local communities, environmentally sensitive environments or culturally significant practices benefit from direct participation by those affected. VET can develop such competence through authentic projects involving accessibility organisations, conservation specialists, heritage communities and public institutions.

The Spanish material also supports a layered understanding of XR competence. Foundational digital and immersive literacy enables professionals to understand the purpose, opportunities and limitations of the technology. Functional competence supports operation, visitor facilitation and basic evaluation. Interpretative competence connects digital systems with cultural, historical or environmental knowledge. Design and coordination competence encompasses accessibility, user experience, stakeholder participation and organisational objectives. Specialist technical competence is required for advanced programming, photogrammetry, three-dimensional modelling, scanning, data processing or systems integration.

Not every tourism professional requires specialist technical competence. Increasingly, however, professionals require enough knowledge to work intelligently with specialists and to evaluate whether technological outputs address actual tourism problems. This interface capacity is likely to remain relevant even as individual devices and platforms become obsolete.

[70] C. Innocente, L. Ulrich, S. Moos and E. Vezzetti, “A Framework Study on the Use of Immersive XR Technologies in the Cultural Heritage Domain”, *Journal of Cultural Heritage*, 62 (2023), pp. 268–283,

From a transferability perspective, the most durable lessons from the Spanish cases are therefore not associated with particular XR products. Accessibility-by-design, interdisciplinary co-creation, scientific mediation, context-sensitive technological choice, professional upskilling, participatory heritage interpretation and critical evaluation of sustainability effects are more transferable than individual applications or devices.

Taken together, the Spanish cases position XR as a form of inclusive and conservation-sensitive mediation. Its most convincing applications emerge where technology responds to a clearly identifiable constraint: physical inaccessibility, ecological sensitivity, limited interpretative possibilities, geographically dispersed heritage, or the temporal restriction of access to cultural events.

The central lesson is consequently that tourism technology should be evaluated by the quality of access, understanding and professional practice it enables rather than by the degree of immersion it produces. From a VET perspective, this requires competence development combining digital literacy with accessibility, environmental and cultural knowledge, user-centred design, interdisciplinary collaboration, ethical judgement and critical sustainability assessment.

XR competence becomes professionally meaningful when learners are able to ask not simply what a technology can do, but for whom it improves access, what interpretative or environmental problem it addresses, what resource it may help protect, what new barriers it could generate, and whether its claimed sustainability effects can actually be demonstrated.

2.4 Comparative Models of Tourism Transformation and Competence Development

The comparative analysis of Germany, Greece, Italy, Poland, Portugal, and Spain indicates a shared transition towards more sustainable, digitally enabled, and competence-intensive forms of tourism development. Across the six national contexts, environmental responsibility is increasingly interconnected with destination competitiveness, organisational and business innovation, technological transformation, and evolving competence requirements for tourism professionals. Sustainability and digitalisation therefore emerge not as separate trajectories of sectoral change but as increasingly interdependent dimensions of a broader transformation affecting tourism governance, service provision, business models, workforce development, and vocational education.

This transition, however, does not follow a uniform pathway. The analysed national contexts differ in the degree to which sustainability principles have become institutionalised, in the respective roles of national, regional, and local authorities, in the significance of intermediary organisations and business networks, in the maturity and diffusion of certification mechanisms, in the extent of digital integration, and in the institutional arrangements through which new professional competences are developed. Differences are also visible in the relative importance of workplace learning, formal vocational education, higher education, collaborative projects, destination-level partnerships, and community-based learning.

These variations suggest that sustainable tourism transformation should not be conceptualised as a linear progression towards a single preferred or more advanced model. Rather, the comparative evidence points to multiple configurations through which governance arrangements, entrepreneurial activity, technological adoption, environmental objectives, institutional capacity, and competence development interact. Similar transition objectives may therefore be pursued through different combinations of actors, instruments, resources, and learning mechanisms.

For analytical purposes, the six national contexts can consequently be interpreted through a set of distinct but partly overlapping models of tourism transformation. These models should be understood as analytical ideal types rather than comprehensive descriptions of national tourism systems. They neither imply internal homogeneity within individual countries nor constitute a ranking of national performance or transition maturity. Regional, sectoral, organisational, and institutional differences remain substantial within each national context.

The proposed models are therefore derived from recurring patterns identified across the analysed trends, practices, institutional arrangements, and case studies. Their purpose is to make differences in transformation mechanisms analytically visible while preserving the contextual character of the evidence. The relevant unit of comparison is thus not the country understood as a uniform tourism system, but the configuration of governance, competence development, technological integration, entrepreneurship, and sustainability mechanisms that becomes particularly visible within the material examined for each national context

2.4.1 Institutionalisation and Standards: the German Model

The German material illustrates a comparatively strongly institutionalised configuration of sustainable tourism transformation. Sustainability is frequently embedded in certification schemes, environmental standards, destination-governance arrangements, and relatively stable networks connecting tourism organisations, enterprises, research institutions, educational providers, and public authorities. The defining characteristic of this configuration is therefore not simply the presence of environmental initiatives, but the extent to which sustainability objectives are incorporated into structured organisational procedures and institutional relationships.

Certification and standardisation play an important role within this model by translating broad sustainability principles into more operational criteria for organisational practice. For tourism enterprises and destinations, such frameworks can provide greater procedural clarity regarding environmental management, resource efficiency, quality assurance, monitoring, and external communication. At the same time, formalisation creates additional competence requirements. Professionals need to understand the substantive objectives underlying standards as well as certification procedures, reporting requirements, environmental indicators, documentation practices, and the organisational consequences of compliance.

The German cases also point to the importance of institutional learning. Universities, research organisations, protected-area institutions, destination networks, vocational education providers, public bodies, and tourism enterprises frequently participate in competence-development processes.

This creates relatively dense inter-organisational environments in which environmental, technological, managerial, and professional knowledge can circulate between actors and be progressively incorporated into organisational routines.

A similar pattern is visible in the XR-related material. Immersive technologies are frequently developed or implemented through partnerships involving museums, tourism organisations, universities, research institutes, technology companies, environmental institutions, and public-sector actors. Their significance therefore lies not only in the technologies themselves but also in the collaborative structures through which expertise is assembled, tested, transferred, and maintained. This reinforces the interpretation of the German configuration as an institutionalised competence ecosystem, in which sustainability and digital innovation are supported by relatively structured mechanisms of coordination, professional learning, and organisational cooperation.

The analytical significance of this model lies in the relationship between institutional continuity, standardisation, and competence accumulation. Formal frameworks can support consistency, knowledge retention, and the integration of sustainability objectives into routine organisational practice. At the same time, they may impose substantial requirements in terms of administrative capacity, specialised knowledge, documentation, and staff resources. These requirements may be more difficult to meet for smaller organisations and can make experimentation more resource-intensive where formal procedures are complex. Institutionalisation should therefore be understood not as an unequivocal indicator of transition maturity, but as a specific configuration in which greater procedural stability is accompanied by higher demands on organisational and professional capacity[71].

2.4.2 Decentralised Innovation and Multilevel Governance: the Spanish Model

The Spanish material illustrates a configuration of tourism transformation characterised by destination-level innovation operating within a multilevel governance environment. National and European strategic frameworks coexist with substantial regional and local implementation capacity, enabling autonomous communities, municipalities, destination-management organisations, and public–private networks to develop differentiated approaches to sustainability, digitalisation, certification, smart-tourism systems, accessibility, and technological innovation.

The analytical significance of this configuration lies in the interaction between common strategic directions and territorially differentiated implementation. Rather than relying on a single standardised pathway, transformation is mediated through multiple levels of governance and adapted to the characteristics of individual destinations. Coastal, urban, island, cultural, and environmentally sensitive destinations may therefore pursue similar strategic objectives through different combinations of technological instruments, institutional partnerships, and management practices.

[71] M. Balaš and W. Strasdas, *Sustainability in Tourism: Developments, Approaches and Clarification of Terms*, Umweltbundesamt, Texte 53/2019, 2019.

The Spanish cases also reveal a particularly strong interaction between sustainability and digitally supported destination management. Environmental monitoring, visitor-flow management, sustainability indicators, certification mechanisms, tourism-intelligence platforms, AI-supported applications, accessibility solutions, and immersive interpretation increasingly form part of interconnected destination-management systems. Digitalisation therefore extends beyond visitor-facing services and becomes relevant to information gathering, coordination, monitoring, communication, and management decision-making.

The competence implications extend beyond the capacity to generate local innovation. Destination organisations increasingly require the ability to operate across governance levels, exchange and interpret data, align local initiatives with wider standards, cooperate with regional and national institutions, and integrate heterogeneous technological systems. Interoperability should therefore be understood not only as a technical characteristic of digital infrastructure but also as an organisational and institutional capability[72].

The Spanish model thus illustrates a configuration in which contextual adaptability and multilevel experimentation are accompanied by a continuing need for coordination, shared standards, and institutional connectivity. Its analytical relevance lies in demonstrating that destination-level innovation can be highly responsive to territorial conditions, but its broader transformative potential depends on the capacity to connect local experimentation with coherent governance, comparable information systems, and durable competence-development mechanisms This development gives rise to a correspondingly hybrid competence profile. Destination professionals require not only knowledge of environmental management and tourism operations, but also data literacy, digital-service design, accessibility awareness, stakeholder coordination, and the ability to interpret indicators and translate them into operational and strategic decisions. The emerging competence challenge therefore lies less in technological proficiency alone than in the capacity to integrate environmental, digital, organisational, and governance-related knowledge within destination management. At the same time, the decentralised nature of implementation increases the need for coordination across destinations and institutions. Differences in institutional resources, technological maturity, data practices, reporting systems, professional capacity, and access to specialist support can result in uneven conditions for implementation. Consequently, strong local innovation capacity may coexist with wider systemic fragmentation where standards, data infrastructures, governance arrangements, and support mechanisms remain insufficiently aligned.

2.4.3 Strategic Coordination and Project-Based Capacity Building: the Portuguese Model

The Portuguese material illustrates a configuration of tourism transformation characterised by strategic coordination combined with extensive use of collaborative and externally supported projects as mechanisms of implementation and competence development. National tourism

[72] SEGITTUR, *Smart Tourist Destinations*, Sociedad Mercantil Estatal para la Gestión de la Innovación y las Tecnologías Turísticas, Madrid; OECD, "Building Strong and Resilient Tourism Destinations", *OECD Tourism Papers*, no. 2025/03, OECD Publishing, Paris 2025.

priorities, European programmes, regional organisations, municipalities, educational institutions, business associations, and tourism enterprises interact within a relatively dense network of initiatives addressing sustainability, digitalisation, heritage valorisation, certification, destination intelligence, and regional development.

The analytical significance of this configuration lies in the relationship between strategic direction and distributed implementation. National policy frameworks establish broad priorities, while implementation frequently takes place through regional networks, municipalities, universities and polytechnic institutions, local associations, tourism enterprises, and temporary project partnerships. Transformation is therefore neither exclusively centrally coordinated nor predominantly generated through autonomous local experimentation. It emerges through the interaction between strategic policy orientation and territorially embedded implementation structures.

The Portuguese cases demonstrate particularly clearly the role of projects as environments for competence development. Initiatives concerning digital heritage, XR applications, environmental management, certification, rural and wine tourism, regional innovation, and sustainable destination development frequently bring together educational institutions, public authorities, tourism organisations, enterprises, technology providers, and other specialist partners. Participation in such initiatives can expose professionals and organisations to knowledge, technologies, methodologies, and collaborative practices that might otherwise remain outside their existing competence base.

This pattern supports the interpretation of the Portuguese configuration as a model of project-based capacity building. Projects can function not only as instruments for delivering technological or organisational outputs but also as temporary learning infrastructures through which participants acquire new forms of digital, environmental, managerial, entrepreneurial, and collaborative competence. Living labs, workshops, pilot activities, network-based training, applied research, and joint development processes can accelerate knowledge transfer between research, education, public administration, and tourism practice.

At the same time, the Portuguese material reveals an important distinction between project capacity and institutional capacity. An organisation may participate effectively in an externally supported initiative, contribute to innovative outputs, and develop substantial competence during the project period without necessarily acquiring the internal resources required to maintain, adapt, or scale those practices once external support ends. Temporary access to specialist expertise, funding, technological infrastructure, or coordination capacity should therefore not be equated automatically with durable organisational capability.

The central institutional question concerns the extent to which project-generated knowledge becomes embedded within organisational routines, staff competences, curriculum structures, partnerships, and decision-making processes. Long-term transformation depends on whether temporary learning is converted into reusable methodologies, internal expertise, continuing professional development, stable inter-organisational relationships, and sufficient capacity to adapt innovation after the original project framework has ended.

The Portuguese configuration can therefore be interpreted as a strategically coordinated, project-mediated model of capacity development. Its analytical relevance lies in demonstrating how externally supported collaboration can accelerate experimentation and competence formation while simultaneously creating a risk of discontinuity if knowledge and responsibility remain dependent on temporary project structures.

The key issue is thus not whether project-based innovation is effective in itself, but whether project participation generates institutional learning. Sustainable transformation requires mechanisms through which externally enabled experimentation is progressively converted into durable professional, organisational, and territorial capability. In this sense, the Portuguese model highlights the transition from project capacity to institutional capacity as a central condition of long-term tourism transformation[73].

2.4.4 Territorial Diversity and Hybrid Innovation: the Italian Model

The Italian material illustrates a configuration of tourism transformation characterised by pronounced territorial differentiation and the coexistence of multiple forms of innovation. The analysed cases encompass sustainable entrepreneurship, agritourism, heritage-based tourism, certification, protected-area management, digital interpretation, and advanced applications of XR and digital heritage technologies. These practices emerge within highly diverse regional, sectoral, and institutional contexts, making the Italian configuration particularly heterogeneous in terms of both innovation pathways and implementation capacity.

For analytical purposes, the Italian material is therefore best interpreted as a model of territorially differentiated and hybrid innovation. Innovative practices frequently emerge where strong place-based identity is combined with entrepreneurial capacity, institutional cooperation, cultural or environmental assets, and access to specialist knowledge. This is particularly visible in rural tourism, gastronomy, cultural heritage, protected landscapes, and regionally embedded destination initiatives, where tourism development is closely connected with local production systems, landscape values, community resources, and cultural identity.

A distinctive feature of this configuration is the close relationship between sustainability and territorial identity. Environmental practices are frequently embedded within broader systems of agriculture, food production, biodiversity, landscape management, cultural heritage, and visitor-experience design. Sustainability therefore operates not only as a regulatory or environmental requirement but also as part of the territorial value proposition through which destinations and enterprises differentiate themselves.

A similar pattern is visible in the field of digital innovation. The Italian XR cases extend beyond entertainment-oriented applications towards digital heritage documentation, archaeological reconstruction, accessibility, museum management, environmental interpretation, and structured digital assets such as HBIM. Technology consequently becomes integrated with conservation,

[73] OECD, *Preparing the Tourism Workforce for the Digital Future*, OECD Tourism Papers, No. 2021/02, OECD Publishing, Paris, 2021.

interpretation, destination communication, and institutional knowledge management rather than functioning solely as an additional visitor-facing product.

This convergence produces increasingly hybrid professional roles. Tourism professionals may need to operate at the interface between cultural knowledge, digital systems, visitor experience, conservation objectives, entrepreneurship, and specialist technical expertise. The competence challenge is therefore not limited to acquiring discrete digital or sustainability-related skills. It concerns the capacity to integrate heterogeneous forms of knowledge and to collaborate across professional and institutional boundaries.

The Italian material consequently points towards integrative professional capability as a central competence requirement. This capability includes the ability to connect domain-specific knowledge with digital literacy, interpretation, accessibility, entrepreneurial judgement, stakeholder cooperation, and the critical evaluation of technological and sustainability claims. Its importance increases in contexts where tourism innovation depends on interaction between cultural institutions, enterprises, public authorities, technology providers, universities, and local communities.

At the same time, the Italian cases reveal substantial variation in implementation capacity. Highly innovative practices may coexist with organisations or territories characterised by more limited financial resources, digital expertise, institutional support, or access to specialist networks. Territorial differentiation should therefore be understood not only as a source of innovation diversity but also as a potential source of uneven capability[74].

This has important implications for transferability. The replication of individual projects is unlikely to be sufficient where the institutional, territorial, and organisational conditions that enabled their development are absent. More durable transfer depends on the capacity to create local competence ecosystems linking enterprises, cultural and environmental organisations, education and research institutions, technology providers, and governance actors.

The Italian configuration therefore illustrates a model in which innovation is strongly place-based, cross-sectoral, and dependent on the interaction between territorial resources and institutional capability. Its analytical relevance lies in demonstrating that tourism transformation can emerge through highly differentiated local and regional pathways, but that the sustainability and scalability of such innovation depend on whether local ecosystems are able to connect identity, knowledge, entrepreneurship, technology, and governance over time.

2.4.5 Place-Based and Intermediary-Supported Transformation: the Polish Model

The Polish material illustrates a configuration of tourism transformation in which sustainability and digitalisation are closely connected with local assets, regional initiatives, small enterprises, municipalities, local action groups, cultural institutions, and nature-based tourism. Innovation emerges through territorially embedded initiatives rather than through a single, strongly integrated

[74] M. Cerquetti et al., "Enhancing Intangible Cultural Heritage for Sustainable Tourism Development in Rural Areas: The Case of the 'Marche Food and Wine Memories' Project (Italy)", *Sustainability*, 14(24) (2022).

national pathway, resulting in substantial diversity in both the forms of experimentation and the capacity to implement them.

The analysed cases demonstrate considerable activity in rural tourism, sustainable mobility, cultural heritage, local food systems, nature-based experiences, digital interpretation, and XR-supported access. These initiatives frequently draw on locally specific environmental, cultural, and social resources and are developed through cooperation between municipalities, enterprises, associations, cultural institutions, development organisations, and technology providers. The transformation process is therefore strongly place-based.

For analytical purposes, the Polish configuration can be interpreted as a model of place-based transformation supported by intermediary institutions. Local action groups, municipalities, regional organisations, NGOs, cultural institutions, development agencies, and other intermediary actors frequently perform a connecting function between local enterprises and wider systems of knowledge, funding, training, promotion, and technological support. Their role is particularly important in tourism environments characterised by a high share of small actors and dispersed organisational structures.

Intermediary institutions can reduce some of the coordination costs associated with fragmented tourism systems. They may support access to external funding, facilitate cooperation, organise training, create shared promotional frameworks, connect enterprises with specialist expertise, and translate broader sustainability or digitalisation objectives into locally applicable practices. Their significance lies less in direct service delivery than in strengthening the relational infrastructure through which local actors gain access to resources that would otherwise remain difficult to obtain individually.

The competence challenge in this configuration concerns the ability to connect strong place-based knowledge with broader professional capabilities in digitalisation, marketing, sustainable business development, cooperation, product design, and destination management. Local actors may possess substantial knowledge of landscape, heritage, food, culture, or community resources while lacking the digital, organisational, or market-related capabilities required to transform these assets into coherent and visible tourism offers.

The Polish material therefore reveals an important distinction between resource availability and valorisation capacity. The presence of valuable natural, cultural, or territorial resources does not automatically translate into competitive and sustainable tourism products. Effective transformation requires competences in interpretation, cooperation, digital communication, product development, market positioning, and long-term organisational coordination.

Digital infrastructure and digital literacy are particularly significant in this respect. Access to technology, connectivity, specialist support, and basic digital competence can determine whether local enterprises and institutions are able to participate meaningfully in digital tourism development. Uneven technological conditions may therefore reinforce existing differences in implementation capacity between regions, organisations, and enterprise types.

The XR-related material reinforces this interpretation. In the Polish cases, digital technologies appear particularly relevant when they are introduced contextually and incrementally, for example through digital guiding, heritage interpretation, remote access, virtual educational resources, blended visitor experiences, or relatively accessible forms of immersive content. The analytical emphasis is therefore not on technological intensity but on the appropriateness of the technological solution to the local problem, user group, infrastructure, and organisational capacity.

This supports a model of functional and contextual digital competence. Tourism professionals do not necessarily require advanced technological specialisation. They increasingly need the ability to select appropriate tools, integrate them with human interpretation, support different user groups, collaborate with technology providers, and evaluate whether digital solutions create meaningful additional value within the specific conditions of a destination.

The Polish configuration also highlights the importance of incremental capacity development. Smaller destinations and organisations may benefit more from gradual digitalisation, shared services, intermediary support, and practical competence development than from rapid adoption of technologically complex systems. Building staff confidence, testing relatively simple applications, evaluating visitor response, and developing partnerships can provide a more sustainable pathway towards more advanced forms of innovation.

At the same time, place-based and intermediary-supported transformation can generate uneven implementation conditions. Local innovation may remain dependent on specific organisations, temporary projects, individual leaders, or access to external funding. Differences in infrastructure, financing, digital competence, organisational resources, and inter-institutional cooperation can limit the durability or wider diffusion of successful practices.

Transferability should therefore be understood in terms of mechanisms rather than replication of individual projects. The most transferable elements include intermediary support, local networking, shared access to expertise, blended digital interpretation, incremental technology adoption, cooperation with cultural and environmental institutions, and the integration of local knowledge with professional competence development.

The Polish model thus illustrates a configuration in which tourism transformation is strongly embedded in local resources and relationships. Its analytical relevance lies in demonstrating that sustainable and digital innovation can emerge from territorially grounded experimentation, but its longer-term consolidation depends on the capacity to connect local knowledge with intermediary support, professional competence, infrastructure, and wider governance structures[75].

The central issue is therefore not the absence or presence of innovation, but the extent to which locally generated initiatives can be transformed into durable organisational and territorial capability. In this sense, the Polish material points towards a model in which place-based resources,

[75] I. Kapera, "Sustainable Tourism Development Efforts by Local Governments in Poland", *Sustainable Cities and Society*, 40 (2018), pp. 581–588.

intermediary institutions, and functional competence development jointly shape the capacity for sustainable tourism transformation[76].

2.4.6 Regenerative and Community-Centred Transformation: the Greek Model

The Greek material illustrates a configuration of tourism transformation in which sustainability is closely connected with locality, community participation, environmental vulnerability, and the adaptation of tourism practices to specific territorial conditions. Island, rural, cultural, and heritage contexts are particularly significant, as tourism development frequently interacts directly with ecological constraints, local livelihoods, cultural continuity, infrastructure limitations, and the resilience of small communities.

Transformation in these contexts is often mediated through combinations of municipalities, local enterprises, universities, NGOs, tourism organisations, community actors, and other intermediary institutions. Rather than being driven exclusively through nationally standardised mechanisms, sustainability initiatives frequently emerge from place-specific collaborations and from the need to respond to locally defined environmental, social, and economic conditions.

For analytical purposes, the Greek configuration can therefore be interpreted as a model of place-specific and community-centred transformation. Its defining feature is the close relationship between tourism development and territorial context. Sustainable tourism practices are not treated solely as generic management instruments but are frequently embedded in local ecological systems, cultural resources, energy conditions, food production, landscapes, and community structures.

Within this configuration, regenerative perspectives are particularly relevant. Several cases move beyond the objective of reducing the negative environmental effects of tourism and instead connect tourism activity with biodiversity protection, renewable energy, local food systems, circular practices, landscape stewardship, cultural continuity, or community development. In such contexts, tourism can potentially contribute to forms of territorial value creation rather than functioning only as an economic activity whose adverse effects must be mitigated.

The concept of regeneration, however, requires analytical caution. Not every community-based, environmentally responsible, or locally embedded initiative constitutes regenerative tourism in a strict sense. The more defensible conclusion is that the Greek material reveals a pronounced orientation towards tourism models that seek closer alignment between visitor activity, ecological conditions, local livelihoods, and community well-being. Regeneration is therefore best treated as an emerging direction within the material rather than as a defining characteristic of all the analysed initiatives.

This orientation generates distinctive competence requirements. Tourism professionals need environmental and entrepreneurial competence, but they also require the ability to cooperate with communities, interpret local cultural and natural resources, engage with public and social actors,

[76] Widawski, A. Krzemińska, A. Zaręba and A. Dzikowska, “A Sustainable Approach to Tourism Development in Rural Areas: The Example of Poland”, *Agriculture*, 13(10) (2023).

mediate between different stakeholder interests, and adapt tourism products to ecological and cultural conditions. In small or environmentally sensitive destinations, such competences become particularly important because tourism decisions can have immediate consequences for local infrastructure, ecosystems, cultural practices, and community acceptance.

The Greek XR material adds a further dimension to this configuration by illustrating how immersive technologies can be integrated into vocational and professional learning. Simulation-based environments can reproduce selected elements of hospitality operations, customer interaction, environmental procedures, spatial decision-making, and service workflows, allowing learners to practise professional responses in controlled settings before or alongside workplace experience.

The significance of these applications lies less in technological novelty than in their potential for simulation-based and curriculum-integrated digital learning. XR can support experiential learning when simulation is connected with clearly defined learning outcomes, instructor guidance, reflection, and subsequent application in authentic professional contexts. It should therefore be understood as a pedagogical augmentation of vocational learning rather than as a substitute for workplace experience[77].

This combination of place-based sustainability and simulation-supported learning points towards a broader competence architecture. Professionals increasingly need to combine contextual knowledge of destinations with environmental judgement, entrepreneurial capability, communication, digital literacy, and the capacity to operate across institutional and community boundaries. The Greek material therefore illustrates how sustainability competence and digital competence can become mutually reinforcing when both are embedded in concrete territorial and professional situations.

At the same time, the durability of such innovation depends on implementation conditions. Place-specific initiatives and immersive learning environments may require access to funding, technological infrastructure, specialist trainers, institutional partnerships, and continuing organisational support. Where these resources remain dependent on temporary projects or individual actors, locally successful practices may be difficult to maintain or extend[78].

The Greek configuration can therefore be interpreted as a model in which territorial embeddedness, community participation, and experiential competence development play a particularly important role. Its analytical relevance lies in demonstrating that tourism transformation can be shaped simultaneously by ecological and community conditions and by pedagogical innovation, while its longer-term consolidation depends on converting locally embedded experimentation into stable professional, institutional, and educational capacity

[77] D.A. Katsaprakakis et al., “Greek Islands’ Energy Transition: From Lighthouse Projects to the Emergence of Energy Communities”, *Energies*, 15(16) (2022).
[78] M. Fischer-Kowalski, M. Löw, D. Noll, P. Petridis and N. Skoulikidis, “Samothraki in Transition: A Report on a Real-World Lab to Promote the Sustainability of a Greek Island”, *Sustainability*, 12(5) (2020).

2.4.7 Cross-Country Comparison: From National Profiles to Transformation Mechanisms

The six analytical configurations reveal substantial differences in the organisation, governance, and implementation of tourism transformation. At the same time, comparison across Germany, Greece, Italy, Poland, Portugal, and Spain identifies a recurring set of mechanisms through which sustainable and digitally enabled tourism practices become developed, transferred, and potentially embedded within organisations and destinations. These mechanisms do not operate independently. Their significance lies in the ways in which institutional structures, intermediary actors, territorial conditions, competence development, organisational learning, technological choices, and inclusion interact within particular tourism ecosystems.

Taken together, these mechanisms indicate that tourism transformation should not be interpreted primarily as the diffusion of particular technologies, standards, or exemplary practices. It depends on the capacity of tourism ecosystems to institutionalise learning, connect actors through intermediary structures, adapt innovation to territorial conditions, develop hybrid professional capabilities, sustain organisational learning, align technology with clearly defined purposes, and ensure meaningful access to the transition. The comparative unit of analysis consequently shifts from individual national initiatives towards the configuration of mechanisms through which change becomes possible, durable, and transferable[79]

2.4.8 An Emerging Typology of Transformation Models

The comparative analysis allows six dominant, although overlapping, configurations of tourism transformation to be distinguished. These configurations should be understood as analytical ideal types derived from recurring patterns in the examined material rather than as exhaustive descriptions of national tourism systems. Their purpose is to identify the combinations of governance, institutional capacity, technological adoption, territorial resources, organisational learning, and competence development that become particularly visible in each national context.

The German material is most clearly associated with an institutionalised competence ecosystem, in which standards, certification, organisational learning, and relatively stable cross-sector partnerships provide mechanisms for embedding sustainability and innovation within organisational routines. The Spanish configuration can be characterised as multilevel and digitally mediated governance, where destination-level experimentation, data-supported management, accessibility, and digital infrastructures operate within wider regional and national frameworks. Portugal illustrates a model of strategically coordinated, project-based capacity building, in which collaborative programmes and externally supported initiatives accelerate innovation and knowledge transfer, while their long-term significance depends on whether project-generated competences become institutionalised.

The Italian material points towards territorially differentiated hybrid innovation, in which sustainability is closely connected with local identity, entrepreneurship, heritage, cultural and

[79] OECD, *Preparing the Tourism Workforce for the Digital Future*, 2021,

environmental resources, and increasingly advanced forms of digital interpretation. Poland illustrates place-based transformation supported by intermediary actors, where local resources and experimentation are enabled by municipalities, local action groups, cultural institutions, development organisations, and other actors that connect small enterprises with knowledge, funding, networks, and technological support. The Greek configuration is most clearly associated with community-centred and experiential transformation, combining strong territorial embeddedness and community participation with sustainability initiatives adapted to local ecological conditions and with examples of simulation-based and curriculum-integrated digital learning.

These configurations are neither mutually exclusive nor territorially self-contained. Elements associated with each model can be identified in other national contexts, and substantial variation exists within individual countries. Their analytical value therefore lies not in assigning countries to rigid categories but in revealing dominant configurations through which common pressures—including climate transition, digitalisation, technological change, changing visitor expectations, demographic and labour-market pressures, and competence shortages—are translated into different institutional and organisational responses.

The typology also demonstrates that transformation pathways are configurational rather than linear. No single combination of certification, digital technology, governance arrangements, entrepreneurship, or education represents a universal endpoint. Similar objectives may be pursued through different institutional mechanisms, and similar technologies may generate different outcomes depending on territorial context, organisational capacity, professional competence, and the quality of cooperation between actors. The comparative question consequently shifts from identifying which national model is more advanced towards understanding which combinations of mechanisms enable transformation under particular conditions.

2.4.9 Implications for Competence Development

The comparative analysis indicates that no uniform set of green or digital skills can adequately support tourism transformation across all contexts. Different institutional and territorial configurations generate different combinations of competence requirements. Systems with a high degree of formalisation place greater emphasis on understanding standards, certification procedures, monitoring, reporting, and organisational management. Digitally mediated destination systems increase the importance of data literacy, tourism intelligence, digital-service design, interoperability, and critical technology assessment. Community-centred contexts require stakeholder engagement, facilitation, participatory entrepreneurship, local interpretation, and the capacity to negotiate between tourism development and community interests.

Heritage-intensive environments generate additional requirements related to cultural mediation, digital storytelling, accessibility, ethical interpretation, conservation, and the management of digital cultural assets. Rural and organisationally fragmented tourism systems may require greater entrepreneurial versatility, digital market access, networking competence, and the ability to perform across several occupational functions. Project-intensive environments additionally

require competence in collaboration, knowledge transfer, experimentation, and the conversion of temporary project learning into durable organisational capability.

These variations reinforce the need for a competence architecture that combines a common professional foundation with contextual specialisation. The common foundation should include sustainability literacy, digital literacy, communication, collaboration, entrepreneurship, ethical judgement, and the ability to learn continuously. Context-specific competence can then be developed in relation to particular tourism environments, technologies, professional roles, governance arrangements, and territorial conditions.

The comparative evidence suggests, however, that the central challenge extends beyond the possession of individual competences. Tourism professionals increasingly need the capacity to combine different forms of knowledge and to exercise judgement about when, how, and for what purpose they should be applied. Sustainability knowledge must be connected with operational decision-making; digital competence with critical assessment of technological appropriateness; entrepreneurship with territorial and social responsibility; and communication with stakeholder coordination. This points towards integrative professional capability as a more adequate objective than the accumulation of isolated skills[80].

The role of vocational education and training should therefore not be reduced to delivering a fixed catalogue of competences. Its more significant function is to develop the capacity of learners and professionals to integrate competences, transfer them between situations, respond to uncertainty, and continue learning as technologies, environmental requirements, organisational practices, and tourism business models evolve. Initial education, work-based learning, continuing professional development, simulation, project participation, mentoring, and cooperation between education and industry should consequently be understood as complementary components of a wider competence-development system.

From this perspective, VET becomes part of the transformation infrastructure of tourism. It connects policy objectives with workplace practice, supports the diffusion and contextual adaptation of innovation, strengthens the capacity of SMEs and local actors to participate in transformation, and provides the human capability required to translate sustainability and digitalisation from strategic objectives into routine professional activity.

The comparative evidence ultimately suggests that the durability of tourism transformation depends less on the adoption of any single certification scheme, technology, business model, or governance instrument than on the quality of the competence ecosystem surrounding it. Where organisations can access relevant knowledge, cooperate across institutional and professional boundaries, develop staff continuously, interpret technological and environmental change, and adapt solutions to territorial conditions, innovation is more likely to become embedded and transferable.

[80] European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, *Transition Pathway for Tourism*, Publications Office of the European Union, Luxembourg, 2022.

The central comparative conclusion is therefore that sustainable and digital tourism transformation is fundamentally a process of institutional and competence development. Technologies, standards, entrepreneurial initiatives, and governance arrangements remain important, but their effectiveness depends on the capacity of individuals and organisations to connect them within coherent, context-sensitive systems of practice. The long-term objective is consequently not simply to equip the tourism workforce with a predetermined set of future-oriented skills, but to develop professional and institutional capacities that enable tourism systems to continue learning and adapting as the conditions of transformation evolve.

The comparative analysis makes it possible to identify six dominant, although overlapping, configurations of tourism transformation. These configurations should be understood as analytical ideal types derived from recurring patterns identified in the examined material rather than as exhaustive descriptions of national tourism systems. Their analytical purpose is to capture different combinations of governance, institutional capacity, technological adoption, territorial resources, organisational learning, and competence development that become particularly visible within the respective national contexts. The German material is associated most clearly with an institutionalised competence ecosystem, in which standards, certification, organisational learning, and relatively stable cross-sector partnerships provide mechanisms for embedding sustainability and innovation within organisational routines. The Spanish configuration is characterised by multilevel and digitally mediated governance, where destination-level experimentation, data-supported management, accessibility, and digital infrastructures operate within wider regional and national frameworks. Portugal illustrates a strategically coordinated model of project-based capacity building, in which collaborative programmes and externally supported initiatives accelerate innovation and knowledge transfer, while their longer-term significance depends on the extent to which project-generated competences become institutionalised. The Italian material points towards territorially differentiated hybrid innovation, connecting sustainability with local identity, entrepreneurship, heritage, cultural and environmental resources, and increasingly advanced forms of digital interpretation. Poland illustrates place-based transformation supported by intermediary actors, where municipalities, local action groups, cultural institutions, development organisations, and other actors connect locally embedded resources and experimentation with knowledge, funding, networks, and technological support. The Greek configuration is associated with community-centred and experiential transformation, combining territorial embeddedness and local participation with sustainability initiatives adapted to ecological conditions and with examples of simulation-based and curriculum-integrated digital learning.

These configurations are neither mutually exclusive nor territorially self-contained. Elements associated with each can also be observed in other national contexts, while substantial differences remain within individual countries. Their analytical value therefore lies not in assigning national tourism systems to rigid categories, but in identifying dominant configurations through which similar external pressures are translated into different institutional and organisational responses. Climate transition, digitalisation, technological development, changing visitor expectations, labour-market pressures, and competence shortages affect all six contexts, yet they interact with different

governance structures, economic conditions, territorial resources, professional traditions, and institutional capacities. The comparative evidence consequently suggests that tourism transformation is configurational rather than linear. No single combination of certification, technology, entrepreneurship, governance, or educational provision represents a universal development pathway. Similar objectives can be pursued through different institutional mechanisms, while apparently similar technologies or practices may generate different results depending on local conditions, organisational capacity, professional competence, and the quality of cooperation between actors. The relevant comparative question is therefore not which national system is more advanced, but which combinations of mechanisms make particular forms of transformation possible under specific territorial and institutional conditions.

This diversity has direct implications for competence development. The comparative material indicates that no uniform catalogue of green or digital skills can adequately support tourism transformation across all contexts. Different configurations generate different combinations of competence requirements. More strongly formalised organisational environments increase the importance of understanding standards, certification procedures, monitoring systems, reporting requirements, and organisational management. Digitally mediated destination systems require data literacy, tourism intelligence, digital-service design, interoperability, and the capacity to assess technological solutions critically. Community-centred and locally embedded environments place greater emphasis on stakeholder engagement, facilitation, participatory entrepreneurship, local interpretation, and the ability to mediate between tourism development and community interests. Heritage-intensive contexts additionally require cultural mediation, digital storytelling, accessibility awareness, ethical interpretation, conservation-related knowledge, and competence in working with digital cultural assets, while rural and organisationally fragmented tourism systems may require greater entrepreneurial versatility, networking competence, digital market access, and the ability to perform across several occupational roles. Project-intensive environments create further requirements related to collaboration, experimentation, knowledge transfer, and the conversion of temporary project learning into durable organisational capability.

The resulting competence requirements support an architecture that combines a common professional foundation with contextual specialisation. The common foundation includes sustainability literacy, digital literacy, entrepreneurship, communication, collaboration, ethical judgement, and the capacity for continuous learning, while context-specific competence develops in relation to particular tourism environments, technologies, professional roles, governance arrangements, and territorial needs. The comparative material also indicates, however, that the central challenge extends beyond the possession of individual competences. Tourism professionals increasingly require the capacity to combine different forms of knowledge and to exercise judgement regarding when, how, and for what purpose they should be applied. Sustainability knowledge must be connected with operational decision-making, digital competence with critical assessment of technological appropriateness, entrepreneurship with territorial and social responsibility, and communication with stakeholder coordination. This points towards integrative professional capability as a more adequate objective than the accumulation of isolated skills.

The comparative evidence ultimately suggests that the durability of tourism transformation depends less on the adoption of any single certification scheme, technology, business model, or governance instrument than on the quality of the competence ecosystem surrounding it. Where organisations can access relevant knowledge, cooperate across institutional and professional boundaries, develop staff continuously, interpret technological and environmental change, and adapt solutions to territorial conditions, innovation is more likely to become embedded in organisational practice and sustained over time. The central comparative conclusion is therefore that sustainable and digital tourism transformation is fundamentally a process of institutional and competence development. Technologies, standards, entrepreneurial initiatives, and governance arrangements remain important, but their effectiveness depends on the capacity of individuals and organisations to connect them within coherent and context-sensitive systems of practice. The long-term objective is consequently not simply to equip the tourism workforce with a predetermined set of future-oriented skills, but to develop professional and institutional capacities that enable tourism systems to continue learning, adapting, and reorganising as the conditions of transformation evolve[81].

2.5 Innovation Mechanisms in Sustainable Tourism

The comparative material makes it possible to identify a set of recurring innovation mechanisms that operate across national contexts and cut across the transformation models discussed above. Unlike the country-based configurations, these mechanisms are not associated exclusively with particular institutional systems or territorial settings. They may coexist within the same destination, organisation, or project and can be combined in different ways depending on institutional capacity, market position, territorial resources, technological infrastructure, and the availability of relevant competences. Their analytical value lies in explaining how innovation is generated, embedded, and sustained rather than in identifying particular technologies or organisational forms.

One important mechanism is the institutionalisation of sustainability through certification and standardisation. Environmental and sustainability standards can provide organisations with structured criteria for assessing performance, assigning responsibility, formalising procedures, and monitoring progress. Their transformative potential, however, does not derive from the certification label itself. It depends on whether the certification process changes organisational routines and creates mechanisms of continuous improvement. Where standards become integrated into everyday management, they can support organisational learning by requiring enterprises and destinations to collect information, interpret environmental indicators, clarify responsibilities, and adjust operational practices. Where certification functions primarily as a communication or marketing instrument, its capacity to generate substantive organisational change is considerably weaker. Competence is therefore central to certification-driven innovation, since standards need to be understood,

[81] H.T.T. Nguyen, H.S.T. Pham and S. Freeman, “Dynamic Capabilities in Tourism Businesses: Antecedents and Outcomes”, *Review of Managerial Science*, 17 (2023), pp. 1645–1680.

interpreted, monitored, and translated into operational decisions rather than treated as external compliance requirements.

A second mechanism concerns the growing role of data-supported and digitally mediated tourism management. Platforms, applications, dashboards, artificial intelligence, digital twins, immersive environments, and visitor-management systems increasingly connect tourists, enterprises, destinations, and information infrastructures. Their significance lies not in technological novelty but in the capacity to transform information into more adaptive forms of decision-making. Data can be used to analyse visitor flows, mobility patterns, resource consumption, environmental pressures, demand, and user behaviour, while digital tools can also extend access to cultural, environmental, and destination information. The innovation mechanism therefore consists in integrating digital information with operational and strategic management. This requires digital competence at several levels, ranging from basic operational literacy to analytical, managerial, and strategic capability. It also requires critical competence concerning data quality, privacy, AI ethics, accessibility, technological dependence, and the organisational consequences of relying on increasingly complex digital systems.

A further mechanism can be described as regenerative and participatory value creation. In this configuration, tourism is more closely integrated with ecosystems, local communities, cultural practices, and territorial economies. Visitors may participate in environmental education, conservation activities, local production, cultural experiences, or other place-based practices, while local actors become more directly involved in defining tourism priorities and shaping tourism products. The innovative element lies in broadening the concept of tourism value beyond visitor expenditure and enterprise profitability towards ecological, social, cultural, and territorial outcomes. Such approaches require professional capabilities in community engagement, partnership building, environmental interpretation, local value-chain development, facilitation, and impact assessment. At the same time, regenerative terminology requires caution, since community participation or environmentally responsible practice alone does not necessarily constitute regenerative tourism. The more defensible analytical point is that some forms of innovation seek to create reciprocal relationships between tourism activity and the well-being of places rather than merely reduce negative impacts.

Sustainability can also operate as a mechanism of product and market differentiation. Environmental responsibility, local sourcing, landscape quality, cultural continuity, low-impact mobility, organic production, or sustainable accommodation may become integral components of the identity and perceived quality of tourism products. This mechanism is broader than a premium or luxury market strategy because sustainability-based differentiation does not necessarily depend on high prices or exclusivity. Its defining feature is that ecological, cultural, and territorial qualities contribute directly to the design, positioning, and communication of the tourism offer. This creates additional competence requirements in service design, storytelling, branding, market segmentation, sustainability communication, and entrepreneurial judgement. It also increases the importance of

credibility and verification, since the market value of sustainability claims can create incentives for symbolic or exaggerated communication that is not matched by underlying organisational practice.

Innovation increasingly also occurs through the integration of tourism with wider territorial systems. Mobility, infrastructure, spatial planning, heritage protection, energy, water management, biodiversity, housing, and local development are closely connected with tourism performance and sustainability, particularly at destination and regional level. Problems such as congestion, transport emissions, seasonal pressure, water consumption, carrying capacity, land use, and the concentration of visitor flows cannot generally be addressed by individual enterprises acting independently. Integrated territorial innovation therefore changes the unit of intervention from the single organisation to the destination or tourism territory. It requires mechanisms of coordination between public authorities, businesses, residents, cultural and environmental institutions, and other stakeholders. The associated competence profile includes destination governance, strategic planning, data interpretation, environmental management, stakeholder engagement, and the ability to coordinate action across organisational and sectoral boundaries.

The comparative material further demonstrates that learning itself can constitute an innovation mechanism. Sustainable and digital transformation depends on whether organisations and destinations are able to acquire, absorb, and apply new knowledge at a pace corresponding to changes in standards, technologies, market expectations, and environmental conditions. Training should therefore not be treated only as an auxiliary activity that follows innovation. Workplace experimentation, simulation, mentoring, project-based learning, peer exchange, workshops, university cooperation, and continuing professional development can become part of the innovation process by enabling organisations to test, evaluate, and progressively embed new practices. In this context, VET providers can perform a broader role than that of qualification providers. Where they act as knowledge partners, they can connect emerging sector needs with curricula, provide access to specialist infrastructure, support experimentation, and create learning environments in which students and practitioners engage with authentic tourism problems. Learning-driven innovation therefore links individual competence development with organisational adaptation.

These mechanisms are reinforced by networked forms of innovation. Many of the challenges associated with sustainable and digitally enabled tourism require combinations of knowledge, finance, technology, institutional authority, and access to users that individual organisations rarely possess independently. Cross-sector partnerships can enable these resources to be pooled and can create conditions for experimentation that would otherwise be unavailable to smaller enterprises or local institutions. Their importance is particularly visible in destination-management systems, cultural heritage, protected-area tourism, advanced digital and XR projects, certification processes, and sustainability-oriented regional initiatives. Networked innovation, however, should not be equated with cooperation in a purely structural sense. Effective partnerships depend on relational capabilities, including trust, communication, role clarity, conflict management, knowledge sharing, and the capacity to maintain cooperation beyond temporary projects or funding periods.

Taken together, these mechanisms demonstrate that innovation in sustainable tourism is rarely produced by a single technological, organisational, or policy intervention. It emerges through combinations of standardisation, digital mediation, territorial integration, participatory value creation, market differentiation, organisational learning, and inter-organisational cooperation. Their effectiveness depends on the extent to which organisations possess the competences and institutional capacity required to connect them. Certification without organisational learning can remain symbolic; data without analytical capability may fail to influence decisions; technology without a clearly defined purpose may add complexity rather than value; participation without meaningful influence may remain procedural; and partnerships without relational capacity may dissolve once external support ends.

The comparative evidence therefore supports an understanding of sustainable tourism innovation as a process of capability formation and institutional integration. The key question is not only whether new technologies, standards, products, or governance instruments are introduced, but whether organisations and destinations develop the capacity to interpret them, combine them with local knowledge, evaluate their effects, and incorporate them into durable systems of practice. From this perspective, innovation becomes inseparable from competence development, organisational learning, and the quality of the institutional relationships through which transformation is sustained[82].

2.5.1 From Innovation Mechanisms to Competence Ecosystems

The innovation mechanisms identified above should not be interpreted as mutually exclusive models of transformation. In practice, they frequently coexist and reinforce one another within the same destination, organisation, or development initiative. Certification may be combined with digital monitoring and data-supported management; regenerative or community-centred approaches may be connected with sustainability-based differentiation and territorial branding; immersive heritage projects may simultaneously depend on university cooperation, public funding, community participation, technological expertise, and workplace learning; and integrated destination strategies may require both environmental standards and increasingly sophisticated systems of data collection and interpretation. The analytical significance of these combinations lies in the fact that innovation outcomes cannot be explained adequately by the presence of a single intervention. Sustainable tourism transformation is better understood as configurational, with outcomes shaped by the interaction between institutional arrangements, technological choices, territorial conditions, organisational resources, and competence availability.

This configurational perspective changes the appropriate unit of analysis. Rather than focusing exclusively on an isolated sustainability practice, digital technology, certification instrument, training programme, or business model, attention shifts towards the competence ecosystem within which these elements are introduced, interpreted, connected, and maintained. Such an ecosystem

[82] L. Bellato and A. Pollock, “Regenerative Tourism: A State-of-the-Art Review”, *Tourism Geographies*, 27(3–4) (2025), pp. 558–567.

encompasses tourism enterprises and workers, VET and higher-education institutions, public authorities, destination-management organisations, local communities, technology providers, cultural and environmental institutions, professional networks, and intermediary organisations. What matters is not merely the presence of these actors, but the quality of the relationships that connect them and the extent to which knowledge, resources, and experience can circulate across organisational and professional boundaries.

The effectiveness of a competence ecosystem therefore depends on its capacity to convert distributed knowledge into professional and organisational practice. Access to expertise alone does not guarantee innovation, just as participation in a project or training programme does not automatically generate durable capability. Knowledge must be interpreted, adapted to context, incorporated into routines, transferred between individuals and organisations, and updated as technologies, environmental requirements, and market conditions change. The critical process is consequently one of knowledge circulation, absorption, integration, and application. This distinguishes a functioning competence ecosystem from a looser network of actors whose cooperation remains episodic or dependent on temporary external support.

From this perspective, innovation and competence development become analytically inseparable. New technologies generate requirements for digital, analytical, managerial, and ethical competence; environmental standards require organisations to develop capabilities in measurement, interpretation, reporting, and operational implementation; new business models depend on entrepreneurial judgement, collaboration, communication, and market understanding; and more integrated forms of destination governance require data literacy, facilitation, stakeholder coordination, and strategic decision-making. At the same time, the causal relationship operates in the opposite direction. Innovations cannot be adopted, adapted, or diffused effectively where the necessary professional and institutional capabilities are absent. Competence therefore constitutes not merely an outcome of transformation but one of its enabling conditions.

This reciprocal relationship calls into question a narrow skills-gap perspective. Identifying which competences are insufficient remains important, but it provides only a partial explanation of transformation capacity. The more fundamental question concerns the institutional conditions under which competences can be developed, shared, renewed, and applied. The same nominal skill may have very different practical value depending on whether workers have access to appropriate technologies, workplace learning, mentoring, organisational support, professional networks, opportunities for experimentation, and mechanisms for translating learning into decision-making. Competence shortages should therefore be examined together with the structures through which competence formation takes place.

An ecosystem perspective also draws attention to the distribution of competence-development opportunities. Tourism organisations differ substantially in their ability to access specialist knowledge, training, finance, digital infrastructure, and external partnerships. SMEs, rural destinations, community organisations, and smaller cultural institutions may depend more heavily on intermediary actors or shared support mechanisms than larger organisations with internal specialist

capacity. The effectiveness of the broader tourism transformation process therefore depends not only on the aggregate availability of skills but also on whether knowledge and learning opportunities are accessible across different organisational and territorial contexts[83].

The concept of the competence ecosystem consequently provides a bridge between the analysis of tourism innovation and the analysis of vocational education and training. It shifts attention from competences as isolated attributes of individual workers towards the relationships between individual capability, organisational learning, institutional support, and sectoral transformation. VET becomes significant within this framework not simply because it supplies qualified labour to tourism enterprises, but because it can contribute to the circulation and renewal of knowledge across the ecosystem, connect emerging professional requirements with educational provision, support experimentation, and provide mechanisms through which new competences can be translated into workplace practice.

The comparative analysis therefore supports a conceptual shift from asking primarily which skills are missing towards examining which institutional arrangements enable competences to be developed, combined, shared, updated, and applied in changing professional contexts. This perspective provides the conceptual link between the preceding analysis of sustainable and digital tourism transformation and the subsequent examination of competence gaps, VET systems, emerging occupational requirements, and the institutional capacity needed to respond to them[84].

[83] R. Thomas, E. Wood, "Innovation in Tourism: Re-conceptualising and Measuring the Absorptive Capacity of the Hotel Sector", *Tourism Management*, vol. 45, 2014, pp. 39–48.
[84] Cedefop, "Skills ecosystem", in *Terminology of European Education and Training Policy*; Cedefop, *Shaping Learning and Skills for Europe: A Time for Commitment*, Publications Office of the European Union, Luxembourg, 2025.

3 Skills Gaps and Training Needs in Tourism VET

The changing structure of tourism work creates a corresponding need to reassess how vocational education and training identifies, develops, and updates professional competences. As sustainability, digitalisation, technological innovation, entrepreneurship, accessibility, and new forms of service delivery become increasingly embedded in tourism practice, competence requirements are becoming more dynamic, interconnected, and context-dependent.

This chapter examines these developments from the perspective of skills gaps and training needs. Rather than treating competence shortages solely as deficits at the level of individual learners or workers, it considers the relationship between labour-market expectations, educational provision, teacher capacity, workplace learning, and institutional conditions for competence development. Particular attention is given to areas in which stakeholder expectations, perceived preparedness, and training provision may not fully align, providing a basis for assessing the responsiveness of tourism VET to ongoing sectoral transformation.

3.1 Research Objectives and Mixed-Methods Design

Understanding skills gaps in tourism VET requires attention not only to which competences are considered important, but also to how different stakeholder groups perceive changing occupational requirements, current levels of preparedness, and the responsiveness of education and training provision. The analysis therefore focuses on the relationship between emerging competence demands and the capacity of VET to recognise, interpret, and respond to them.

This chapter sets out the research objectives and methodological approach used to examine these relationships. It treats competence gaps as context-dependent and relational rather than as simple deficits located exclusively at the level of individual learners or workers. Particular emphasis is placed on comparing the perspectives of VET teachers, students, and tourism-industry representatives and on combining quantitative and qualitative evidence in order to capture both broader patterns and the institutional and professional contexts in which they arise.

3.1.1 Mixed-Methods Research Design

A mixed-methods research design was adopted to combine the comparative breadth of stakeholder perceptions with more detailed qualitative interpretation of the experiences, meanings, and contextual conditions underlying those perceptions. The study comprised three complementary components: a questionnaire survey, individual semi-structured interviews, and focus-group discussions. These methods generated different but mutually informative forms of evidence concerning competence requirements, perceived training needs, technological readiness, and the relationship between vocational education and changing labour-market expectations in tourism[85].

[85] J.W. Creswell and V.L. Plano Clark, Designing and Conducting Mixed Methods Research, 3rd ed., SAGE, Los Angeles, 2018.

The quantitative component was designed to identify recurring patterns in stakeholders' assessments of competence importance, perceived preparedness, training needs, digital and technological readiness, and emerging occupational expectations. Its purpose was not to provide an objective measurement of respondents' actual competence levels, but to examine the distribution and relative prominence of perceptions across the participating stakeholder groups. The survey therefore provided a comparative structure within which areas of convergence, divergence, and potential mismatch between educational and labour-market perspectives could be identified.

The qualitative components were used to examine these patterns in greater depth. Semi-structured interviews enabled participants to explain the reasoning behind their assessments, describe specific experiences, and identify institutional or contextual factors influencing competence development and technology adoption. Focus-group discussions added an interactive dimension by allowing participants to respond to, elaborate on, and challenge perspectives expressed by others. This was particularly useful for examining issues shaped by collective experience, professional norms, organisational conditions, and differing interpretations of responsibility between education and industry.

The combination of quantitative and qualitative evidence supported methodological triangulation. In the present study, triangulation was not understood as a procedure for establishing a single objectively correct stakeholder account, but as a means of comparing evidence generated through different methods and perspectives. Survey findings could therefore be considered alongside interview and focus-group material to determine whether quantitative patterns were reinforced, qualified, contradicted, or explained by qualitative evidence. Divergence between data sources was treated as analytically meaningful rather than as a methodological defect.

This approach was particularly relevant to the analysis of perceived competence gaps because assessments of occupational requirements are inherently position-dependent. VET teachers may interpret competence needs in relation to curriculum feasibility, pedagogical requirements, available infrastructure, and their experience of learners. Students may place greater emphasis on their own preparedness, learning experiences, confidence, and expectations regarding future employment. Industry representatives may assess competence primarily in relation to workplace performance, recruitment difficulties, customer expectations, technological change, and organisational needs. None of these perspectives can therefore be treated automatically as a complete or authoritative representation of tourism-sector competence requirements. Comparing them makes it possible to identify both shared priorities and differences in expectations, institutional perspectives, experiences of curriculum relevance, and interpretations of occupational change.

Methodological integration occurred primarily at the interpretative stage, where findings from the survey, interviews, and focus groups were considered in relation to one another. Quantitative patterns could thus be contextualised through qualitative evidence, while qualitative observations could be assessed against broader tendencies identified in the survey. This enabled the study to move beyond a simple inventory of perceived skills shortages towards a more comprehensive

analysis of how competence needs are understood and experienced by different actors within the tourism VET ekosystem[86].

3.1.2 Participants and Sampling Framework

Data collection was conducted across Germany, Greece, Italy, Poland, Portugal, and Spain and involved three stakeholder groups directly connected with the development, acquisition, or utilisation of tourism competences: VET teachers involved in tourism-related education, students enrolled in tourism-related VET programmes, and representatives of tourism enterprises or other tourism-sector organisations. The inclusion of these three groups was intended to capture complementary perspectives on competence requirements and vocational preparedness. Teachers contributed insights into curriculum implementation, pedagogical practice, and institutional conditions; students provided evidence concerning perceived preparedness, learning experiences, and expectations regarding future employment; and industry representatives contributed the perspective of workplace requirements, recruitment needs, and changing occupational practice.

For the survey component, the methodological protocol established a minimum target of 30 respondents in each participating country, including at least ten participants from each stakeholder category. The final survey sample comprised 203 respondents: 60 VET teachers, 94 VET students, and 49 tourism-industry representatives. This structure was intended to ensure that all three perspectives were represented within each national context and to enable exploratory comparison both between stakeholder groups and across countries. The resulting sampling framework should not, however, be interpreted as a probability sample of national tourism or VET populations. The study was designed primarily as a comparative stakeholder needs assessment rather than a nationally representative survey. Quantitative findings are therefore interpreted as patterns observed within the participating samples and are considered together with the qualitative evidence. Where larger national samples were obtained, they increased the breadth and diversity of the empirical material but did not, in themselves, establish statistical representativeness in the absence of probability-based recruitment procedures

3.1.3 Survey Instrument

Separate questionnaire blocks were developed for VET teachers, VET students, and tourism-industry representatives. Each questionnaire contained 32 questions adapted to the position and experience of the respective respondent group, while retaining sufficient thematic overlap to support comparative analysis. The instruments were designed to examine not only respondents' perceptions of existing competence levels but also their assessment of future occupational requirements, areas requiring further training, technological readiness, and the relationship between education and tourism-sector needs.

[86] M.D. Fetters, L.A. Curry and J.W. Creswell, "Achieving Integration in Mixed Methods Designs—Principles and Practices", Health Services Research, 48(6 Pt 2) (2013), pp. 2134–2156.

The teacher questionnaire addressed professional experience, subjects taught, institutional support for innovation, familiarity with digital and immersive technologies, frequency of digital-tool use, confidence in the educational application of XR, sustainability-related teaching, perceived competence gaps, professional-development needs, and barriers to innovation. Particular attention was devoted to familiarity and perceived proficiency in areas such as understanding VR, AR, and MR concepts, operating immersive equipment, developing or adapting digital content, and addressing basic technical problems. Teachers were also asked about preferred forms of professional development, including practical workshops and access to ready-to-use or adaptable immersive learning materials.

The student questionnaire focused on perceptions of the role of digital technologies in future tourism careers, familiarity with XR, confidence in digital competence, perceived preparedness for employment, learning preferences, interest in immersive learning activities, and areas in which additional competence development was considered necessary. Entrepreneurship, sustainability knowledge, career expectations, and transversal competences were also included. The instrument consequently captured both students' perceptions of their current capabilities and their expectations concerning the competences likely to be important in future employment.

The questionnaire addressed to tourism-industry representatives concentrated more directly on labour-market expectations. It examined cooperation with education and training providers, perceptions of graduate preparedness, digital competence, entrepreneurial capability, sustainability knowledge, transversal skills, familiarity with XR, recruitment priorities, and organisational barriers to the adoption of immersive technologies. Respondents were also invited to identify areas in which vocational programmes could more effectively reflect workplace requirements.

Across the three instruments, a common analytical structure can consequently be identified. The principal dimensions included digital readiness, XR-related competence, sustainability knowledge, entrepreneurial capability, transversal competences, perceived labour-market alignment, institutional support, and barriers to competence development. Questionnaires could be completed either in paper form or online. Paper responses were subsequently entered into a common digital environment to enable aggregation and comparative analysis of the national datasets

3.1.4 Individual Semi-Structured Interview

The second component of the study consisted of semi-structured individual interviews. The methodological framework established a target of at least five interviews per participating country, with respondents drawn from the same three stakeholder categories included in the survey. Interviews lasted approximately 45 minutes or longer and could be conducted either face-to-face or through online communication platforms. The semi-structured format ensured a common thematic framework while allowing respondents to elaborate on experiences, problems, and contextual circumstances that they regarded as particularly significant.

Interviews with teachers explored the use of digital and immersive technologies in vocational education, examples of innovative pedagogical practice, professional-development requirements,

participation in digital-content development, sustainability-related teaching, barriers to curriculum adaptation, and perceived gaps in digital, green, and transversal competences. Student interviews addressed experience with digital and XR tools, perceived competence priorities, the extent to which existing programmes prepared learners for employment, interaction with the tourism industry, sustainability education, learning preferences, and perceptions of the role of digital competence in future careers. Interviews with industry representatives focused on emerging workforce requirements, perceived digital and sustainability-related competence gaps, transversal skills, previous cooperation with VET institutions, expectations regarding future partnerships, the relevance of XR familiarity to employment, and existing or potential uses of immersive technologies in tourism practice.

The interview component therefore provided explanatory depth to patterns identified through the questionnaire survey. It made it possible to examine why particular competence gaps were perceived to exist, how institutional barriers were experienced in practice, and how respondents understood concepts such as digital readiness, sustainability competence, or effective cooperation between VET providers and the tourism sector.

3.1.5 Focus-Group Discussions

The third component consisted of focus-group discussions. The methodological framework envisaged at least three focus groups in each participating country, with approximately ten participants in each group and sessions lasting at least 60 minutes. Whereas interviews concentrated on individual accounts, focus groups were designed to generate interaction between participants, enabling them to compare experiences, challenge assumptions, articulate disagreement, and collectively develop interpretations of competence needs and institutional constraints.

A common discussion framework addressed familiarity with XR and examples of its application, recent participation in digital, immersive, or sustainability-related training, perceived gaps between VET provision and workplace requirements, cooperation between VET institutions and industry, the future role of XR and other digital technologies in tourism, and the significance of sustainability for professional practice and vocational education.

The group format was particularly relevant to the treatment of competence as a relational and institutional phenomenon. Perceived competence gaps may arise not only from limitations in individual knowledge or skills but also from insufficient cooperation between schools and enterprises, inadequate technological infrastructure, slow curriculum adaptation, limited opportunities for teacher development, or differences between educational and occupational interpretations of future competence requirements. Focus groups therefore enabled the study to examine how these wider conditions were understood and negotiated collectively.

3.1.6 Analytical Approach

Comparison consequently operated along two dimensions: between stakeholder groups and across the six national contexts. Particular attention was paid both to convergence and to divergence. Where teachers, students, and industry representatives independently identified similar

areas of insufficient preparedness or training need, convergence strengthened the evidence that the respective competence domain warranted further attention. Divergence was treated as equally informative. A competence perceived as sufficient by learners, for example, could be evaluated differently by industry representatives, while teachers could identify institutional or pedagogical constraints that were less visible to either students or employers. Such differences were therefore interpreted not simply as inconsistencies but as evidence of the distinct positions occupied by different actors within the tourism competence ecosystem.

Qualitative material was used to contextualise and interpret recurring patterns relating to green competences, digitalisation, entrepreneurship, XR, transversal competences, teacher readiness, infrastructure, and cooperation between vocational education and the tourism sector. The purpose of combining methods was therefore analytical complementarity rather than mechanical confirmation of one dataset by another. Convergence increased confidence in recurrent patterns, whereas divergence provided insight into differing expectations, institutional conditions, and understandings of occupational transformation.

3.1.7 XR as an Analytical Dimension

Extended Reality constituted a specific analytical dimension within the broader investigation of digital transformation. The study examined familiarity with Virtual Reality, Augmented Reality, and Mixed Reality, perceived competence in operating immersive technologies or developing related content, potential educational and occupational applications, barriers to adoption, and teacher and learner interest in XR-supported vocational education.

XR was not treated as an objective in itself or as an indicator of technological advancement. Its relevance was assessed in relation to identifiable vocational-learning and tourism-practice problems, including the simulation of workplace situations, heritage interpretation, environmental education, customer interaction, digital storytelling, and the design of tourism experiences. This distinction is important because technological readiness cannot be reduced to access to devices or familiarity with particular applications. Meaningful implementation also depends on pedagogical design, educator competence, infrastructure, technical support, accessibility, institutional capacity, and the extent to which immersive activities contribute to defined occupational learning outcomes.

The XR component should therefore be interpreted primarily as an assessment of readiness, perceived relevance, competence requirements, and implementation conditions. It does not constitute an experimental evaluation of the educational effectiveness of immersive technologies.

3.1.8 Ethical and Data-Protection Considerations

Participation in the study was voluntary. Respondents were informed about the purpose of the research and the intended use of the information they provided. Where required under applicable national procedures, written consent was obtained using a common consent form. Data handling was conducted in accordance with applicable data-protection requirements, including the principles established by the General Data Protection Regulation.

The research procedures also emphasised respectful and non-judgemental conditions during interviews and focus-group discussions. This was particularly important because participants were invited to express potentially critical views concerning curricula, educational institutions, technologies, professional preparedness, and the relationship between VET provision and labour-market expectations. Creating conditions in which such views could be expressed without unnecessary evaluative pressure was therefore relevant to both the ethical quality and analytical usefulness of the qualitative material.

3.1.9 Methodological Scope and Limitations

The methodological design provides a broad comparative perspective by combining six national contexts, three stakeholder groups, and three forms of data collection. This structure enables competence requirements to be considered simultaneously from educational, learner, and workplace perspectives and allows recurrent patterns to be interpreted in relation to different institutional and national settings. Several limitations nevertheless define the appropriate scope of inference.

Most importantly, the participating samples should not automatically be regarded as nationally representative. Differences in recruitment procedures, respondent composition, institutional environments, and local labour-market conditions may influence the patterns observed. Cross-country comparisons should therefore be interpreted as comparisons between the participating stakeholder samples rather than as direct measurements of national differences in competence levels or VET-system performance.

A further limitation results from the substantial use of self-reported assessments. Perceived competence, confidence, or preparedness does not necessarily correspond to objectively demonstrated performance. Similarly, assessments provided by employers reflect organisational expectations, recruitment experiences, and particular workplace contexts rather than a standardised external measurement of graduate competence. The study consequently provides evidence concerning perceived competence gaps and training needs, not direct testing of participants' occupational proficiency[87].

Additional caution is required in interpreting the XR component. Respondents differed substantially in their degree of familiarity and direct experience with immersive technologies, and some assessments concerned anticipated or potential applications rather than extensive practical use. Findings relating to XR should therefore be interpreted as evidence concerning awareness, readiness, perceived usefulness, barriers to implementation, and training requirements rather than as evidence that particular immersive technologies generate superior learning outcomes.

These limitations delimit rather than negate the analytical contribution of the study. The research design is particularly suited to identifying recurring perceptions of competence gaps,

[87] T. Sitzmann, K. Ely, K. G. Brown, K. N. Bauer, "Self-Assessment of Knowledge: A Cognitive Learning or Affective Measure?", Academy of Management Learning & Education, vol. 9, no. 2, 2010, pp. 169–191.

differences between stakeholder perspectives, institutional barriers to competence development, and areas in which stronger alignment between vocational education and tourism practice may be required. Its principal contribution lies in combining these perspectives in order to examine not only which competences are perceived as insufficient, but also where the institutional conditions for developing, updating, and applying those competences appear to be inadequate. This distinction provides the methodological foundation for the empirical analysis that follows.

3.2 Preliminary Competence-Gap Framework Derived from Sustainable Tourism Practices

Before examining the survey, interview, and focus-group evidence, it is useful to identify the competence requirements that emerge from the sustainable tourism practices analysed in the preceding chapter. This preliminary mapping serves a different analytical function from the stakeholder-based assessment presented later in the chapter. It does not provide direct evidence that particular competences are absent among VET students, teachers, or tourism employees. Rather, it identifies the forms of knowledge, capability, and professional judgement that appear necessary for the implementation of the organisational, technological, environmental, and governance practices observed across Germany, Greece, Italy, Poland, Portugal, and Spain. The resulting framework can therefore be treated as an analytical baseline against which stakeholder perceptions of competence importance, preparedness, and training need can subsequently be compared.

This distinction is methodologically important. The presence of a particular competence requirement within an innovative tourism practice does not demonstrate that the corresponding competence is widely lacking in the workforce. Conversely, teachers, students, or industry representatives may identify important deficits that were not particularly visible in the practices examined in the preceding chapter. Comparing these two forms of evidence makes it possible to distinguish between competences inferred from the requirements of sustainable tourism transformation and competences perceived as insufficient by stakeholders. The analytical value lies precisely in the relationship between the two: convergence may indicate areas in which transformation requirements and stakeholder perceptions reinforce one another, while divergence may reveal emerging competence needs, institutional blind spots, or differences between occupational practice and educational expectations.

The comparative analysis points to nine recurring competence domains: environmental measurement and interpretation; certification and compliance; circular economy and resource management; sustainable mobility; biodiversity and protected-area management; green entrepreneurship; green digital literacy; multi-stakeholder coordination; and accessibility and inclusion. These domains should not be understood as independent or self-contained skill categories. In professional practice they overlap substantially, and their value often depends on the capacity to combine them. The framework therefore anticipates the emergence of hybrid professional competence profiles in which environmental, digital, entrepreneurial, managerial, communicative, and collaborative capabilities interact.

A particularly visible requirement concerns the capacity to measure, interpret, and use environmental information. Sustainable tourism increasingly depends on data concerning energy and water consumption, waste, greenhouse-gas emissions, visitor flows, biodiversity pressures, and related environmental indicators. The competence requirement extends beyond data collection. Professionals need to understand what indicators represent, judge their relevance, identify meaningful changes, and translate information into operational or managerial decisions. This can be conceptualised as environmental analytical competence, combining environmental literacy with measurement, interpretation, and decision-making. Its importance increases where enterprises and destinations use certification systems, sustainability dashboards, reporting frameworks, or digitally supported management tools. For smaller organisations, the requirement may be particularly demanding because the same employee or manager may need to collect information, interpret indicators, communicate findings, and determine which operational responses are feasible. The educational implication is therefore broader than teaching environmental accounting as an isolated technical subject. Learners require opportunities to work with authentic or realistically structured data and to understand the sequence through which information becomes action: data - interpretation -decision - evaluation. This may include carbon-footprint concepts, energy and water audits, waste measurement, environmental indicators, and sustainability dashboards, but the central competence lies in connecting measurement with professional judgement.

Closely related to this analytical capability is competence in certification, standards, and compliance. Certification can operate simultaneously as a governance mechanism, market signal, and stimulus for organisational learning, but its practical significance depends on professionals' ability to understand and apply the requirements underlying the label. Competence in this area therefore extends beyond familiarity with the names of certification schemes. It includes interpreting criteria, collecting and maintaining evidence, documenting procedures, assigning organisational responsibilities, monitoring performance, communicating results, and integrating certification requirements into everyday operations. The distinction is particularly important for SMEs, for which certification may impose proportionally greater administrative and financial demands. In such organisations, the barrier may not be unwillingness to engage with sustainability but limited capacity to interpret procedures and maintain compliance over time. VET can respond by treating certification as an applied management process rather than purely descriptive knowledge, for example through simulated audits, documentation exercises, improvement plans, and case-based assessment.

A further domain concerns the practical implementation of circular-economy and resource-management principles. Tourism organisations increasingly encounter expectations relating to waste prevention, reuse, recycling, sustainable procurement, renewable energy, local sourcing, and more efficient use of materials. Knowledge of circularity as a general sustainability principle is insufficient unless professionals can analyse how resources move through specific tourism operations. They need to identify where waste is generated, which processes can be redesigned, which materials or products can be reused, and how procurement and supplier relationships influence environmental performance. Circular competence is therefore simultaneously environmental, operational, managerial, and entrepreneurial. This is particularly relevant in accommodation, gastronomy, events,

agritourism, and other tourism activities characterised by significant material and energy flows. A useful educational logic is to move from resource audit to redesign, enabling learners to diagnose resource use, identify opportunities for reduction or reuse, evaluate their operational feasibility, and assess both environmental and economic implications. In this way, circular-economy competence becomes closely connected with sustainable business-model innovation.

Sustainable mobility constitutes another important area of professional capability. The environmental performance and accessibility of tourism depend substantially on how visitors travel to, within, and between destinations. Low-emission transport, public-transport integration, walking and cycling infrastructure, micromobility, accessible route planning, and visitor-flow management therefore have direct implications for tourism design and destination management. Mobility cannot be treated solely as a transport-sector responsibility. Tourism professionals need to understand how mobility influences visitor experience, destination accessibility, emissions, seasonality, spatial distribution, and the viability of particular tourism products. At destination and municipal level, this may require cooperation with transport planners, public authorities, technology providers, accommodation businesses, and mobility operators. The resulting competence is hybrid, combining tourism management, sustainability, accessibility, digital mapping, product design, and inter-organisational coordination. VET can develop such competence through applied destination problems, including the design of low-emission itineraries, integration of public transport with walking and cycling, identification of accessibility barriers, or development of slow-mobility tourism products. The aim is not to train transport specialists but to prepare tourism professionals to integrate mobility considerations into sustainable visitor-experience design.

The analysed practices also reveal a need for stronger ecological and interpretive competence in nature-based and environmentally sensitive tourism. Protected areas, coastal environments, rural landscapes, and biodiversity-oriented experiences require professionals who understand ecological limits as well as visitor expectations. Relevant knowledge includes ecosystems, biodiversity, habitat sensitivity, visitor impacts, environmentally responsible behaviour, and the relationship between tourism activity and conservation. Ecological knowledge alone, however, is insufficient. Tourism professionals also need to communicate such knowledge effectively through eco-guiding, nature interpretation, environmental storytelling, and visitor education. At destination and management level, additional capabilities are required in visitor-flow management, impact monitoring, stakeholder coordination, and the design of tourism products compatible with conservation objectives. These capabilities can be described as nature-positive tourism competence, understood here not as a claim that all nature-based tourism produces net ecological benefits, but as the capacity to design and manage tourism in accordance with ecological constraints and, where appropriate, in support of conservation objectives. For VET, protected areas and natural destinations offer particularly valuable contexts for experiential learning through field-based activities, cooperation with environmental institutions, interpretation projects, and visitor-impact assessment.

The intersection between sustainability and entrepreneurship generates another competence domain. Tourism enterprises may recognise the importance of environmental responsibility while

still facing considerable difficulty in translating it into viable operational and investment decisions. Measures relating to energy efficiency, certification, renewable energy, environmentally responsible services, or new sustainable tourism products involve costs, uncertainty, financing requirements, regulatory considerations, and market risk. Entrepreneurial competence is therefore an important component of the green transition. Professionals need to understand how environmental objectives interact with customer value, operating costs, investment decisions, financing, market positioning, and longer-term business resilience. This implies a shift from conventional entrepreneurship education towards green value creation, in which learners are expected to assess environmental and economic implications simultaneously. Relevant competence areas include sustainable business models, investment appraisal, total cost of ownership, green finance, regulatory risk, responsible branding, sustainable service design, and market communication. The ethical dimension is equally important. As sustainability increasingly contributes to tourism positioning and branding, professionals need the capacity to distinguish substantiated environmental communication from exaggerated or unsupported claims. Evidence-based sustainability communication should therefore be understood as part of entrepreneurial competence rather than merely as a marketing technique.

Digital transformation intersects with these environmental requirements and creates a further domain that can be described as green digital literacy. Sustainable tourism increasingly relies on digital dashboards, sensors, booking systems, destination-management platforms, digital maps, visitor-flow tools, certification databases, AI-supported applications, and immersive technologies. The relevant competence is therefore broader than generic digital literacy. Green digital literacy refers to the capacity to use digital technologies to understand, manage, communicate, or improve environmental performance while also exercising judgement regarding their relevance and limitations. Its form varies according to professional role. Frontline employees may need to operate digital systems correctly; managers may need to interpret environmental information; destination professionals may analyse visitor flows; guides may use mobile or immersive technologies for environmental or cultural interpretation; and entrepreneurs may rely on digital platforms to communicate sustainable products. Not every tourism professional requires advanced technological expertise. More important is the ability to determine which digital tools are appropriate to a particular professional problem, evaluate the information they generate, and understand how this information should influence decision-making. VET should consequently avoid treating green and digital competence as entirely separate curriculum areas and instead create tasks in which both dimensions interact[88].

Sustainable tourism transformation also creates significant requirements for multi-stakeholder coordination. Many of the challenges identified in the comparative material cannot be addressed by a single organisation acting independently. Visitor flows, mobility, biodiversity protection, certification, cultural heritage management, local food systems, digital infrastructure, and regional tourism products require cooperation between actors with different responsibilities, resources, and

[88] PANTOUR, *Sectoral Skills Intelligence Monitoring System*, 2024; Bianchi, Pisiotis, Giraldez, *GreenComp*, 2022.

interests. Municipalities, tourism enterprises, destination organisations, educational institutions, universities, NGOs, local communities, technology providers, environmental organisations, and intermediary bodies all participate in different configurations of tourism governance. Professionals therefore increasingly require capabilities in stakeholder mapping, facilitation, negotiation, partnership development, project coordination, conflict management, and network governance. These should not be reduced to generic interpersonal or "soft" skills. In complex tourism systems they constitute operational capabilities necessary for coordinating distributed responsibility and creating continuity across organisational boundaries. Their importance increases in fragmented destinations, cross-municipal initiatives, and cross-border settings where no single institution possesses sufficient authority or expertise to manage transformation alone. VET can respond through interdisciplinary projects, stakeholder simulations, collaborative destination-planning exercises, and authentic assignments involving external partners.

Accessibility and inclusion constitute the final domain of the preliminary framework. Sustainable tourism cannot be reduced to environmental performance alone if participation in tourism remains constrained by physical, sensory, cognitive, linguistic, economic, or digital barriers. Accessibility therefore needs to be integrated with green and digital competence development rather than treated solely as a specialist or peripheral issue. Relevant capabilities include awareness of universal and inclusive design, accessible visitor information, route planning, digital accessibility, inclusive customer service, and the ability to respond to diverse visitor needs. Digital transformation makes this requirement particularly important because technologies can simultaneously remove and create barriers[89]. Virtual environments may provide alternative access to physically inaccessible heritage sites while remaining difficult to use for people with sensory impairments or limited digital confidence. Mobile applications may improve interpretation while excluding users who lack suitable devices, connectivity, or digital competence. Accessibility therefore requires critical evaluation throughout service and experience design. From a VET perspective, inclusive design should be embedded across tourism learning rather than confined to a single specialised module. Learners should routinely be encouraged to ask who can access a tourism product or digital service, who may be excluded, what barriers are being created, and which alternative forms of participation should be provided[90].

Taken together, the nine domains demonstrate that the competence requirements associated with sustainable tourism transformation cannot be adequately represented as a collection of discrete green skills. Environmental measurement is connected with digital analysis and managerial decision-making; certification requires organisational competence; circularity intersects with entrepreneurship and supplier relations; sustainable mobility depends on destination coordination; nature-based tourism combines ecological knowledge with interpretation; sustainable entrepreneurship requires ethical and financial judgement; green digital literacy connects technology

[89] T. Domínguez Vila, L. Rubio-Escuderos and E. Alén González, "Accessible Tourism: Using Technology to Increase Social Equality for People with Disabilities", *Tourism Review* (2024).
[90] OECD, *Preparing the Tourism Workforce for the Digital Future*, *OECD Tourism Papers*, No. 2021/02, OECD Publishing, Paris, 2021.

with environmental objectives; collaborative governance requires boundary-spanning capability; and accessibility cuts across both digital and physical service design. The resulting competence structure is therefore inherently integrative.

The preliminary framework should accordingly be understood as a map of competence requirements generated by transformation, not as evidence that all nine domains constitute demonstrated deficits in the tourism workforce. Its function is to provide a structured reference point for the stakeholder evidence examined in the following sections. The empirical analysis can then determine which of these competence requirements are also perceived as insufficient by teachers, students, and industry representatives, which receive different levels of importance across stakeholder groups, and which additional needs emerge from occupational and educational experience. This comparison makes it possible to move from a practice-derived map of transformation requirements towards a more differentiated account of perceived competence gaps, training needs, and institutional conditions of competence development.

3.2.1 From Separate Gaps to Interconnected Competence Domains

This observation supports a shift from the analysis of isolated skills towards broader competence clusters. For analytical purposes, the nine domains can be organised into four interconnected clusters. Environmental and technical competences encompass environmental measurement, circular economy and resource management, sustainable mobility, biodiversity-related knowledge, and the operational dimensions of certification. Digital and analytical competences include data interpretation, environmental technologies, digital mapping, platforms, monitoring systems, and XR-related applications. Entrepreneurial and organisational competences concern sustainable business models, investment and financing decisions, innovation, certification management, organisational adaptation, and the creation of environmental and territorial value. Transversal and governance competences include communication, stakeholder coordination, facilitation, negotiation, accessibility, inclusion, partnership development, and collaborative decision-making.

These clusters should not be interpreted as separate layers of competence. Their boundaries are porous, and many emerging professional tasks are located precisely at their intersection. Environmental data become professionally relevant only when they can be interpreted and connected with managerial decisions. Digital competence acquires value when it is combined with understanding of tourism operations, environmental objectives, and user needs. Entrepreneurial activity increasingly requires sustainability judgement, while destination governance depends on communication, data interpretation, institutional coordination, and the ability to negotiate between different territorial interests. The analytical significance of the cluster structure therefore lies not in simplifying the nine domains into four independent categories, but in making visible the combinations through which professional capability is increasingly constructed.

The preliminary framework provides a reference point for interpreting the stakeholder evidence presented in the following sections. The empirical question is not simply whether teachers, students, and tourism-industry representatives recognise the same competence domains identified through

the analysis of sustainable tourism practices. It is also whether they attribute similar levels of importance to them, whether they assess current preparedness in comparable ways, and whether the organisational and institutional barriers identified in tourism practice are also visible within vocational education.

Comparison between the practice-derived framework and stakeholder evidence can reveal several analytically distinct relationships. Convergence occurs where competences inferred from sustainable tourism practice are also identified by teachers, students, or industry representatives as areas of insufficient preparation or increased training need. Divergence occurs where the practice analysis points to an emerging competence that stakeholders do not yet consider important, or where stakeholders identify a need that was not prominent in the analysed tourism practices. Such divergence may indicate differences in professional perspective, variations in the pace of occupational change, or a time lag between emerging practice and its recognition within education or industry.

A further relationship concerns implementation gaps. These occur where the importance of a competence is broadly recognised but the institutional conditions required for its development remain insufficient. A competence may therefore be regarded as necessary by teachers, learners, and employers while still being weakly developed because educators lack appropriate preparation, curricula are insufficiently flexible, technological infrastructure is unavailable, workplace cooperation is limited, funding is inadequate, or organisations lack opportunities for practice and reinforcement. In such cases, the central problem is not the absence of awareness but the inability of the competence-development system to translate recognised needs into sustained learning.

The analysis that follows consequently moves beyond the question of which skills are missing. It examines the relationship between competence demand, stakeholder recognition, perceived preparedness, and the institutional capacity of VET systems and tourism organisations to respond. Competence gaps are thus interpreted as phenomena situated within a broader competence ecosystem rather than as deficiencies located exclusively in individual workers or learners.

3.2.2 Implementation Capacity as a Cross-Cutting Gap

The nine competence domains are accompanied by a cross-cutting issue that operates at a different analytical level: the capacity of VET institutions and tourism organisations to convert identified competence needs into sustained opportunities for learning, practice, and application. The preceding analysis indicates that training and innovation activities may be fragmented, project-dependent, or weakly connected with workplace implementation. This issue is particularly relevant to SMEs and smaller institutions, which may have limited access to internal trainers, specialist expertise, time, finance, technological infrastructure, or organisational resources for prolonged competence-development activity.

This problem should not be treated as an additional competence domain equivalent to environmental measurement, green digital literacy, entrepreneurship, or stakeholder coordination. It is better understood as an implementation capacity gap. The distinction is important because

recognition of a competence need does not ensure that the competence can be developed effectively. Training may produce limited or temporary effects where learners have few opportunities to practise new capabilities, where teachers lack continuing support, where technologies are unavailable after a project has ended, or where workplace routines do not allow newly acquired knowledge to be applied.

Implementation capacity therefore concerns the architecture through which competence development is enabled, reinforced, and sustained. Curriculum content is only one component of this architecture. Work-based learning, blended provision, mentoring, peer learning, applied projects, business clinics, access to specialist infrastructure, collaboration with employers, and participation in enterprise or destination networks can all contribute to converting formal learning into professional and organisational practice. Their effectiveness depends on whether learning opportunities are sufficiently connected with authentic occupational problems and whether organisations possess the capacity to absorb and maintain the resulting knowledge.

The concept of an implementation capacity gap also helps distinguish between different sources of apparent competence shortage. A recognition gap exists where an emerging competence requirement is not yet sufficiently acknowledged by relevant actors. A competence gap exists where a competence is recognised as necessary but stakeholders perceive current capability as insufficient. An implementation gap exists where the need is recognised and the desired competence is identifiable, but institutional, organisational, pedagogical, or resource conditions constrain its effective development and use. These categories may overlap, but distinguishing between them is analytically important because they imply different responses. Increasing awareness may address a recognition gap, education and training may respond to a competence gap, while an implementation gap requires changes to the institutional conditions through which learning is delivered, supported, and transferred into practice.

Implementation capacity thus provides an important bridge between the preliminary competence framework and the stakeholder analysis that follows. It directs attention away from a purely individualised interpretation of skills shortages and towards the capacity of organisations and education systems to create the conditions in which competences can be acquired, integrated, and applied over time.

3.3 Stakeholder-Identified Competence Priorities

The preceding section derived competence requirements from the sustainable tourism practices examined across the six national contexts. The analysis now turns to evidence generated through surveys, individual interviews, and focus-group discussions with VET teachers, students, and tourism-industry representatives. The objective is to examine how actors directly involved in tourism education, learning, and employment interpret emerging competence requirements, how they assess current vocational preparation, and where they perceive the most significant needs for further development.

Across the stakeholder material, three broad areas recur with particular frequency: environmental and green competences, entrepreneurial and transversal competences, and digital and XR-related competences. These categories are analytically distinguishable but should not be interpreted as independent skill sets. The stakeholder evidence reflects the same tendency towards competence hybridisation identified in the practice-derived framework. Contemporary tourism work increasingly requires environmental understanding to be combined with business judgement, digital capability with communication and customer interaction, and technological competence with collaboration, adaptability, and professional decision-making[91]. The stakeholder evidence is interpreted through the distinction established above between recognition gaps, perceived competence gaps, and implementation gaps.

The three categories provide a framework for interpreting differences between stakeholder groups without assuming that any one perspective constitutes an objective account of labour-market demand. Teachers, students, and industry representatives occupy different positions within the tourism competence ecosystem and may therefore assess the same competence differently. Such differences are analytically significant because they can reveal mismatches between educational provision, learner expectations, workplace requirements, and institutional capacity. The stakeholder analysis that follows therefore focuses not simply on the identification of missing skills, but on the relationship between competence demand, competence perception, perceived preparedness, and the conditions under which competence development can occur[92]

3.3.1 Environmental and Green Competences

Environmental and green competences emerge from the stakeholder material as a central component of contemporary and future tourism professionalism. At the same time, the evidence indicates that sustainability is not always understood at the same level of complexity. A recurring distinction can be observed between familiarity with basic ecological practices and the more advanced capability to interpret sustainability systemically, evaluate evidence, recognise trade-offs, and translate environmental objectives into professional decisions. This distinction is important because the competence challenge identified by respondents does not appear to concern environmental awareness alone. Rather, it concerns the progression from awareness and procedural compliance towards analytical, managerial, and judgement-based forms of sustainability competence.

Students and teachers reported that sustainability is already present in tourism education to varying degrees, both through dedicated content and through topics embedded within other subjects. However, the examples described frequently concern relatively basic operational practices such as waste separation, recycling, reduction of energy and water consumption, or other familiar measures intended to limit resource use. These practices remain relevant and necessary, but they

[91] R. Thomas and E. Wood, “Innovation in Tourism: Re-conceptualising and Measuring the Absorptive Capacity of the Hotel Sector”, *Tourism Management*, 45 (2014), pp. 39–48.
[92] R. Thomas and E. Wood, “The Absorptive Capacity of Tourism Organisations”, *Annals of Tourism Research*, 54 (2015), pp. 84–99.

become insufficient when they constitute the principal framework through which sustainability is understood. Learners may become capable of following prescribed environmental procedures without developing the ability to explain why particular measures are required, evaluate whether they are effective, interpret environmental information, or understand how individual operational decisions interact with broader organisational and destination-level sustainability objectives.

The industry material points towards a more complex competence requirement. Tourism organisations increasingly need employees who can work with environmental indicators, certification requirements, monitoring systems, reporting frameworks, and operational data. This suggests a distinction between procedural ecological awareness and systemic environmental competence. The former enables workers to perform predefined environmentally responsible actions, whereas the latter enables them to understand the rationale behind such measures, assess their effectiveness, interpret evidence, and contribute to organisational improvement. From a VET perspective, this distinction implies that sustainability education should extend beyond teaching appropriate behaviours and introduce learners to the mechanisms through which environmental performance is measured, interpreted, managed, and improved.

Certification provides a particularly clear example of this shift. Stakeholders referred to the growing relevance of environmental standards and certification systems, especially in accommodation and hospitality. Their effective implementation requires substantially more than familiarity with sustainability terminology or recognition of particular labels. Employees may need to collect evidence, interpret indicators, work with audit or reporting procedures, maintain documentation, and connect formal requirements with everyday operational practice. Industry respondents indicated that graduates are not always sufficiently prepared for such tasks, creating an area of convergence between the competence requirements inferred from sustainable tourism practices and stakeholder perceptions of vocational preparedness. Certification should therefore be approached in tourism VET as an applied organisational process. Simulated audits, simplified documentation exercises, environmental indicators, improvement plans, and certification scenarios can help learners connect sustainability knowledge with operational decision-making rather than treating certification as an abstract or external requirement.

The stakeholder material also reveals a need for critical sustainability literacy. Respondents described uncertainty or conceptual overlap between terms such as sustainable tourism, responsible tourism, and green tourism and indicated that sustainability is sometimes interpreted primarily through visible environmental actions without sufficient consideration of their wider consequences. Critical sustainability literacy involves the ability to question environmental claims, distinguish substantive organisational change from symbolic action, and evaluate sustainability initiatives through evidence rather than promotional language. This capability is increasingly important as sustainability becomes part of tourism branding and competitive positioning. Environmental claims can create customer value, but they can also create incentives to communicate sustainability more strongly than it is implemented. Understanding greenwashing should therefore form part of

professional sustainability competence, not only as an ethical concern but also as a managerial, reputational, and decision-making issue.

Critical sustainability literacy also requires tourism professionals to examine the environmental implications of digital transformation itself. Green and digital transitions are frequently presented as mutually reinforcing, yet digital technologies depend on energy, devices, infrastructure, data processing, maintenance, and replacement cycles. The use of digital or immersive technology should therefore not automatically be interpreted as an environmentally sustainable intervention. Green competence increasingly includes the ability to assess whether technological solutions contribute meaningfully to sustainability objectives, whether their additional environmental and organisational costs are justified, and whether less resource-intensive alternatives could achieve comparable outcomes. This further reinforces the interdependence of environmental and digital competence.

The stakeholder evidence also broadens sustainability beyond ecological efficiency. Respondents' accounts indicate that learners may associate sustainability primarily with environmental issues, whereas educator and industry perspectives point towards a wider understanding encompassing local economies, cultural heritage, community well-being, accessibility, participation in tourism value creation, and the relationship between visitors and host communities. Sustainability competence should therefore be interpreted as a multidimensional professional capability integrating environmental, social, cultural, and economic considerations. This broader understanding changes the nature of the professional problems that tourism learners need to address. A tourism service may be relatively efficient in resource use while generating pressure on local residents; a destination may promote environmentally responsible mobility while remaining inaccessible to some visitor groups; and a heritage initiative may reduce physical pressure on a site while failing to engage the community whose heritage is being represented.

The competence required in such situations involves the ability to recognise interdependencies and negotiate trade-offs rather than merely apply predetermined sustainability rules. Learning methods that expose students to multiple stakeholder perspectives are particularly valuable in this respect. Role play, simulation, community-based projects, case analysis, and stakeholder exercises can enable learners to examine tourism decisions from the perspectives of residents, visitors, businesses, employees, public authorities, cultural organisations, environmental actors, and people who experience accessibility barriers. These approaches can move sustainability education from rule-following towards professional judgement.

A place-sensitive dimension is also visible in the stakeholder material. Respondents referred to local economies, community participation, rural tourism, and the redistribution of visitors beyond highly concentrated tourism areas. These themes suggest that sustainable tourism competence needs to include an understanding of how tourism affects local producers, cultural practices, employment, infrastructure, and community life. Professionals may therefore require capabilities in partnership development, stakeholder communication, cultural sensitivity, and the design of tourism products rooted in territorial resources. However, visitor redistribution should not itself be assumed to be sustainable. Directing visitors towards less frequented locations can create new pressures if

infrastructure, ecological sensitivity, community preferences, and local carrying capacity are not considered. The relevant competence lies in evaluating redistribution as a destination-management decision rather than treating it solely as a marketing objective.

Climate adaptation adds a further dimension to green competence. Tourism is highly exposed to changing environmental conditions and climate-related disruption, particularly in coastal, mountain, rural, and heritage destinations. Stakeholder accounts point towards the growing relevance of seasonal planning, risk management, visitor-flow management, and adaptation of tourism services to changing environmental conditions. Sustainability competence therefore extends beyond mitigation and resource efficiency. Tourism professionals increasingly need to understand how destinations and organisations can adapt to heat, water scarcity, changing weather patterns, ecosystem vulnerability, seasonal disruption, and crowding. Digital tools may support these activities through monitoring, mapping, predictive systems, and scenario-based planning, but the professional requirement remains integrative: climate resilience increasingly intersects with digital literacy, data interpretation, operational planning, and risk management.

The stakeholder material also links sustainability competence with cultural heritage preservation. Respondents referred to digital documentation, three-dimensional modelling, scanning, virtual reconstruction, and other technologies capable of supporting access to, interpretation of, or documentation of cultural assets. This creates a hybrid competence area connecting sustainability, heritage, and digital technology. The implication is not that tourism learners should acquire specialist expertise in digital conservation or 3D modelling. Rather, tourism professionals increasingly need sufficient understanding to recognise when such technologies may support heritage protection, accessibility, visitor management, or interpretation, and to collaborate effectively with museums, cultural institutions, heritage specialists, and technology providers. This points towards a broader form of interface competence: the ability to operate productively across professional domains without possessing full specialist expertise in each of them.

Industry respondents repeatedly emphasised that tourism professionals should understand sustainability beyond marketing discourse and basic ecological actions. Their expectations relate more strongly to operational capability, critical judgement, environmental awareness, and the capacity to connect sustainability principles with management decisions. Student responses, meanwhile, suggest that sustainability is widely recognised as important but that learners would benefit from more practical and applied forms of education. The resulting issue can be described as a theory–practice gap. Sustainability may already be present in curricula while still being taught in forms that provide insufficient opportunities for application, interpretation, and decision-making.

Addressing this gap requires learning environments in which students encounter sustainability through authentic or realistically simulated professional problems. Partnerships with tourism enterprises, municipalities, protected areas, cultural institutions, sustainability organisations, and destination-management bodies can strengthen the connection between conceptual knowledge and professional practice. Applied assignments may involve evaluating the environmental performance of an accommodation facility, designing a sustainable tourism route, interpreting environmental data,

analysing certification requirements, assessing the credibility of environmental marketing claims, or proposing adaptation measures for a climate-sensitive destination. Such activities allow sustainability competence to develop through judgement, problem solving, and contextual application rather than through memorisation alone[93].

The stakeholder evidence therefore suggests that environmental and green competence should be embedded across tourism curricula rather than treated as a narrow or specialised subject area. Learners require a common foundation in environmental and sustainability principles, but this foundation should develop progressively towards more advanced forms of application. Relevant learning should include environmental indicators, certification and auditing, climate adaptation, sustainable mobility, visitor-flow management, community-based tourism, cultural heritage, accessibility, and the social and economic dimensions of sustainability. Critical literacy is equally important. Learners need to be able to identify unsupported environmental claims, assess trade-offs, interpret evidence, and distinguish substantive transformation from symbolic or primarily communicative measures. Applied and experiential methods—including case studies, field projects, audits, simulations, role play, stakeholder exercises, workplace assignments, and cooperation with external organisations—are particularly suitable for developing this form of capability.

Taken together, the stakeholder evidence indicates that the central challenge is not simply insufficient environmental awareness. Basic ecological awareness appears to be present in at least parts of tourism education and professional practice. The more significant issue concerns the transition from awareness to the ability to make informed and context-sensitive professional decisions. This progression can be described as a movement from environmental awareness to sustainability judgement. Sustainability judgement involves the ability to recognise environmental and social consequences, interpret evidence, identify trade-offs, evaluate claims, compare alternative interventions, and justify decisions in relation to specific tourism contexts.

Such judgement is inherently integrative. It draws simultaneously on environmental knowledge, digital information, entrepreneurship, ethics, communication, stakeholder understanding, and organisational awareness. Environmental and green competence should therefore not be treated as an isolated skill category but as one of the organising dimensions of contemporary tourism professionalism. The stakeholder evidence strengthens the broader argument developed throughout the study: sustainability should move from the margins of tourism education towards its professional core, not merely as an additional subject, but as a framework through which tourism decisions are interpreted, evaluated, and justified[94].

3.3.2 Entrepreneurial and Transversal Competences

Entrepreneurial and transversal competences emerge from the stakeholder material as another significant area of perceived weakness in tourism VET. Unlike narrowly defined technical or

[93] C. Innocente, L. Ulrich, S. Moos and E. Vezzetti, "A Framework Study on the Use of Immersive XR Technologies in the Cultural Heritage Domain", *Journal of Cultural Heritage*, 62 (2023), pp. 268–283

[94] OECD and United Nations Environment Programme, *Climate Change and Tourism Policy in OECD Countries*, OECD Publishing, Paris, 2011.

occupational skills, these competences concern the capacity to act effectively in situations characterised by uncertainty, interaction, change, and incomplete information. They include the ability to identify opportunities, take initiative, collaborate with others, communicate across professional and cultural boundaries, manage interpersonal situations, adapt to changing circumstances, solve problems, and translate ideas into practical action. Their significance is particularly pronounced in tourism because professional practice combines intensive human interaction with market volatility, seasonality, technological change, environmental pressures, changing visitor expectations, and frequent dependence on coordination between multiple actors.

The stakeholder evidence suggests that the principal problem is not a lack of recognition of these competences. Teachers, students, and industry representatives broadly acknowledge the importance of entrepreneurship, communication, teamwork, adaptability, initiative, and interpersonal and emotional competence. The more significant issue concerns the extent to which these capabilities are systematically developed, practised, and assessed within vocational education. This indicates a distinction between recognised importance and educational embeddedness. A competence may be widely regarded as essential while remaining only weakly represented in authentic learning tasks, workplace experience, assessment practices, or curriculum structures. The analytical question therefore concerns not only whether a competence is valued, but whether learners encounter sufficient opportunities to exercise it under conditions resembling those of professional tourism practice.

Entrepreneurial competence is particularly illustrative of this distinction. Industry respondents describe tourism as a field in which professionals increasingly need to respond to unexpected developments rather than merely implement established procedures. Market disruptions, new technologies, climate-related pressures, changes in visitor preferences, shifts in distribution channels, and emerging forms of tourism consumption require professionals capable of recognising opportunities, adapting services, mobilising available resources, and developing workable responses under uncertain conditions. Entrepreneurship should therefore be understood more broadly than the capacity or intention to establish an independent business.

A more appropriate concept in this context is entrepreneurial agency. This refers to the capacity to recognise possibilities for improvement, take initiative, mobilise resources and relationships, evaluate risks and constraints, make decisions under uncertainty, and translate ideas into action. Such agency may be exercised through conventional entrepreneurship, but it is equally relevant within existing organisations. Employees can contribute entrepreneurially through intrapreneurial activity: developing new visitor experiences, adapting services to new customer groups, identifying opportunities for resource efficiency, designing alternative routes, introducing digital solutions, or connecting tourism products with agriculture, culture, heritage, technology, gastronomy, and local production. Entrepreneurial capability is therefore relevant not only to business owners but to a much wider range of tourism occupations.

The stakeholder material suggests that this type of initiative is becoming increasingly valuable as tourism organisations operate in more dynamic and interconnected environments. The capacity to

identify and act upon opportunities also becomes closely linked with sustainability. Professionals may need to recognise opportunities to reduce resource use, create locally embedded tourism products, extend services beyond peak seasons, improve accessibility, establish partnerships with local producers, or translate environmental and cultural resources into viable forms of tourism value. Entrepreneurial agency thus intersects with sustainability judgement, digital competence, territorial knowledge, and stakeholder cooperation rather than constituting an isolated business competence.

At the same time, teacher and student accounts indicate that entrepreneurship education can remain excessively abstract. Where learning concentrates primarily on terminology, theoretical models, or the preparation of conventional business plans, students may acquire conceptual knowledge without developing confidence in entrepreneurial action. The distinction can be described as a theory–action gap. Knowing the components of a business model or understanding the formal stages of business creation is not equivalent to being able to recognise an authentic tourism problem, generate and compare possible responses, test an idea, obtain feedback, mobilise collaborators, adapt an initial solution, and make decisions when outcomes remain uncertain.

This distinction has direct implications for vocational pedagogy. Entrepreneurial competence is more likely to develop where learners are given opportunities to act rather than merely describe entrepreneurial processes. Project-based work, simulations, collaboration with tourism enterprises, mentoring, challenge-based assignments, product-development exercises, and interaction with local destination actors can create environments in which students encounter uncertainty and have to make choices with practical consequences. Learners may, for example, develop and test a sustainable tourism product, redesign an existing visitor experience, propose a response to seasonality or visitor concentration, create an accessible service concept, or work with a local enterprise to address a real operational problem. Such activities connect entrepreneurial knowledge with experimentation, reflection, and iterative improvement.

The key pedagogical transition is therefore from learning about entrepreneurship towards learning through entrepreneurial action. This does not imply replacing conceptual knowledge with unstructured activity. Effective experiential learning requires appropriate scaffolding, feedback, reflection, and opportunities to connect action with relevant concepts and evidence. The objective is to enable learners to develop not only an understanding of entrepreneurial processes but also the confidence and judgement required to act within them.

Entrepreneurial agency is closely connected with transversal competence because tourism innovation is rarely an individual activity. Opportunities must be communicated, negotiated, developed with others, and adapted to organisational and territorial constraints. Teamwork, communication, problem solving, adaptability, creativity, negotiation, and emotional competence therefore function as enabling conditions for entrepreneurial action. Their importance is particularly visible in service encounters, project teams, destination partnerships, multicultural workplaces, and situations involving conflict or rapidly changing customer expectations.

These competences should not be reduced to a generic category of “soft skills”. In tourism they often have direct operational consequences. Communication influences service quality, safety,

customer satisfaction, and coordination between employees. Adaptability affects the capacity to respond to disruptions and changing demand. Teamwork determines whether complex visitor experiences can be delivered across organisational boundaries. Negotiation and facilitation become necessary where tourism organisations interact with municipalities, communities, cultural institutions, technology providers, and environmental actors. Emotional competence can influence the management of demanding service encounters, interpersonal tension, and professional relationships. Transversal capabilities are therefore better understood as professional action competences that enable occupational and technical knowledge to be applied effectively in complex social situations.

The stakeholder evidence consequently points towards the need to integrate entrepreneurial and transversal competences rather than develop them through separate or peripheral curriculum components. Authentic entrepreneurial activity necessarily involves communication, collaboration, initiative, adaptation, and judgement, while transversal competence becomes more meaningful when exercised in relation to substantive professional problems. VET can therefore create learning environments in which students work in teams, engage with external stakeholders, respond to changing constraints, present and defend proposals, incorporate feedback, and reflect on the consequences of their decisions.

This integration also has implications for assessment. Competences such as initiative, adaptability, collaboration, and entrepreneurial judgement cannot be evaluated adequately through knowledge-based testing alone. Assessment needs to capture processes of decision-making, problem solving, teamwork, reflection, and the ability to justify choices. Project outputs, portfolios, simulations, observation, peer and external feedback, reflective assignments, and workplace-based assessment may therefore complement more conventional forms of evaluation. The purpose is not to assess personality characteristics but to examine observable professional behaviours and the quality of decisions made in relevant occupational contexts.

Taken together, the stakeholder evidence suggests that the central challenge is not whether entrepreneurial and transversal competences are recognised as important. Their importance appears to be relatively well established. The more significant issue concerns the transition from recognition to educational embeddedness and from conceptual understanding to professional action. Tourism VET therefore needs to create repeated opportunities for learners to exercise initiative, cooperate across boundaries, respond to uncertainty, test ideas, interpret feedback, and make decisions in authentic or realistically simulated professional contexts.

This progression can be conceptualised as a movement from entrepreneurial awareness towards entrepreneurial agency and, more broadly, towards adaptive professional agency. The latter extends beyond opportunity recognition to encompass the capacity to combine professional knowledge, transversal competence, sustainability judgement, and digital capability in response to changing occupational situations. From this perspective, entrepreneurial and transversal competences are not supplementary attributes added to technical tourism qualifications. They

constitute an important part of the professional capacity through which individuals are able to act, adapt, collaborate, and contribute to innovation within a transforming tourism sector[95].

Creativity, Innovation, and Tolerance of Failure

Creativity constitutes another recurring dimension of the stakeholder evidence and appears closely connected with entrepreneurial and adaptive professional capability. Respondents indicated that tourism professionals increasingly need not only to perform established tasks efficiently but also to generate ideas, redesign services, differentiate visitor experiences, and respond creatively to operational, environmental, or market-related challenges. This requirement is particularly visible in sustainable tourism, where organisations may need to reduce environmental pressures, develop products rooted in local identity, adapt existing services to new visitor expectations, or create alternatives to conventional patterns of tourism development[96].

The evidence also suggests, however, that confidence in using creativity professionally is uneven. Some learners appear relatively comfortable with digital tools while being less confident when required to use those tools to design a new service, develop an original marketing concept, or solve an unfamiliar tourism problem. This distinction is analytically important because digital proficiency does not automatically translate into innovation competence. The ability to operate a technological tool differs from the ability to select it purposefully, combine it with domain knowledge, generate alternative solutions, and evaluate whether the resulting intervention creates meaningful professional value. Innovation competence therefore depends not only on technical knowledge but also on problem framing, creativity, judgement, experimentation, and the capacity to connect ideas with practical implementation.

The stakeholder material further indicates that fear of failure, reluctance to take visible risks, and concern about negative evaluation can inhibit creative participation. This suggests that entrepreneurial and innovation competence are shaped partly by the learning environment in which they are developed. Where mistakes are interpreted primarily as evidence of inadequate performance, learners may become more inclined to reproduce familiar solutions than to experiment with alternatives. Innovation-oriented vocational education therefore needs to provide structured environments in which ideas can be tested, questioned, revised, and, where appropriate, abandoned without disproportionate penalty.

This capability can be described as productive tolerance of failure. The concept does not imply that failure should be celebrated or treated as inherently valuable. Rather, it refers to the capacity to use unsuccessful or incomplete attempts as sources of information within an iterative process of problem solving. A failed prototype, service concept, or project decision becomes educationally meaningful when learners are able to identify the assumptions that proved incorrect, distinguish

[95] R. Mazur, L. Walaszczyk, “Transversal Competencies for Future Tourism Graduates: Stakeholder Alignment and Curriculum Innovation in European VET”, *Research Square*, 2026.

[96] V.F. Motta and S.V.R. Galina, “Experiential Learning in Entrepreneurship Education: A Systematic Literature Review”, Teaching and Teacher Education, 121 (2023).

between design and implementation problems, examine the evidence generated by the attempt, and use this information to improve subsequent decisions[97].

Reflection is therefore essential to the development of creative and innovation competence. Learners should be encouraged not only to generate ideas but also to evaluate their feasibility, identify limitations, seek feedback, revise initial assumptions, and explain why particular solutions were retained, modified, or rejected. This moves creativity away from an understanding based primarily on spontaneous idea generation and towards a more disciplined form of iterative professional problem solving.

For tourism VET, the pedagogical implication is that creativity should be developed through repeated cycles of problem identification, ideation, experimentation, feedback, revision, and reflection. Authentic or realistically simulated tourism challenges are particularly suitable for this purpose because they require learners to balance customer expectations, business viability, sustainability objectives, technological possibilities, and territorial constraints. Project work, prototyping, design challenges, simulations, collaborative assignments, and employer-supported innovation tasks can provide opportunities for learners to develop ideas while also confronting the practical consequences of their choices[98].

Creativity and innovation should therefore not be treated as isolated personal attributes or as competencies possessed only by particularly entrepreneurial individuals. They are professional capabilities that can be strengthened through appropriate learning design, repeated practice, constructive feedback, and opportunities to work with uncertainty. In this sense, the relevant progression is from idea generation to iterative innovation competence: the capacity to formulate possibilities, test them critically, learn from imperfect outcomes, and progressively improve solutions in response to evidence and feedback.

Communication, Teamwork, and Service Interaction

Communication and teamwork emerge from the stakeholder material as fundamental components of professional competence in tourism. Although they are frequently classified as “soft skills”, such terminology can obscure their operational significance and professional complexity. In tourism, communication is not merely a personal disposition or interpersonal preference. It is a functional competence that directly influences service quality, customer satisfaction, conflict management, service recovery, sales, safety, teamwork, and coordination within and between organisations.

Effective communication in tourism requires more than the ability to transmit information clearly. Professionals must often interpret incomplete or emotionally charged messages, adjust communication to different audiences, respond to complaints, manage expectations, explain

[97] R. Vuorikari, S. Kluzer and Y. Punie, DigComp 2.2: The Digital Competence Framework for Citizens, Publications Office of the European Union, Luxembourg, 2022.

[98] M. Bacigalupo, P. Kampylis, Y. Punie and G. Van den Brande, EntreComp: The Entrepreneurship Competence Framework, Publications Office of the European Union, Luxembourg, 2016.

constraints, and maintain service quality under pressure. In many situations, communication also has a cross-cultural dimension, as employees interact with visitors, colleagues, and partners who may differ in language, cultural norms, communication styles, and expectations. Professional communication therefore combines linguistic, interpersonal, contextual, and situational judgement.

Teamwork should similarly be understood as more than willingness to cooperate. Tourism services are frequently produced collectively and depend on coordination across functions, shifts, departments, and sometimes separate organisations. Effective teamwork requires timely information exchange, role clarity, mutual trust, responsiveness, and the ability to adjust one's actions when operational conditions change. It also involves recognising interdependence: the quality of an individual employee's performance may depend on information, decisions, or actions provided by others. Teamwork is therefore an organisational competence as well as an interpersonal one.

The stakeholder evidence suggests that industry representatives place particular value on these capabilities. Respondents indicated that some technical procedures can be acquired relatively quickly after entry into employment, whereas deficiencies in communication, initiative, interpersonal maturity, or the ability to cooperate effectively may be more difficult to address. Student accounts likewise suggest limited confidence in situations involving complaints, stress, interpersonal tension, or multicultural teamwork. These findings point to a recurring gap between conceptual knowledge of communication and the ability to apply it in demanding service situations.

This distinction reveals another dimension of the theory–practice gap identified throughout the stakeholder material. Classroom-based instruction can introduce principles of customer service, teamwork, intercultural communication, or conflict management, but it does not necessarily reproduce the emotional, relational, and temporal pressures characteristic of real tourism work. The competence challenge therefore lies not only in knowing appropriate communication strategies but in being able to select and apply them when information is incomplete, emotions are heightened, expectations conflict, or decisions must be made rapidly.

Transversal competence development consequently requires exposure to situations involving ambiguity, disagreement, time pressure, competing expectations, and emotional demands. Role play, scenario-based exercises, simulation, workplace placements, customer-service cases, and structured reflective debriefing can provide opportunities to practise communication and teamwork under conditions that more closely resemble professional reality. Such methods are particularly valuable when learners are required not only to perform a task but also to reflect on how communication influenced the outcome, which assumptions shaped their response, and how alternative strategies might have changed the interaction.

The educational objective should therefore extend beyond behavioural rehearsal towards situational professional judgement. Learners need to develop the capacity to recognise the interpersonal characteristics of a situation, select an appropriate response, adjust communication as circumstances change, and evaluate the consequences of their actions for customers, colleagues, and the organisation. This is particularly important in service recovery, where effective performance may

require simultaneous attention to customer emotion, organisational procedures, fairness, operational feasibility, and reputational consequences.

Communication and teamwork also intersect with other competence domains identified in the analysis. Sustainability initiatives require stakeholder communication and negotiation; digital transformation requires collaboration between tourism professionals and technology specialists; accessible tourism depends on sensitivity to diverse communication needs; and entrepreneurial activity requires the ability to present ideas, mobilise partners, obtain feedback, and coordinate collective action. Their significance therefore extends well beyond customer-facing interaction.

The stakeholder evidence supports treating communication, teamwork, and service interaction as core professional action competences rather than supplementary "soft skills". Their value lies in enabling technical, digital, environmental, and entrepreneurial knowledge to be applied effectively in socially complex situations. From a VET perspective, this implies that such competences should be developed repeatedly across the curriculum and assessed through authentic or realistically simulated performance rather than confined to isolated theoretical instruction.

Intercultural Competence

Communication in tourism is inherently intercultural because professional interactions frequently involve people whose linguistic repertoires, expectations, social norms, communication conventions, and understandings of service differ. Foreign-language proficiency therefore remains an important component of tourism professionalism, but the stakeholder material suggests that linguistic competence alone is insufficient. Effective interaction also requires the ability to recognise and interpret differences in communication style, expectations, behaviour, and social convention without assuming that individuals can be understood solely through national or cultural categories.

Intercultural competence should consequently be understood as a form of context-sensitive professional judgement. It includes curiosity, openness, respect, adaptability, perspective taking, and the capacity to interpret behaviour in relation to both cultural and situational context. It also requires professionals to recognise the limits of their own assumptions and to remain attentive to individual variation. The objective is not to acquire a fixed catalogue of behavioural characteristics associated with particular nationalities or cultural groups, but to develop the ability to respond appropriately when expectations, meanings, or communication conventions are unfamiliar or ambiguous.

The stakeholder material suggests that tourism learners may receive foreign-language education without equivalent opportunities to develop competence in intercultural interaction. This creates a potentially important gap because misunderstandings in tourism do not necessarily arise from insufficient vocabulary or grammatical knowledge. They may result from differences in expectations concerning politeness, personal distance, time, complaint behaviour, service responsiveness, hierarchy, or appropriate forms of interpersonal engagement. The professional challenge therefore lies in recognising that communication difficulties may have multiple causes and in avoiding premature interpretation through stereotypical cultural explanations.

For tourism VET, intercultural learning should therefore be embedded in professional situations rather than confined to descriptive knowledge about cultural differences. Learners need opportunities to work with scenarios involving ambiguous communication, differing service expectations, multicultural teams, conflict, ethical dilemmas, and situations in which the meaning of behaviour is not immediately clear. Role play, simulation, case analysis, international project work, workplace learning, and reflective discussion can help learners examine how their own assumptions influence interpretation and how alternative responses may affect the interaction.

The educational objective can be described as the development of adaptive communication. This involves the ability to observe, interpret, adjust, and communicate effectively in response to individual and contextual differences while maintaining professional standards and respect for the person involved. Adaptive communication differs fundamentally from the memorisation of national stereotypes because it treats cultural knowledge as a resource for inquiry rather than as a deterministic explanation of behaviour[99].

This distinction is particularly important in tourism, where simplified assumptions about cultural groups can negatively affect service quality, inclusion, and professional judgement. Intercultural competence should therefore strengthen responsiveness to diversity while simultaneously increasing awareness of within-group variation, individual preferences, situational factors, and the risk of stereotyping. In this sense, intercultural competence is closely connected with communication, ethical judgement, inclusion, emotional competence, and adaptability, and should be treated as an integral component of contemporary tourism professionalism rather than as an optional extension of foreign-language education[100].

Emotional Regulation and Occupational Resilience

Emotional competence emerges from the stakeholder material as another area requiring greater attention in tourism VET. Tourism work frequently involves complaints, service failures, unexpected disruptions, high visitor expectations, time pressure, safety-related incidents, interpersonal conflict, and other emotionally demanding situations. Employees are often expected to maintain professional standards while simultaneously managing their own emotional responses and responding appropriately to the emotions of customers, colleagues, and other stakeholders.

The competence involved should therefore be understood as more than personal well-being or an individual capacity to “cope with stress”. It includes self-awareness, emotional regulation, empathy, de-escalation, situational judgement, and the ability to maintain appropriate professional behaviour under pressure. In this sense, the concept of occupational emotional resilience is useful because it links emotional competence directly with professional performance. Its relevance lies in

[99] D.K. Deardorff, “Identification and Assessment of Intercultural Competence as a Student Outcome of Internationalization”, Journal of Studies in International Education, 10(3) (2006), pp. 241–266.

[100] Y.Y. Liu, J. Liu and B.E.M. King, “Intercultural Communicative Competence: Hospitality Industry and Education Perspectives”, Journal of Hospitality, Leisure, Sport & Tourism Education, 30 (2022).

enabling workers to preserve judgement, communication quality, service standards, and interpersonal effectiveness in demanding or rapidly changing situations.

This form of resilience is particularly important in tourism because emotional demands are often embedded in the service relationship itself. Employees may need to respond to dissatisfaction while maintaining organisational procedures, manage conflict without escalating it, communicate during disruption or uncertainty, and balance empathy with operational constraints. Emotional competence therefore becomes closely connected with communication, service recovery, teamwork, safety, and customer experience rather than remaining a purely personal or psychological attribute.

At the same time, resilience should not be individualised in ways that obscure organisational responsibility. Employee coping capacity cannot compensate indefinitely for inadequate staffing, excessive workloads, unsafe working conditions, insufficient managerial support, unclear procedures, or dysfunctional organisational cultures. Training workers to regulate stress is valuable, but it should not become a substitute for addressing structural causes of occupational strain. Occupational emotional resilience should therefore be understood as a shared individual–organisational capability: employees require competences that enable them to function effectively under pressure, while organisations remain responsible for creating conditions in which such demands remain manageable.

This distinction has important implications for vocational education. VET can prepare learners for emotionally demanding situations by helping them recognise stress responses, understand emotional triggers, practise de-escalation, manage difficult interactions, and reflect on the consequences of different responses. However, such preparation should also develop learners' ability to recognise when a situation reflects an organisational or safety problem rather than an individual failure to cope. Emotional competence therefore includes not only self-regulation but also professional judgement concerning boundaries, escalation procedures, support-seeking, and appropriate organisational responses.

Simulation, role play, scenario-based learning, and supervised workplace experience are particularly relevant because they situate emotional competence within authentic professional contexts. Learners can practise responding to complaints, service failures, unexpected operational disruption, interpersonal conflict, or safety-related situations while receiving structured feedback on both communication and decision-making. Reflective debriefing is especially important because it enables learners to examine how emotional responses influenced their behaviour, how alternative responses might have changed the outcome, and which organisational conditions shaped the situation[101].

The educational objective should therefore be broader than stress management alone. Tourism VET should support the development of emotionally informed professional judgement: the capacity to recognise emotional dynamics, regulate one's own responses, respond appropriately to others,

[101] C.M. Brotheridge and A.A. Grandey, "Emotional Labor and Burnout: Comparing Two Perspectives of 'People Work'", Journal of Vocational Behavior, 60(1) (2002), pp. 17–39.

maintain professional standards, and identify when organisational intervention is required. In this sense, occupational emotional resilience forms part of the wider architecture of adaptive professional capability, linking communication, self-regulation, ethical judgement, teamwork, and the capacity to act effectively under pressure [102].

Leadership and Collaborative Responsibility

Leadership emerges from the stakeholder material as an important competence for sustainable and digitally transforming tourism organisations. Its relevance should not, however, be restricted to employees occupying formal managerial positions. Many VET graduates enter small or medium-sized organisations in which responsibilities are distributed relatively informally, role boundaries are flexible, and progression into supervisory or coordinating functions may occur early in a professional career. Leadership competence should therefore be understood more broadly as the capacity to assume responsibility for collective action, coordinate tasks, support colleagues, contribute to decision-making, manage disagreement, and remain accountable for shared outcomes.

This broader interpretation is particularly relevant in tourism because service delivery is frequently organised through teams whose effectiveness depends on coordination rather than formal hierarchy alone. Employees may need to organise workflow, communicate priorities, respond to operational disruption, support less experienced colleagues, or take responsibility for a particular task or project without holding a permanent managerial title. Leadership in this sense is closely connected with teamwork, communication, initiative, judgement, and the capacity to act responsibly in situations where authority is distributed.

Sustainable and digital transformation adds a further dimension to this competence. Organisational change often requires established routines to be questioned and new practices to be introduced into everyday work. Employees and managers may need to explain new procedures, demonstrate their practical relevance, coordinate implementation, respond to uncertainty, address resistance, and communicate changes to colleagues or customers. Leadership therefore becomes part of change competence: the capacity to translate organisational objectives into collective action and to support others through processes of adaptation.

This requirement is especially significant in tourism SMEs, where dedicated sustainability, innovation, or digital-transformation departments may not exist. New practices may depend on individuals who combine responsibility for transformation with their existing occupational roles. An employee may, for example, coordinate a new environmental procedure, introduce a digital booking or monitoring tool, support colleagues in using unfamiliar technology, or act as the internal contact person for a certification process. Such activity requires not only technical knowledge but also the ability to mobilise cooperation and maintain continuity during implementation[103].

[102] A.A. Grandey, “Emotion Regulation in the Workplace: A New Way to Conceptualize Emotional Labor”, Journal of Occupational Health Psychology, 5(1) (2000), pp. 95–110.

[103] M. Bacigalupo, P. Kampylis, Y. Punie and G. Van den Brande, EntreComp: The Entrepreneurship Competence Framework, Publications Office of the European Union, Luxembourg, 2016.

Leadership in this context is therefore better understood as collaborative responsibility rather than as individual authority. The relevant professional capability lies in coordinating action while remaining responsive to the knowledge, experience, and concerns of others. This includes listening, negotiating, clarifying responsibilities, recognising when specialist expertise is required, and creating conditions in which team members can contribute to implementation. It also requires awareness of the limits of one's own authority and the ability to distinguish between issues that can be resolved within a team and those requiring managerial or institutional intervention[104].

From a VET perspective, these capabilities are unlikely to develop through theoretical instruction alone. Project-based learning, simulations, team assignments, workplace-based tasks, and rotating leadership roles can create opportunities for learners to experience both leading and being led. Such activities can expose students to decision-making, delegation, disagreement, accountability, and the practical consequences of coordination choices. Their educational value increases when they are accompanied by structured reflection on how responsibility was distributed, how decisions were communicated, how conflict was handled, and how leadership affected the performance of the group.

The competence objective should therefore not be to prepare every learner for immediate formal management, but to develop the capacity for responsible participation in collective action. In this sense, leadership competence forms part of a wider architecture of adaptive professional capability. It enables individuals to contribute to organisational change, support cooperation, assume responsibility when required, and help translate sustainability and digital-transformation objectives into everyday professional practice.

The VET–Market Alignment Gap

The stakeholder evidence suggests that entrepreneurial and transversal competences are widely recognised as important for tourism employment but remain insufficiently embedded in vocational education and training. The resulting VET–market alignment gap should not be understood solely as a problem of missing curriculum content. It also concerns the ways in which competences are developed, practised, and assessed within educational settings.

Part of the problem is curricular. Entrepreneurship may be treated as a discrete subject rather than as a transversal mode of learning that encourages initiative, opportunity recognition, experimentation, and responsibility across different areas of tourism education. Communication, teamwork, adaptability, or interpersonal competence may similarly be assumed to emerge automatically through participation in group activities or workplace learning. The stakeholder evidence suggests that such assumptions are insufficient. Competences such as initiative, creativity, conflict management, intercultural communication, emotional regulation, and collaborative decision-

[104] R.T. By and C. Dale, "The Successful Management of Organisational Change in Tourism SMEs: Initial Findings in UK Visitor Attractions", International Journal of Tourism Research, 10(4) (2008), pp. 305–313.

making require deliberate learning opportunities and repeated application in situations that approximate the complexity of professional practice[105].

The challenge is therefore not simply to include these competences in curriculum documents, but to create learning environments in which learners are required to exercise them. A curriculum may formally recognise teamwork, entrepreneurship, or communication while providing few opportunities for students to make decisions, negotiate roles, respond to disagreement, manage uncertainty, or reflect on the consequences of their actions. In such circumstances, the formal presence of a competence does not necessarily translate into its effective development. The relevant distinction is therefore between curricular recognition and pedagogical enactment[106].

This issue is particularly important because transversal competences are highly contextual. Technical competence can often be assessed through relatively observable procedures, outputs, or performance criteria. Communication, adaptability, leadership, emotional regulation, or collaborative competence are more dependent on the characteristics of the situation in which they are exercised. A learner may communicate effectively in a routine interaction but perform less effectively under time pressure, during conflict, or when confronted with cultural ambiguity. Similarly, teamwork competence cannot be inferred solely from participation in a group assignment if individual contributions, coordination processes, decision-making, and responsibility remain invisible.

Assessment therefore needs to capture competence in action rather than rely exclusively on declarative knowledge or self-report. Observation of performance, structured reflection, peer feedback, teacher judgement, workplace assessment, simulations, role play, project work, and authentic or realistically designed professional tasks can provide complementary evidence of how learners apply transversal competences in context. No single assessment method is likely to capture the full complexity of these capabilities. A more defensible approach is to combine multiple forms of evidence and to assess not only outcomes but also processes of communication, decision-making, collaboration, adaptation, and reflection.

This creates a methodological challenge for tourism VET because assessment needs to remain sufficiently structured to support fairness and transparency while also recognising that professional performance varies across situations. Clear behavioural indicators, explicit assessment criteria, structured observation protocols, reflective assignments, and repeated assessment across different contexts can help address this tension. The objective is not to transform complex interpersonal capabilities into simplistic numerical scores, but to make expectations visible and provide learners with meaningful feedback on how their professional behaviour develops over time.

[105] OECD, Building Future-Ready Vocational Education and Training Systems, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris, 2023.

[106] Cedefop, Teachers and Trainers in a Changing World: Building up Competences for Inclusive, Green and Digitalised Vocational Education and Training, Publications Office of the European Union, Luxembourg, 2025.

The gap between labour-market expectations and VET provision should therefore be interpreted as simultaneously curricular, pedagogical, and evaluative. Employers may recognise the importance of initiative, communication, adaptability, teamwork, and emotional competence, while VET institutions may formally acknowledge these same areas, yet learners may still graduate with limited opportunities to practise or demonstrate them in demanding professional contexts. The problem is thus not necessarily a lack of consensus regarding what matters, but an insufficient translation of recognised competence requirements into learning design and assessment practice[107].

From this perspective, stronger alignment between VET and the tourism labour market requires more than periodic curriculum revision. It requires the development of pedagogical and assessment architectures that enable entrepreneurial and transversal competences to be practised repeatedly, observed in context, reflected upon, and progressively refined. The VET–market alignment gap can therefore be understood not only as a curriculum gap, but also as a pedagogical and assessment gap between the competences recognised as important and the educational conditions through which those competences are actually developed and demonstrated[108].

Experiential Learning as the Principal Development Mechanism

Experiential learning emerges from the stakeholder material as an important mechanism for developing entrepreneurial and transversal competences. Role play, simulation, project work, interdisciplinary challenges, internships, mentoring, and service-learning create opportunities for learners to make decisions, cooperate with others, respond to uncertainty, receive feedback, and reflect on the consequences of their actions. Their value lies in reproducing dimensions of professional practice that cannot be fully developed through declarative instruction alone.

A useful pedagogical sequence can be described as experience - decision - feedback - reflection - adaptation. This cycle is particularly relevant to competences such as communication, teamwork, initiative, creativity, leadership, and problem solving, where effective performance depends on judgement and contextual application rather than memorisation. Business and collaborative projects can support entrepreneurial initiative and teamwork, interdisciplinary challenges can connect tourism with environmental, technological, cultural, or marketing perspectives, while service-learning can link professional action with community needs.

Work-based learning is especially important because it situates competence development within authentic organisational environments. However, workplace exposure alone does not guarantee learning. Internships dominated by routine tasks may provide experience without substantially developing initiative, creativity, or reflective capability. Effective work-based learning therefore requires clear learning objectives, mentoring, feedback, structured reflection, and opportunities for learners to assume progressively greater responsibility.

[107] OECD, PISA Vocational Education and Training (VET): Assessment and Analytical Framework, OECD Publishing, Paris, 2024.

[108] D.A. Kolb, Experiential Learning: Experience as the Source of Learning and Development, Prentice-Hall, Englewood Cliffs, 1984.

The key distinction is thus between exposure and structured experience. Experiential learning becomes educationally meaningful when learners are required to act, evaluate outcomes, revise assumptions, and apply what they have learned in subsequent situations. Its principal contribution to tourism VET lies in converting experience into increasingly adaptive professional capability.

Teacher Competence as an Enabling Condition

Teacher competence emerges from the stakeholder material as an important enabling condition for the development of entrepreneurial and transversal competences. Educators require more than subject-specific knowledge. They also need the pedagogical capacity to design and facilitate experiential learning, manage group dynamics, supervise collaborative projects, provide constructive feedback, support reflection, and assess competences that cannot be reduced to simple right-or-wrong answers.

This creates a distinct teacher-development requirement. If tourism VET is expected to strengthen learners' initiative, collaboration, adaptability, emotional competence, and entrepreneurial agency, educators need methods capable of creating learning situations in which these capabilities can be practised and evaluated. Teacher competence therefore becomes part of the implementation architecture of transversal learning rather than a separate professional-development issue.

Relevant professional development may include facilitation, simulation design, project- and challenge-based learning, reflective practice, assessment of transversal competences, mentoring, and cooperation with employers and other external partners. These capabilities are particularly important where learning depends on authentic problems, interdisciplinary projects, or workplace-based experience.

The stakeholder evidence therefore reinforces a broader conclusion: competence gaps cannot be addressed solely through curriculum revision. The effectiveness of new curriculum objectives depends on whether educators possess the pedagogical and organisational capacity to translate them into meaningful learning experiences. Strengthening tourism VET consequently requires parallel development of curriculum content, teacher competence, assessment practices, and institutional support[109].

From Soft Skills to Transversal Professional Competence

The stakeholder material supports reconsideration of the conventional distinction between technical competence and "soft skills". Communication, teamwork, adaptability, intercultural competence, emotional regulation, creativity, and leadership are not secondary attributes in tourism work. They directly influence how effectively technical knowledge is applied in professional situations.

[109] V. Symeonidis, A. Pouliou and C.J. Lees, The Multifaceted Role of Learning Outcomes across the Continuum of Teacher Education: An Approach to Empower VET Teachers and Trainers, Cedefop Working Paper, Publications Office of the European Union, Luxembourg, 2025.

For this reason, it is more analytically useful to describe them as transversal professional competences. The term emphasises that these capabilities operate across occupational tasks and professional contexts and become particularly important where work requires interaction, judgement, adaptation, or coordination.

These competences also intersect closely with green, digital, and entrepreneurial domains. A sustainable tourism initiative may require stakeholder negotiation and collaborative decision-making; a digital service may depend on empathy and user-oriented communication; an XR experience may require intercultural sensitivity and narrative competence; and a green business model may require creativity, risk assessment, teamwork, and communication.

The competence domains should therefore not be treated as separate categories that operate independently. In professional practice, they combine into hybrid competence configurations, in which transversal competences enable technical, digital, environmental, and entrepreneurial knowledge to be translated into effective professional action[110].

The terminology adopted here reflects the increasing use of transversal skills and competences in European skills and vocational-education frameworks rather than the less precise category of "soft skills". ESCO defines transversal knowledge, skills and competences as capabilities relevant across a broad range of occupations and economic sectors and notes that they are frequently referred to as core, basic or soft skills; importantly, it also treats them as building blocks for the development and effective application of more occupation-specific competences. Cedefop similarly emphasises that transversal and key competences are integral to vocational education, employment, adaptation to changing work contexts and lifelong learning rather than supplementary to occupational expertise. LifeComp further conceptualises communication, collaboration, flexibility, self-regulation and related personal and social capabilities as competences applicable across different spheres of activity. Tourism-specific skills intelligence likewise distinguishes interconnected digital, green and social competence requirements, indicating that contemporary tourism performance increasingly depends on combinations of technical and transversal capabilities. The term transversal professional competences is therefore used in the present study to emphasise their direct relevance to occupational performance, while hybrid competence configurations is an analytical concept developed here to describe the way transversal, technical, digital, environmental and entrepreneurial competences combine in professional practice[111].

From Employability to Adaptive Professional Agency

The empirical evidence suggests that entrepreneurial and transversal competences should not be valued solely because they enhance immediate employability. Their broader significance lies in enabling professionals to act effectively in changing and uncertain tourism environments. The central

[110] A. Sala, Y. Punie, V. Garkov and M. Cabrera Giraldez, LifeComp: The European Framework for Personal, Social and Learning to Learn Key Competence, Publications Office of the European Union, Luxembourg, 2020.

[111] European Commission, ESCO, Towards a Structured and Consistent Terminology on Transversal Skills and Competences, Publications Office of the European Union, 2022; Cedefop, Key Competences in Initial Vocational Education and Training: Digital, Multilingual and Literacy, Cedefop Research Paper No. 78, Publications Office of the European Union, Luxembourg, 2021.

capability can be described as adaptive professional agency. It involves the capacity to recognise change, interpret what a situation requires, mobilise relevant knowledge and relationships, take initiative, communicate and coordinate with others, and adjust action in response to feedback. It therefore connects entrepreneurial agency with transversal professional competence and provides an integrative explanation for why creativity, communication, intercultural competence, emotional regulation, teamwork, adaptability, and leadership repeatedly appear together in the stakeholder material.

These competences are not interchangeable, but they contribute to a shared professional capacity: the ability to act responsibly and effectively in situations that cannot be fully anticipated in advance. Adaptive professional agency therefore depends not only on possessing knowledge or discrete skills, but on selecting, combining, and applying them appropriately in changing contexts.

This has important implications for VET. Entrepreneurial and transversal competences should not be added to curricula as supplementary topics. They need to be embedded in the organisation of learning itself. Learners require opportunities to make decisions, collaborate, encounter uncertainty, assume responsibility, respond to consequences, and reflect on their performance.

The required transition is therefore from preparing learners primarily to reproduce existing occupational practices towards enabling them to participate actively in how tourism organisations adapt, innovate, and change. In this sense, the objective of VET is not only employability, but the development of professionals capable of exercising adaptive professional agency throughout changing occupational contexts.

3.3.3 Digital and XR-Related Competences

Digital and XR-related competences constitute the third major area emerging from the stakeholder evidence. The material reveals a clear distinction between everyday familiarity with digital technologies and the professional digital competence required in tourism. Learners may use social media, mobile applications, and online communication confidently while remaining unfamiliar with the systems, data environments, and digital workflows through which tourism organisations operate. This challenges the assumption that younger learners are automatically prepared for digitally transformed workplaces.

The resulting competence challenge is therefore not primarily one of technological access, but of professional digital relevance. Industry representatives distinguished between general ICT competence and familiarity with tourism-specific systems such as Property Management Systems, Customer Relationship Management platforms, booking and channel-management systems, and other operational technologies. The stakeholder material suggests that learners do not always encounter such environments during formal VET education and may acquire their first practical experience only during internships or employment. This creates a digital relevance gap between general technological confidence and readiness to work within sector-specific digital environments.

The educational response should not, however, consist in organising curricula around particular commercial software products. Rapid technological change would quickly make such an approach

obsolete. A more durable objective is the development of sector-specific digital fluency: the ability to understand the functions performed by tourism technologies, the information they process, and the relationships between digital systems and operational processes. Learners should understand concepts such as reservation management, customer data, inventory, channel distribution, pricing, customer relationship management, and digital service workflows.

Practical exposure to real or simulated systems remains important, but software navigation should be treated as a means rather than the final competence objective. Learners need to understand not only how to operate a particular interface, but what the system does within the organisation and why. This functional understanding strengthens technological adaptability because competence can be transferred when platforms, interfaces, or employers change.

The transition required is therefore from generic digital literacy to sector-specific digital fluency. A learner trained only to reproduce procedures in one system may struggle when confronted with a different platform, whereas a learner who understands the underlying operational logic is better positioned to transfer knowledge across technologies and adapt to continuing digital change[112].

Data Literacy and Evidence-Informed Decision-Making

A recurring competence requirement concerns the ability to work meaningfully with data. Tourism organisations increasingly use information on customer behaviour, demand, bookings, prices, visitor flows, resource consumption, and market trends to support operational and strategic decisions. The stakeholder material suggests, however, that such capabilities are not yet systematically embedded across tourism VET.

The relevant competence should not be equated with advanced data science. Most tourism professionals do not need to become programmers or statisticians, but they increasingly need to interpret information, recognise patterns, assess data quality and credibility, and use evidence to justify professional decisions. This capability can be described as applied tourism data literacy.

Its relevance extends across occupational roles. Accommodation staff may work with occupancy and customer data, destination professionals with visitor-flow information, marketing staff with digital engagement indicators, and sustainability specialists with resource-use data. Data literacy therefore functions as a transversal professional competence rather than as a narrowly technical specialisation.

For VET, data learning should be connected with authentic tourism problems. Learners can analyse seasonal demand, visitor flows, customer behaviour, environmental indicators, or simple operational datasets and use the results to justify proposed actions. The underlying competence progression can be expressed as data → interpretation → judgement → action. This also demonstrates the increasing convergence of digital and green competences, as sustainability decisions increasingly depend on the interpretation of digitally generated evidence. The

[112] P.A. Kirschner and P. De Bruyckere, “The Myths of the Digital Native and the Multitasker”, Teaching and Teacher Education, 67 (2017), pp. 135–142.

interpretation of data literacy adopted here is consistent with frameworks that treat digital competence as involving not only access to information but also the ability to identify, evaluate, interpret and manage data in relation to practical purposes. DigComp 2.2 includes information and data literacy as a core dimension of digital competence and emphasises the critical evaluation of data, information and digital content. In tourism, digitalisation increasingly generates occupational requirements related to tourism data analysis, customer information, demand patterns, digital marketing, business-process optimisation and other forms of data-supported decision-making. OECD analysis distinguishes between specialist data-science functions and the broader digital capabilities required across the tourism workforce, supporting the view that most tourism professionals do not need advanced statistical or programming expertise but increasingly require the capacity to interpret and apply digitally generated information within occupational contexts. The term applied tourism data literacy is used here analytically to describe this sector-specific capacity to move from data through interpretation and professional judgement to action[113].

Artificial Intelligence and Critical Digital Literacy

Artificial intelligence introduces an additional layer of digital competence. Stakeholders referred to applications such as chatbots, recommendation systems, content generation, personalisation, and demand forecasting. The educational objective should not, however, be limited to learning how to operate particular AI tools, since rapid technological change makes tool-specific knowledge inherently temporary.

A more durable requirement is critical digital literacy: the capacity to understand where AI can support professional activity, evaluate the quality of its outputs, and recognise the ethical, environmental, and organisational consequences of its use. Learners need to understand that AI-generated content and recommendations are not automatically accurate, neutral, contextually appropriate, or sustainable. Relevant concerns include reliability, bias, privacy, transparency, data quality, inappropriate automation, and the homogenisation of tourism content.

These issues are particularly important in tourism because professional value frequently depends on local specificity, cultural interpretation, interpersonal communication, and trust. Uncritical use of generative technologies may produce inaccurate or standardised representations of destinations and weaken contextual quality. AI competence therefore requires not only operational proficiency but also professional judgement concerning when, how, and to what extent automated systems should be used.

Critical digital literacy should also include awareness of the environmental costs of digitalisation. AI and other digital technologies depend on energy, computing infrastructure, data processing, and hardware. Digital transformation should therefore not be assumed to be inherently sustainable. The

[113] R. Vuorikari, S. Kluzer and Y. Punie, DigComp 2.2: The Digital Competence Framework for Citizens – With New Examples of Knowledge, Skills and Attitudes, Publications Office of the European Union, Luxembourg, 2022; OECD; Preparing the Tourism Workforce for the Digital Future, OECD Tourism Papers, No. 2021/02, OECD Publishing, Paris, 2021.

relevant competence lies in evaluating technological choices in relation to their professional purpose, reliability, ethical implications, and environmental consequences.

The competence required for professional use of artificial intelligence extends beyond operational familiarity with individual tools. DigComp 2.2 emphasises confident, critical and safe engagement with digital technologies, including AI, while UNESCO's AI competency framework stresses critical judgement, ethical responsibility and understanding of AI systems rather than unreflective tool use. Tourism-specific research similarly identifies both opportunities and risks associated with generative AI, including productivity and personalisation alongside concerns about reliability, privacy, cybersecurity, overreliance and the loss of human or contextual dimensions of tourism services. Recent empirical research additionally demonstrates that generative AI can reproduce highly homogenised representations of destinations and reinforce destination stereotypes, strengthening the case for critical evaluation of AI-generated tourism content. The environmental dimension is also relevant: AI systems depend on energy-intensive computing and data-centre infrastructure, meaning that digitalisation should not be assumed to be environmentally neutral or inherently sustainable. Critical digital literacy is therefore understood here as the capacity to evaluate the reliability, appropriateness, ethical implications, contextual quality and environmental consequences of AI-supported professional action[114].

Digital and Immersive Competences for Adaptive Tourism Practice

XR represents a more specialised dimension of digital competence emerging from the stakeholder material. Respondents identified applications of Virtual, Augmented, and Mixed Reality in vocational education, tourism services, cultural heritage, accessibility, destination communication, and professional training. From a VET perspective, its particular significance lies in the possibility of creating simulated or mediated environments in which learners can practise professional situations that may be difficult, costly, or risky to reproduce in real settings.

Simulation can support the development of customer-service, communication, decision-making, emergency-response, and other professional competences by allowing learners to experiment without exposing real customers or organisations to inexperienced performance. Its educational value, however, does not result from immersion itself. It depends on scenario design, feedback, reflection, educator facilitation, and alignment with learning outcomes. XR should therefore be understood as a pedagogical environment rather than merely instructional hardware. The relevant professional competence includes not only the ability to operate immersive technologies, but also the judgement required to determine when simulation adds educational value and how it should complement workplace learning[115].

[114] R. Vuorikari, S. Kluzer and Y. Punie, DigComp 2.2: The Digital Competence Framework for Citizens, Publications Office of the European Union, Luxembourg, 2022; F. Miao, K. Shiohira and N. Lao, AI Competency Framework for Students, UNESCO, Paris, 2024.

[115] M. Conrad, D. Kablitz and S. Schumann, "Learning Effectiveness of Immersive Virtual Reality in Education and Training", Computers & Education: X Reality, 4 (2024).

A second competence area concerns heritage interpretation. Virtual reconstruction, 3D documentation, digital tours, and immersive experiences can support access to and interpretation of cultural assets. The stakeholder examples should be treated as illustrations provided by respondents rather than independently evaluated cases, but they nevertheless reveal an important competence requirement. Tourism professionals do not necessarily need specialist expertise in photogrammetry or XR development; they do, however, require sufficient digital and heritage literacy to collaborate with technical and cultural specialists, assess the appropriateness of digital representations, and recognise the interpretative responsibilities involved. Because virtual reconstruction necessarily involves selection and interpretation, critical XR competence should include awareness of authenticity, uncertainty, cultural sensitivity, and the distinction between documented evidence and reconstructed content.

Accessibility provides a third dimension. Immersive technologies can offer alternative access, virtual previews, or mediated experiences for users who encounter physical barriers, but technological access should not automatically be equated with inclusion. Digital interfaces may themselves create barriers for users with sensory, cognitive, physical, linguistic, or digital-access needs. The relevant competence is therefore inclusive digital design: the ability to consider accessibility, alternative formats, device and connectivity requirements, and different user needs from the beginning of the design process rather than as a later adjustment.

XR also intersects with tourism marketing and destination communication. Immersive previews and virtual experiences may support visitor decision-making and engagement, but their effective use requires more than technical production. Professionals need competence in storytelling, audience understanding, authenticity, brand coherence, user experience, and the relationship between digital representations and actual destination conditions. Immersive-media literacy therefore includes the ability to judge whether an application creates meaningful visitor or organisational value rather than merely technological novelty.

These competence requirements are accompanied by significant implementation barriers. Stakeholders identified equipment and content costs, infrastructure and maintenance requirements, limited educator readiness, technical-support needs, and concerns about the displacement of interpersonal interaction. Such barriers demonstrate that access to technology and the capacity to use it meaningfully are distinct issues. Tourism remains strongly dependent on human interaction, trust, empathy, and interpretation, so digital competence must include judgement about when technology should augment rather than replace human interaction.

The most important distinction is therefore between technological adoption and purposeful integration. XR introduced primarily because it appears innovative may remain pedagogically or professionally superficial. This can be described as a technology–purpose gap: a situation in which technological capability exists without sufficient alignment with user needs, learning objectives, organisational problems, or tourism outcomes. Meaningful XR integration consequently requires not only technical proficiency but also critical, pedagogical, inclusive, and contextual judgement. These capacities form part of a broader model of responsible technology adoption in which the value of

immersive technology is determined by what it enables professionals and learners to achieve, rather than by the sophistication of the technology itself[116].

Teacher Digital Competence as a Systemic Condition

Teacher readiness emerges from the stakeholder material as a critical enabling condition for the digital transformation of VET. The effective integration of emerging technologies requires educators not only to understand their basic functionality but also to translate technological possibilities into pedagogically meaningful learning activities. The relevant competence therefore differs from the specialist expertise expected of software developers or technical professionals. It involves the capacity to evaluate digital tools, design learning scenarios, facilitate technology-enhanced learning, assess student performance, address accessibility requirements, and align digital activities with occupational learning outcomes.

Teacher digital competence also requires sufficient confidence and professional autonomy to experiment with unfamiliar technologies and critically evaluate their educational value. Professional development should therefore combine technological familiarity with pedagogical design, assessment competence, and reflective practice. Peer-learning networks, communities of practice, and shared educational resources may be particularly valuable because the pace of technological change makes it increasingly difficult for individual educators to maintain expertise across the expanding range of digital applications.

This reinforces the broader argument concerning implementation capacity. Technological infrastructure alone cannot generate sustained educational transformation. Investment in hardware, software, or immersive technologies must be accompanied by corresponding development of pedagogical competence, technical support, organisational learning, and opportunities for educators to experiment, evaluate, and adapt. Teacher digital competence should therefore be understood as part of the institutional capacity through which technological resources are converted into educational capability.

Connecting the Green and Digital Transitions

A significant finding emerging from the stakeholder material concerns the increasing intersection between green and digital competences. Digital technologies can contribute to environmental monitoring, visitor-flow management, sustainable mobility, resource optimisation, heritage access, and sustainability communication. Data-supported systems may therefore strengthen the capacity of tourism organisations and destinations to identify environmental pressures, monitor performance, and support more informed decision-making.

The relationship between digitalisation and sustainability is nevertheless not inherently positive. Digital technologies depend on material infrastructures, energy consumption, data processing, hardware production, maintenance, and eventual disposal. Their environmental effects therefore

[116] J. Radianti, T.A. Majchrzak, J. Fromm and I. Wohlgenannt, "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda", Computers & Education, 147 (2020).

need to be considered alongside the benefits they may generate. This tension is especially relevant to computationally intensive applications such as artificial intelligence and immersive technologies, where enthusiasm for innovation can obscure resource requirements and implementation costs.

The resulting competence requirement can be described as digital sustainability competence: the capacity to assess how digital technologies can contribute to environmental and social objectives while simultaneously recognising their material, energy, infrastructural, and lifecycle implications. Learners should therefore be able to evaluate technological interventions in relation to both their intended sustainability benefits and their wider consequences.

The green and digital transitions should consequently not be presented as automatically complementary. Their relationship is conditional and context-dependent. Digital technologies may support sustainability objectives, but whether they do so depends on the purpose of the intervention, the technology selected, the resources required, patterns of use, and the alternatives available. Competence at the intersection of the two transitions therefore requires critical evaluation rather than technological optimism.

Digital and Interpersonal Competence as Complementary Capabilities

The stakeholder material further indicates that increasing digitalisation does not diminish the importance of interpersonal competence. This is particularly significant in tourism, where many professional activities remain dependent on communication, empathy, trust, interpretation, cultural sensitivity, and the quality of human interaction.

Digital technologies can automate routine processes, provide information, personalise services, and support professional decision-making. Their increasing presence, however, does not eliminate situations in which human interaction provides essential relational, interpretative, or emotional value. Tourism professionals may therefore need to move continuously between digitally mediated processes and direct interpersonal engagement.

Digital and transversal competences should consequently be understood as complementary rather than competing capabilities. A professional may need to operate digital systems efficiently while recognising when a visitor requires personal assistance, contextual explanation, reassurance, or discretionary judgement. Similarly, AI-supported communication may enhance efficiency without replacing intercultural sensitivity, empathy, or responsibility for the appropriateness of the final response.

This relationship creates a form of hybrid professional competence: the capacity to navigate appropriately between digital and interpersonal modes of service. The relevant capability lies not simply in using technology or preserving human interaction, but in exercising professional judgement concerning when automation, digital mediation, or direct interpersonal engagement is most appropriate.

From Digital Skills to Critical Digital Agency

The stakeholder evidence suggests that the central digital competence challenge extends beyond insufficient technical proficiency. Professional digital competence increasingly combines several interconnected capacities.

The first is functional fluency: the ability to use occupationally relevant technologies and understand the organisational processes they support. The second is analytical capability: the ability to interpret digitally generated information and use evidence in professional decision-making. The third is adaptive capability: the capacity to learn unfamiliar systems and transfer knowledge across technologies as platforms and occupational environments change. The fourth is critical judgement: the ability to evaluate whether a technological solution is reliable, appropriate, ethical, accessible, sustainable, and proportionate to the problem being addressed.

These dimensions can be integrated through the concept of critical digital agency. Critical digital agency refers to the capacity to select, use, interpret, evaluate, and adapt digital technologies responsibly within specific professional contexts. It differs from generic digital literacy because it is occupationally situated, problem-oriented, and explicitly concerned with judgement and responsibility.

A digitally competent tourism professional is therefore not simply an individual capable of operating multiple technologies. Professional competence requires understanding what a technology is intended to achieve, what information it produces, how reliable that information is, what limitations or consequences accompany its use, and how technological outputs should be combined with contextual knowledge and human judgement. Critical digital agency thus shifts the focus from technological proficiency towards the capacity to make informed decisions about technology.

3.4 Implications for VET

3.4.1 From Competence Demand to Curriculum Response: The VET–Labour Market Alignment Gap

The preceding analysis demonstrates that tourism stakeholders recognise the growing importance of sustainability-related, entrepreneurial, transversal, and digital competences, including capabilities associated with data, artificial intelligence, and immersive technologies. Recognition of changing competence requirements, however, does not automatically translate into corresponding educational provision.

The stakeholder material points to a persistent gap between the evolving competence structure of tourism work and the ways in which these competences are organised, developed, practised, and assessed within VET. This gap should not be interpreted simply as a temporal delay between labour-market change and curriculum revision. It is more appropriately understood as a multidimensional VET–labour market alignment gap involving curriculum architecture, pedagogical practice, assessment, work-based learning, teacher competence, institutional resources, and cooperation between education and industry.

The evidence indicates that sustainability and digitalisation have already entered the educational agenda in many of the participating contexts. The principal challenge increasingly concerns the depth, integration, and practical enactment of these themes. Learners may encounter sustainability-related content without developing the capacity to interpret environmental indicators, apply certification requirements, or integrate sustainability considerations into organisational decisions. They may possess general ICT competence while remaining unfamiliar with sector-specific digital environments. Entrepreneurship may be included as a separate subject without providing opportunities to apply entrepreneurial reasoning to sustainability, digitalisation, or changing tourism-service models.

The critical distinction is therefore between curricular presence and competence formation. The inclusion of a topic in a programme does not establish that learners can mobilise the corresponding knowledge in professional situations. Competence emerges when curriculum content is translated into structured opportunities for application, decision-making, feedback, reflection, and assessment.

The VET–labour market alignment problem should consequently be approached not only as a question of what is taught, but also of how learning is organised and under what institutional conditions recognised competence requirements can be transformed into professional capability. This shifts the analytical focus from curriculum revision alone towards the broader capacity of VET systems to interpret changing occupational requirements and translate them into coherent learning, assessment, and workplace-development processes[117].

From Curriculum Presence to Curriculum Integration

A recurring finding concerns the fragmentation of competence development. Sustainability, entrepreneurship, digital literacy, and transversal competences may be formally present within VET programmes while remaining separated into distinct subjects or learning units. Such arrangements can support conceptual understanding but may limit learners' ability to combine different forms of knowledge when responding to complex professional problems.

This is particularly important because contemporary tourism work increasingly requires hybrid competence configurations. Developing a lower-impact tourism product may simultaneously require environmental knowledge, financial reasoning, digital communication, stakeholder cooperation, and service design. Visitor-flow management may involve data interpretation, destination knowledge, accessibility, communication, and sustainability judgement. Similarly, a digitally mediated heritage experience may require technological competence, cultural interpretation, ethical judgement, entrepreneurship, and user-experience design. Professional problems therefore rarely reproduce the disciplinary boundaries through which education is organised.

Curriculum alignment should consequently not be assessed solely by asking whether green, digital, entrepreneurial, or transversal content is present. The more demanding question is whether

[117] V. Symeonidis, A. Pouliou and C.J. Lees, The Multifaceted Role of Learning Outcomes across the Continuum of Teacher Education: An Approach to Empower VET Teachers and Trainers, Cedefop Working Paper, Publications Office of the European Union, Luxembourg, 2025.

learners are expected to integrate these competence domains in professional problem solving. The distinction identifies a curriculum integration gap between the formal inclusion of competence areas and their combined application.

Integrated project work offers one response. Authentic tourism problems can require learners to mobilise several competence domains simultaneously and justify the relationships between them. The educational value lies not only in the resulting product or solution, but in the process of connecting previously separated knowledge and applying it to a shared professional problem.

Recent VET research demonstrates that the formal incorporation of competences or learning outcomes into curricula does not in itself ensure their effective translation into teaching and learning practice. Cedefop's comparative analysis of ten European VET systems shows considerable variation between the formal adoption of learning-outcomes-based curricula and their influence on classroom practice, while OECD analysis of future-ready VET stresses the need to combine occupation-specific competences with transversal capabilities required to respond to changing work environments. These findings support distinguishing between the formal presence of competence domains and their integrated application in professional tasks. The term curriculum integration gap is used here as an analytical construct to describe the distance between curricular inclusion and the mobilisation of multiple competence domains in authentic occupational problem solving[118].

The Theory–Practice Gap

A second dimension of alignment concerns the relationship between conceptual knowledge and professional application. The stakeholder material indicates that relevant contemporary topics may be present in VET without providing learners with sufficient opportunities to enact them in realistic settings.

The distinction is visible across competence domains. Learners may study sustainability without conducting an environmental audit or interpreting operational indicators; learn about tourism technologies without using sector-relevant systems; or discuss communication principles without practising difficult service encounters. The resulting gap is therefore not primarily one of information but of enactment.

The relevant transition is from declarative knowledge to situated professional performance. Understanding a principle is different from deciding how it should be applied when information is incomplete, interests conflict, or operational constraints are present. VET consequently requires learning environments in which competence is exercised rather than merely described.

Simulation, authentic projects, case-based learning, field activities, digital practice environments, workplace assignments, and collaboration with external organisations can contribute to this process. This does not reduce the importance of theoretical knowledge. Conceptual

[118] See: Cedefop, The Influence of Learning Outcomes-Based Curricula on Teaching Practices, Cedefop Research Paper, Publications Office of the European Union, Luxembourg, 2025, doi:10.2801/0800596; OECD, Building Future-Ready Vocational Education and Training Systems, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris, 2023.

understanding remains essential because it enables learners to interpret unfamiliar situations rather than reproduce established routines mechanically. The educational challenge is therefore not to replace theory with practice, but to create systematic connections between them. The distinction between possessing declarative knowledge and being able to mobilise it in professional practice is central to competence-oriented vocational education. Recent Cedefop research examining work- and practice-based IVET shows that intended learning outcomes need to be translated into meaningful workplace and practice-based experiences if they are to contribute to professional progression. Research on learning-outcomes-based curricula similarly demonstrates that formal curriculum intentions do not automatically determine teaching practices. The expression declarative knowledge to situated professional performance is therefore used here to emphasise the transition from knowing principles to applying and adapting them within contextualised occupational situations[119].

Work-Based Learning: Exposure versus Development

The stakeholder evidence assigns particular importance to internships and apprenticeships, but it also challenges the assumption that workplace presence automatically produces meaningful competence development. Learners may be placed in professional environments while remaining confined to repetitive or low-responsibility tasks, and operational pressures may lead host organisations to treat interns primarily as additional labour rather than as developing professionals.

This reveals an important distinction between workplace exposure and work-based learning. Exposure provides familiarity with a professional environment; work-based learning requires purposeful competence development. The latter depends on explicit learning objectives, appropriate task design, mentoring, feedback, reflection, and opportunities to assume progressively greater responsibility and exercise professional judgement.

Placement quality should therefore be evaluated through the learning processes it enables rather than duration alone. A stronger model requires coordination between the VET provider, learner, and host organisation concerning intended learning outcomes, task progression, and feedback. Regular communication can help ensure that the educational function of the placement remains visible.

Mentoring is particularly important because workplace experience does not automatically become learning. Learners need opportunities to discuss decisions, understand organisational routines, receive feedback, and relate practical experience to broader professional concepts. Employer participation in VET consequently requires not only willingness to host learners but also a degree of educational capacity. The educational value of workplace participation depends on more than placement duration or physical presence in an organisation. OECD analysis identifies the workplace as a potentially powerful environment for developing occupational and transversal skills, but emphasises that high-quality work-based learning requires appropriate design, sequencing and

[119] Cedefop, The Impact of Learning-Outcomes-Based Curricula on Work- and Practice-Based IVET, Cedefop Research Paper, Publications Office of the European Union, Luxembourg, 2026, doi:10.2801/9049937; Cedefop, The Influence of Learning Outcomes-Based Curricula on Teaching Practices, 2025.

supporting mechanisms. Guidance, mentoring, feedback, reflection and opportunities for progressively more independent performance are also recognised as important elements of workplace learning. Recent Cedefop evidence similarly stresses the importance of translating intended learning outcomes into meaningful workplace experiences. These findings support the analytical distinction made here between workplace exposure and work-based learning, the latter implying purposeful and structured competence development[120].

Employers as Co-Producers of Competence

Changing occupational requirements also alter the relationship between VET and tourism enterprises. Employers cannot be understood solely as the final recipients of graduates. Where technologies, sustainability practices, customer expectations, and organisational models change rapidly, enterprises possess forms of current professional knowledge that may not yet be fully represented in formal curricula.

This creates a case for employers to participate as co-producers of competence development. Cooperation may include curriculum consultation, workplace projects, mentoring, guest teaching, provision of authentic case material, access to technologies, internships, and collaborative design of learning activities.

Labour-market alignment should not, however, imply curricular subordination to immediate employer demand. VET has a broader educational function. Learners require transferable knowledge, ethical judgement, adaptability, and the capacity to operate in professional contexts that will continue to evolve. Current business needs therefore constitute an important source of evidence, but not the sole determinant of educational objectives.

The relationship should be reciprocal. Industry can strengthen professional relevance, while VET contributes pedagogical, analytical, ethical, and longer-term perspectives. The objective is therefore co-construction rather than curricular subordination. Employer participation can extend across the design, delivery and evaluation of vocational education. OECD analysis identifies employer involvement in qualification and curriculum design, work-based learning, provision of equipment and expertise, assessment, quality assurance and feedback on changing skill needs. Such participation can strengthen labour-market relevance, particularly where occupational requirements change rapidly. At the same time, VET needs to preserve transferable and transversal capabilities that extend beyond the immediate requirements of individual firms. The terms co-producers of competence development and co-construction rather than curricular subordination are used here analytically to capture this reciprocal relationship between vocational education and employers[121].

Teacher Professional Development as a System Bottleneck

[120] P. Musset, “Improving Work-Based Learning in Schools”, OECD Social, Employment and Migration Working Papers, No. 233, OECD Publishing, Paris, 2019, doi:10.1787/918caba5-en; Cedefop, The Impact of Learning-Outcomes-Based Curricula on Work- and Practice-Based IVET, 2026.

[121] See: OECD, Building Future-Ready Vocational Education and Training Systems, OECD Publishing, Paris, 2023.

Teacher competence constitutes a critical link between curriculum intentions and professional relevance. Educators mediate between formal programme requirements and the learning experiences available to students. Even well-designed curricula may have limited impact when teachers lack current sector knowledge, technological familiarity, confidence, or opportunities to update their practice.

The stakeholder material indicates needs relating to sustainability standards, digital systems, XR, and changing tourism practices. Teacher readiness should therefore not be treated as an auxiliary implementation issue. It forms part of the wider competence ecosystem through which labour-market change is translated into learning.

Tourism educators increasingly face a dual professional-development requirement: industry currency and pedagogical translation. Industry currency refers to familiarity with contemporary technologies, standards, organisational practices, and sectoral challenges. Pedagogical translation concerns the capacity to convert these developments into learning objectives, activities, assessment, and feedback.

Industry placements for educators, professional exchanges, and cooperation with enterprises can strengthen the first dimension; peer learning, pedagogical development, project and simulation design, and assessment training can strengthen the second. Teacher development consequently functions as a feedback mechanism connecting labour-market transformation with curriculum renewal. Where this mechanism is weak, the formal curriculum may remain stable while professional practice changes around it.

Curriculum Responsiveness versus Curriculum Volatility

Stronger labour-market alignment creates a further tension. Tourism technologies, business models, and consumer practices may change more rapidly than formal curricula can reasonably be redesigned. Attempting to revise qualifications whenever a new platform, application, or technology becomes prominent would make VET unstable and excessively dependent on short-term developments.

The appropriate response is therefore not continuous curricular replacement but greater curriculum responsiveness. A responsive curriculum combines durable professional capabilities with flexible spaces in which current systems, technologies, and practices can be introduced and updated.

For example, rather than organising digital learning around one Property Management System, learners can develop an understanding of reservation processes, customer data, inventory, distribution, interoperability, and digital workflows while gaining practical experience with representative platforms. Similarly, XR education should not depend on mastery of a particular device, but on transferable capacities to evaluate immersive technologies, identify user needs, assess educational or professional additionality, and adapt to emerging interfaces.

This approach connects responsiveness with competence durability. VET should prepare learners for contemporary work without locking them into today's technologies. The objective is therefore adaptive relevance, rather than permanent correspondence with transient market

conditions. Responsiveness to changing skill requirements is identified by the OECD as a defining characteristic of future-ready VET systems. Such responsiveness depends on high-quality labour-market information, stakeholder engagement, transferable competences and sufficient flexibility to incorporate emerging practices without reducing vocational programmes to short-term employer or technology requirements. VET also needs to provide strong foundational and transversal capabilities that allow graduates to adapt as occupations change. The distinction between curriculum responsiveness and curriculum volatility, as well as the notion of adaptive relevance, are analytical concepts used here to describe the need to balance current occupational relevance with competence durability and transferability[122].

Learners as Participants in Curriculum Relevance

Learners constitute another source of evidence concerning curriculum alignment. Their perspectives can reveal where formal content remains abstract, where workplace placements provide limited developmental value, and where access to emerging technologies or authentic professional tasks is insufficient.

Student feedback should therefore be treated as more than a measure of satisfaction. Learners occupy a distinctive position at the interface between education and early professional experience and can provide evidence about how intended learning opportunities are actually experienced.

Their perspective nevertheless has limitations. Learners cannot be expected to anticipate independently which competences will remain important across longer professional trajectories or how occupational structures will evolve. Learner participation should consequently complement rather than replace professional, pedagogical, and labour-market evidence.

Systematic student feedback can nevertheless strengthen curriculum evaluation by identifying discrepancies between intended learning opportunities and experienced learning opportunities. In this sense, learners contribute to curriculum relevance not by determining curriculum content independently, but by providing evidence about its enactment. Learner perspectives constitute an important source of evidence concerning how intended curricula and learning outcomes are experienced in practice. Recent Cedefop research recommends strengthening learner engagement by making learning outcomes understandable and actionable and by using learner-centred mechanisms such as reflection and self-assessment. Evidence from work- and practice-based IVET also highlights the relevance of learner engagement to progression and the effective enactment of learning outcomes. Learner voice should nevertheless complement rather than replace occupational, pedagogical and labour-market evidence. The distinction between intended learning opportunities and experienced learning opportunities is used here analytically to capture the contribution that learner perspectives can make to curriculum evaluation[123].

[122] OECD, Building Future-Ready Vocational Education and Training Systems, OECD Publishing, Paris, 2023.

[123] Cedefop, Policy Pointers for the Shift to Learning Outcomes: Lessons from European VET Systems, Cedefop Insights, Publications Office of the European Union, Luxembourg, 2026.

Policy Frameworks as Enabling Environments

VET–labour market alignment is shaped not only by individual institutions but also by broader policy and regulatory environments. European and national frameworks increasingly promote green and digital competence development, lifelong learning, and stronger relationships between vocational education and economic transformation.

Such frameworks can provide strategic direction, shared terminology, funding opportunities, qualification structures, and incentives for curriculum development. Their existence, however, should not be equated with implementation.

A sustainability objective may be formally recognised in policy without producing substantial change in classroom practice. Similarly, strategic support for digital transformation does not automatically generate technological infrastructure, teacher competence, employer cooperation, appropriate assessment, or institutional flexibility.

The critical analytical distinction is therefore between policy intention and implementation capacity. Policies and standards establish direction, but their educational effects depend on whether institutions possess the resources, capabilities, professional knowledge, and organisational mechanisms required to translate them into learning. Comparative European evidence demonstrates that formal policy adoption and practical implementation should not be treated as equivalent. Cedefop's analysis of learning-outcomes-based curricula finds that although national policies increasingly incorporate learning outcomes, their influence on classroom practice varies considerably and depends on teacher preparation, school-level practices and wider implementation conditions. Similar variation is found in assessment, where formal regulation does not necessarily translate into equally developed assessment criteria and practices. These findings support the analytical distinction between policy intention and implementation capacity used here[124].

Towards an Integrated Curriculum Architecture

The stakeholder evidence suggests that stronger VET–labour market alignment requires more than adding new subjects or learning outcomes. The deeper challenge concerns curriculum architecture.

An integrated curriculum would embed green, digital, entrepreneurial, and transversal competences across occupational contexts rather than isolate them in separate learning silos. Learners would encounter authentic professional problems requiring several competence domains simultaneously. Work-based learning would include explicit learning objectives, mentoring, feedback, and progressive responsibility. Teachers would maintain structured links with professional practice and engage in continuing development. Employers would contribute to curriculum relevance without determining educational objectives exclusively, while learners would provide systematic evidence concerning the relationship between formal education and workplace experience.

[124] Cedefop, The Influence of Learning Outcomes on Assessment, Cedefop Research Paper, Publications Office of the European Union, Luxembourg, 2026.

Such an architecture can be described as integrative, practice-connected, and adaptive. Its purpose is not perfect correspondence between curriculum content and immediate employment requirements. Such correspondence is neither realistic nor necessarily desirable in a rapidly changing sector. Instead, the objective is to reduce the distance between education and professional practice while preserving the broader developmental function of vocational education. Research on future-ready VET increasingly points towards combinations of responsive curricula, transversal competence development, high-quality work-based learning, employer engagement, teacher professional development and institutional leadership rather than isolated curriculum interventions. OECD analysis emphasises that responsiveness to changing skills needs requires engagement with social partners, while innovation in VET depends on trained teachers, leadership and coordination with the world of work. Cedefop evidence further demonstrates that curriculum intentions need to be connected with teaching, assessment and workplace learning. The description of an integrative, practice-connected, and adaptive curriculum architecture is therefore an analytical synthesis developed in the present study rather than a model reproduced directly from a single existing framework[125].

From Labour-Market Alignment to Adaptive Curriculum Capacity

The analysis suggests that the most important institutional capability is not curriculum updating in itself, but the ability to recognise emerging change, interpret its occupational significance, translate it into learning, evaluate its relevance, and revise provision over time. This can be conceptualised as adaptive curriculum capacity.

Adaptive curriculum capacity operates across several levels. At programme level, it concerns the incorporation and integration of changing competence requirements into teaching and assessment. At teacher level, it depends on professional learning, sectoral currency, and pedagogical flexibility. At institutional level, it requires partnerships, infrastructure, leadership, and effective mechanisms for curriculum review. At system level, it depends on qualification frameworks, funding, policy conditions, and the capacity to respond to sectoral transformation without excessive procedural delay.

The concept shifts the analytical focus from the static question of whether a curriculum is currently aligned with employment towards a more dynamic one: can the VET system continue to realign itself as tourism changes?

This distinction is important because no curriculum can remain permanently current in a sector shaped by technological development, climate pressures, changing visitor expectations, and evolving business models. A more sustainable educational response therefore lies not in constant reactive revision but in developing institutional structures capable of continuous learning and adaptation. Contemporary approaches to VET responsiveness emphasise that changing labour-market needs cannot be addressed through occasional curriculum revision alone. OECD conceptualises future-

[125] OECD, Building Future-Ready Vocational Education and Training Systems, 2023.

ready VET in terms of continuing responsiveness to changing skill requirements, supported by skills intelligence, social-partner engagement, teacher development and institutional flexibility. Recent Cedefop work similarly focuses on the conditions through which intended learning outcomes can be translated into achieved outcomes and stresses the importance of coherence across policy, institutional practice, teaching, assessment and work-based learning. The concept of adaptive curriculum capacity is developed in the present study to capture this dynamic institutional capability: the capacity to recognise change, interpret its occupational significance, translate it into learning and assessment, evaluate the results and revise provision over time[126].

Linking Individual and Institutional Capabilities

The preceding analysis reveals two interconnected levels of competence transformation. At the individual level, three higher-order capabilities have emerged: sustainability judgement, enabling professionals to assess environmental, social, cultural, and economic consequences; adaptive professional agency, enabling them to act effectively and take initiative under uncertainty; and critical digital agency, enabling them to select, use, interpret, and evaluate technologies responsibly.

At institutional level, these capabilities are complemented by adaptive curriculum capacity. The two levels are mutually dependent. Learners cannot develop sophisticated professional judgement through fragmented curricula detached from practice. Teachers cannot provide current digital or sustainability education without opportunities to update their expertise. Work-based learning cannot develop professional agency when learners remain confined to routine auxiliary tasks. Employers cannot reasonably expect adaptable graduates while remaining marginal to the competence-development process.

The competence problem should therefore not be located exclusively within individual learners. It emerges through relationships among learners, educators, curricula, workplaces, institutions, and policy frameworks. This supports a broader interpretation of VET–labour market alignment as a property of the competence ecosystem rather than a simple correspondence between lists of employer demands and graduate skills.

The objective is consequently not merely to eliminate discrete skills gaps. It is to create a learning system capable of recognising changing sectoral requirements and converting them into integrated, transferable, and professionally meaningful capabilities. In this sense, VET–labour market alignment should not be understood as a stable end state. It is an adaptive institutional process through which education continuously interprets, responds to, and learns from transformations in professional practice. The interaction between individual competence development and institutional conditions is consistent with contemporary approaches that treat VET responsiveness as a systemic property rather than solely a matter of learner skills. OECD analysis links future-ready VET to curriculum responsiveness, transversal competence, teacher capability, stakeholder engagement, institutional leadership and innovation, while Cedefop research demonstrates that the translation of

[126] Policy Pointers for the Shift to Learning Outcomes: Lessons from European VET Systems, 2026.

curriculum intentions into achieved learning depends on interconnected processes of teaching, assessment, workplace learning and institutional implementation. In the present study, sustainability judgement, adaptive professional agency and critical digital agency represent higher-order individual capabilities, while adaptive curriculum capacity represents the corresponding institutional capability. Their integration into the broader concept of an adaptive institutional process is an analytical synthesis developed here to explain how changing sectoral requirements can be converted into meaningful and transferable professional competence[127].

3.5 Training Needs Mapped in the Research

The survey of VET teachers (n = 60) indicates a marked need for further professional development in the pedagogical use of digital technologies, particularly XR. The findings should be interpreted as respondents' perceptions and self-assessments rather than as objective measures of competence. Nevertheless, several consistent patterns emerge concerning technological familiarity, confidence, institutional support, and preferred forms of professional development.

Institutional support for innovative teaching methods was most frequently assessed as moderate, with 50% of respondents selecting "To a moderate extent". Smaller proportions reported support to a very small extent (20%), a small extent (15%), a large extent (10%), or a very large extent (5%). The distribution suggests that institutional support for teaching innovation is present, but remains limited in intensity for a substantial proportion of respondents.

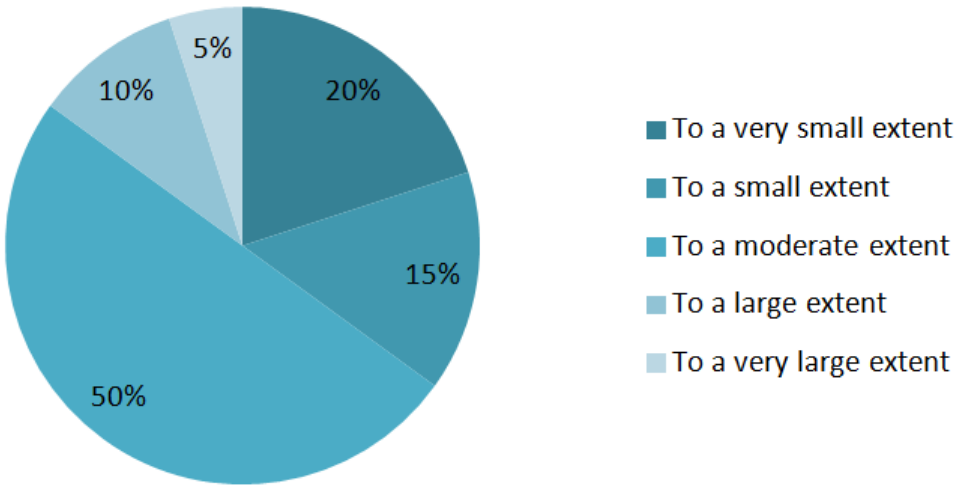


Figure 1. Level of Institutional Support for Innovations in Teaching Methods

[127] Cedefop, The Impact of Learning-Outcomes-Based Curricula on Work- and Practice-Based IVET, 2026.

Awareness of the potential applications of XR in tourism and hospitality was relatively limited: 40% of respondents reported knowing “Very Little” or “Not at All” about such opportunities. Confidence in the extent to which curricula reflected changing industry requirements, including digital transformation, was also restrained, with 35% selecting “Confident”. Familiarity with digital and immersive tools also remained limited, with 45% describing their familiarity as limited, while 50% reported being “Not very confident” in integrating these technologies into teaching. At the same time, interest in practical XR-based learning was high, with 70% of respondents expressing interest in such activities (Figure 2).

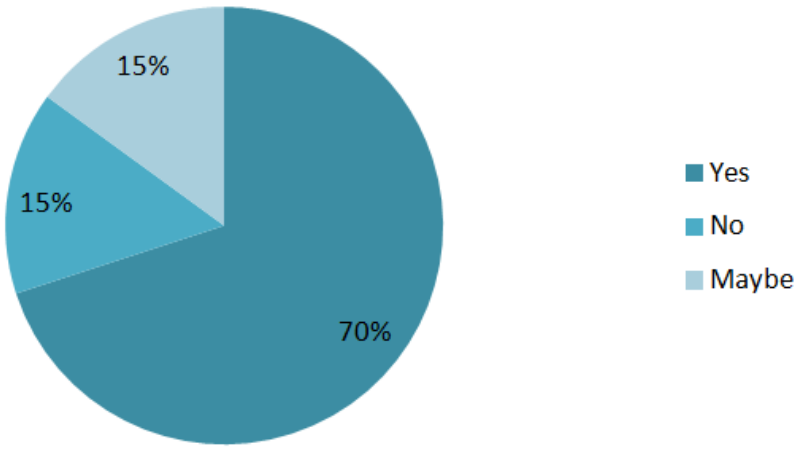


Figure 2. Interest in Practical XR-Based Activities

The comparison between self-assessed proficiency levels across XR-related competences reveals that teachers most frequently located their current capabilities at the average or below-average levels. In relation to basic concepts of VR, AR, and MR, 45% assessed their proficiency as “Average”. Half of respondents assessed their ability to operate XR devices as “Below Average”, while 55% reported below-average proficiency in XR-supported marketing and customer engagement. Creating or editing basic immersive content produced a comparable pattern, with 50% reporting below-average proficiency. Integration of XR into tourism services was assessed as below average by 45%, while troubleshooting and evaluation of XR effectiveness were more frequently assessed as average, by 40% and 45% respectively.

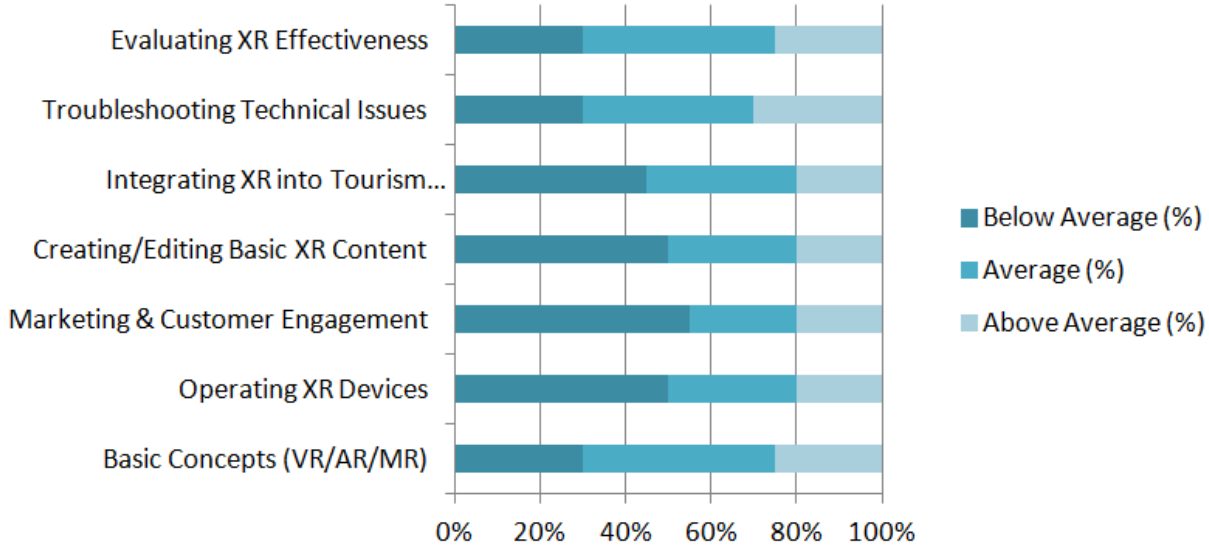


Figure 3. Current Proficiency Levels in Key XR Skills

The perceived future relevance of XR-related competences was consistently higher. Basic understanding of VR, AR, and MR was regarded as "Important" by 60% of respondents, while 40% considered device operation "Essential". XR-supported marketing and customer engagement was regarded as important by 65%, and content creation by 55%. Integration of XR into tourism services was considered essential by 50%, troubleshooting important by 60%, and evaluation of XR effectiveness essential by 55%. Taken together, the two distributions indicate a recurring perceived proficiency–importance asymmetry.

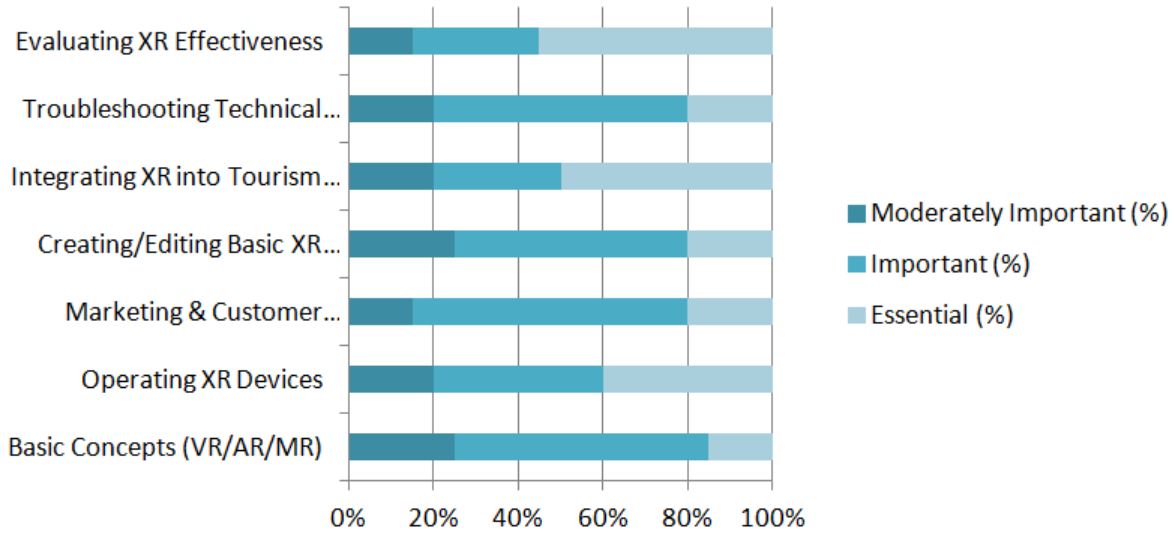


Figure 4. Perceived Importance of XR Skills for Future Career

Taken together, Figures 3 and 4 indicate a consistent perceived asymmetry between current self-assessed proficiency and the anticipated professional importance of XR-related competences.

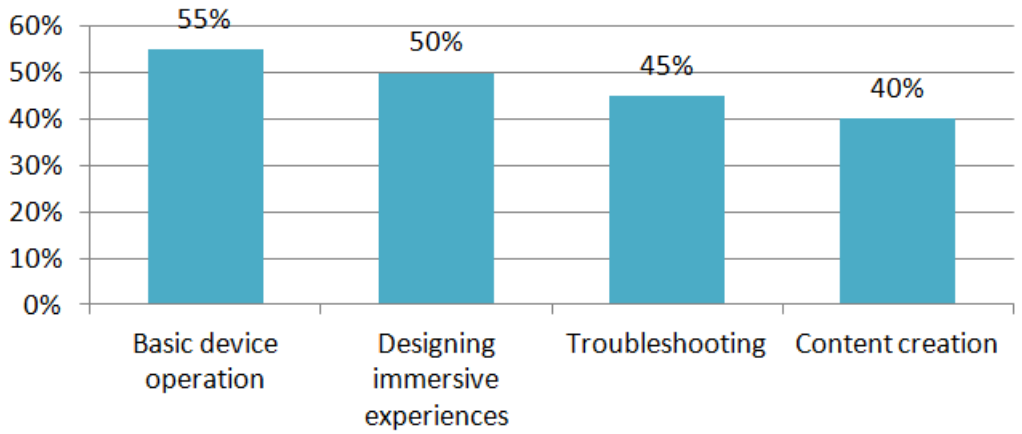


Figure 5. Key Aspects of XR Technology Requiring Training

Respondents also expressed a clear preference for practice-oriented forms of professional development. Practical workshops were selected by 60% of respondents, online courses by 50%, and industry mentoring by 45%. This pattern indicates a preference for professional learning formats that combine practical application with opportunities for guided development.

At the same time, the barriers identified by teachers indicate that competence development cannot be separated from institutional conditions. Lack of equipment access was reported by 80% of respondents, limited curriculum time by 65%, and insufficient technical support by 60%, while 30% identified low perceived relevance as a barrier. These findings point to an implementation capacity gap, in which willingness to engage with new technologies may not be matched by adequate infrastructure, time, or technical support.

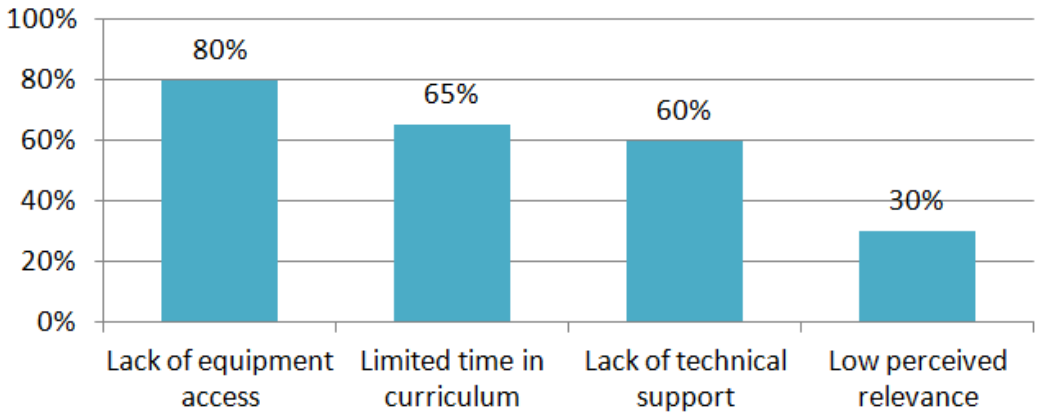


Figure 6. Primary Barriers to Implementing New Technologies in Teaching

More broadly, the teacher responses reveal a contrast between openness to technological innovation and its relatively limited integration into teaching practice. While 65% of respondents strongly agreed with statements indicating openness to new technologies, 55% reported using XR seldom or rarely in their courses. This pattern is consistent with the implementation barriers identified above and suggests that limited XR use cannot be attributed solely to educator attitudes.

Descriptive subgroup patterns further indicate that respondents who self-assessed their digital literacy as advanced (30%) also reported more frequent adaptation of teaching content to emerging trends, with 50% selecting “Often”. This relationship should be interpreted cautiously, as the survey design does not establish causality. Nevertheless, the pattern reinforces the relevance of teacher digital competence as one component of the institutional capacity required for pedagogical innovation. Respondents also identified XR laboratories (45%) and stronger industry collaboration (40%) as potentially useful forms of support, while 60% perceived XR-related competence as potentially enhancing their professional development.

Sustainability-related competence presents a somewhat different pattern. Half of the respondents described themselves as having a “Good working knowledge” of sustainable tourism practices, indicating a comparatively stronger level of perceived preparedness in this area than in relation to XR. Sustainability was reported as being incorporated into teaching primarily through case studies (40%), discussions (35%), and practical projects (30%). At the same time, 70% of respondents considered XR “Very valuable” for teaching green tourism. This indicates a perceived potential for combining sustainability education with immersive and simulation-based approaches, particularly where learners engage with complex environmental, resource-management, or destination-planning scenarios. This finding should, however, be interpreted as evidence of perceived pedagogical value rather than demonstrated learning effectiveness.

3.5.1 Gaps in Preparation for the Job Market and Needs in Digital and Sustainable Competencies

Among VET students (n = 94), the survey indicates a strong perceived relevance of technological change for future employment alongside relatively limited exposure to immersive technologies during education. Seventy per cent of respondents expected technology to influence their careers “To a large extent”. Awareness of XR was moderate, with 50% selecting “Somewhat”, while 60% reported encountering XR in education only seldom or rarely. These findings suggest that students recognise the growing importance of digital transformation despite relatively limited educational exposure to immersive technologies.

Students’ perceived preparedness for digital transformation was more moderate. Forty-five per cent described themselves as “Moderately confident” in using tourism technologies, while 40% considered their preparation for digital innovation to be developed only “To a small extent”. At the same time, interest in practical XR-based learning was high: 80% expressed interest in practical XR activities, and 75% reported being “Very interested” in experiences such as virtual tours or simulated

guest-service situations. The pattern indicates a contrast between students' perceived level of digital preparation and their willingness to engage with immersive forms of learning.

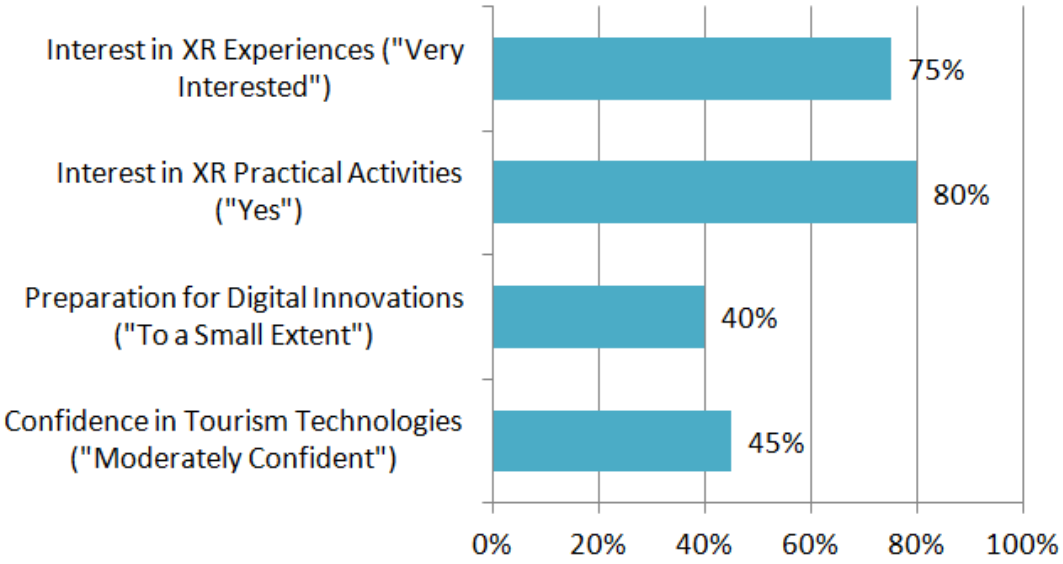


Figure 7. Confidence in Tourism Technologies, Digital Preparation, and Interest in XR Activities

Students' overall assessment of their preparation for employment in the tourism sector was predominantly moderate, with 50% describing themselves as "Moderately prepared". The most frequently identified areas requiring further technical development concerned the use of reservation systems (40%), data analysis (35%), and XR operation (30%). These findings suggest that perceived job readiness depends not only on general digital confidence but also on familiarity with sector-specific technologies and operational applications.

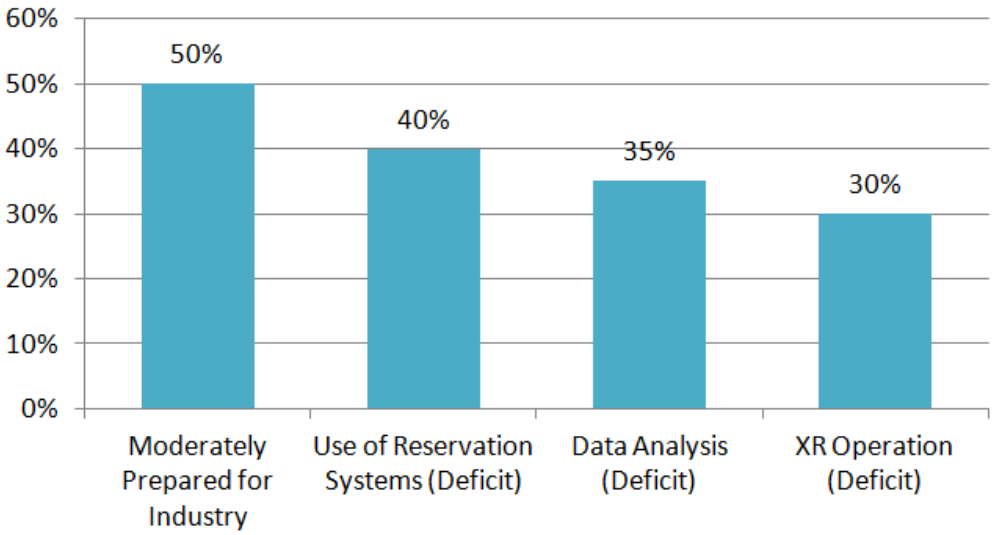


Figure 8. Overall Industry Preparation and Key Technical Development Needs

Students assessed the development of transversal competences such as communication, teamwork, and problem solving as moderate, with 55% selecting "To a moderate extent", while opportunities to practise these competences were reported as occurring only "Sometimes" by 50%

of respondents. Perceived alignment between VET programmes and labour-market requirements was also moderate, with 45% selecting “To a moderate extent”. Respondents most frequently recommended increasing opportunities for practical learning (60%), strengthening collaboration with industry (50%), and improving educational resources (40%). In addition, 70% perceived XR as capable of improving their employment prospects “Quite a Bit”, indicating that students associate immersive technologies with potential professional value. Figure 9 reveals a consistent asymmetry between students’ self-assessed XR proficiency and the perceived importance of these competences. Fifty per cent assessed their understanding of basic XR concepts as average, while 65% regarded this competence as essential. Device operation shows a particularly pronounced contrast, with 55% reporting below-average proficiency and 85% identifying this competence as essential. Similar patterns are visible for XR-related marketing and customer engagement (50% below average; 60% essential), content creation (45%; 55%), and the integration of XR into tourism services (50%; 80%). For troubleshooting, 30% reported below-average proficiency and 40% average proficiency, while 60% regarded the competence as essential. In relation to evaluating XR effectiveness, 30% assessed their proficiency as below average and 45% as average, whereas 75% considered this competence essential. Taken together, these distributions indicate a clear perceived proficiency–importance asymmetry, rather than an objectively measured competence deficit.

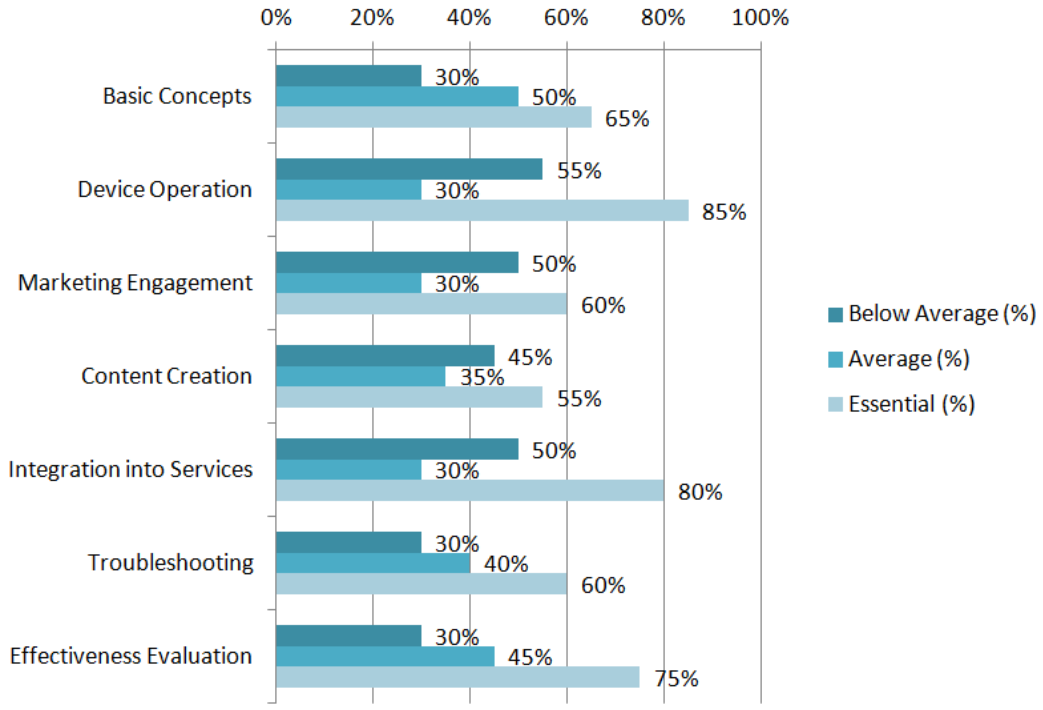


Figure 9 .Selected Indicators of XR Proficiency and Perceived Importance Across Key Skills

Students also identified several barriers to learning XR, most notably lack of access to equipment (75%), limited training opportunities (70%), and insufficient curriculum time (60%). These

findings suggest that the development of XR-related competences is constrained not only by individual preparedness but also by institutional and organisational conditions.

Students most frequently identified basic XR operation as a preferred training area (50%), followed by immersive-experience design (45%), XR marketing (40%), troubleshooting (35%), content creation (30%), and impact evaluation (25%). The distribution indicates demand for training that combines basic operational competence with progressively more applied, creative, and evaluative uses of immersive technology.

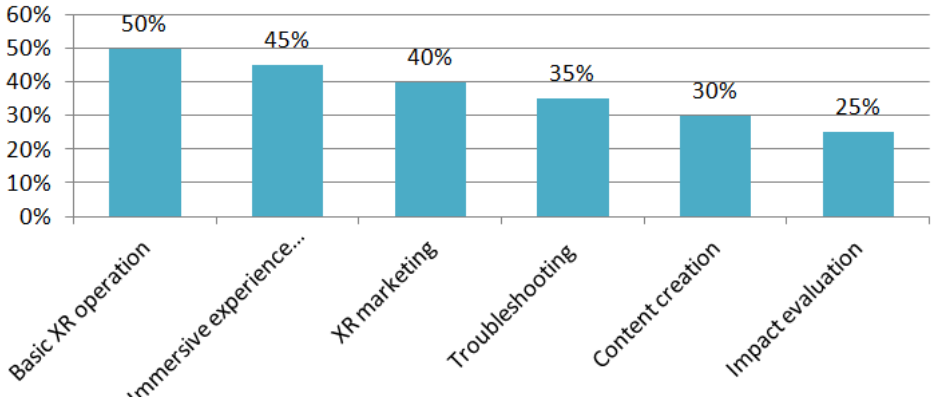


Figure 10. Preferred Training Topics in Learning XR

Students' areas of interest within tourism were concentrated primarily around leisure tourism (50%), adventure tourism (40%), ecotourism (40%), and sustainable tourism (35%). These interests were accompanied by a preference for applied forms of learning: 60% selected hands-on practice, 50% interactive simulations, and 45% real-world experiences. This pattern reinforces the broader preference for experiential and practice-oriented learning observed across the student responses.

Communication was the most frequently selected career competence (55%), followed by technical skills, including areas such as reservation systems and digital marketing (50%), and problem solving (50%). Digital proficiency was selected by 45% of students and sustainability-related competence by 40%. The pattern illustrates the hybrid character of perceived future competence requirements, combining interpersonal, technical, digital, and sustainability-related capabilities.

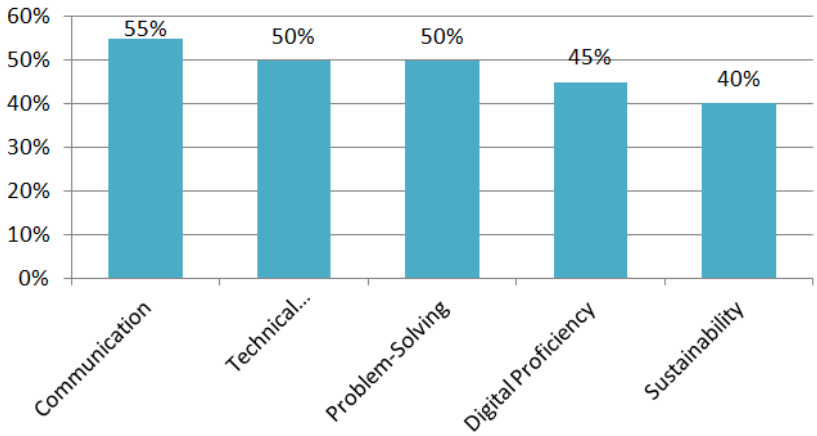


Figure 11. Most Important Career Skills

Students' self-assessments of entrepreneurial competence were predominantly moderate, with 50% selecting "Average". The areas most frequently identified for further development included business planning (45%), financial management (40%), marketing (35%), sustainable business practices (30%), and digital innovation (25%). This pattern suggests that students perceive entrepreneurial preparation as extending beyond general business awareness towards a combination of financial, marketing, sustainability-related, and digital capabilities.

Sustainability-related competence reveals a marked recognition–preparedness asymmetry. Sixty per cent of students described their knowledge of sustainable tourism as a "Basic understanding", while 80% regarded sustainability competence as "Essential". The areas attracting the greatest interest were environmental conservation (50%), community engagement (45%), economic sustainability (40%), cultural preservation (35%), and carbon reduction (30%). These responses suggest that students recognise sustainability as an important dimension of future tourism work while simultaneously perceiving their current knowledge as relatively limited.

Taken together, the student responses indicate strong interest in technology-enabled and practice-oriented learning alongside comparatively limited reported exposure to XR and moderate self-assessed digital preparedness. They also reveal overlapping development needs across digital, sustainability-related, entrepreneurial, and transversal competences. Descriptive subgroup patterns suggest that students reporting higher entrepreneurial self-assessments also more frequently selected sustainability-related topics. This relationship should be treated as exploratory rather than causal. It may justify further investigation of integrated learning approaches connecting entrepreneurship, sustainability, and digital technologies, but it does not in itself demonstrate the effectiveness of XR-based green entrepreneurship training.

3.5.2 Assessment of Graduates' Competences and Training Recommendations

Tourism industry representatives (n = 49) were drawn primarily from accommodation services (40%) and tour operators (30%), with 50% of respondents holding managerial roles. Collaboration with educational institutions was reported as occurring only "Sometimes" by 45% of respondents. Nevertheless, industry representatives expressed willingness to contribute to VET provision through internships (60%), curriculum-related expertise (50%), guest lectures (45%), and site visits (40%). XR awareness was predominantly moderate, with 50% selecting "Somewhat", while 40% reported exploring digital technologies "Often". Support for innovation was most frequently assessed as occurring "To a moderate extent" (50%). Respondents also assessed graduates' entrepreneurial mindset predominantly as moderate (45%), while 40% considered graduates' digital fluency to be developed only "To a small extent".

Industry respondents assessed graduates' overall preparation for tourism employment as predominantly moderate, with 50% selecting "Moderately prepared". The most frequently identified areas requiring further development concerned digital proficiency (60%), followed by sustainability-related competence (45%), technical skills (40%), business and entrepreneurial competence (35%), and communication (30%). These findings should be interpreted as employers' perceptions of graduate preparedness rather than as objective measurements of competence.

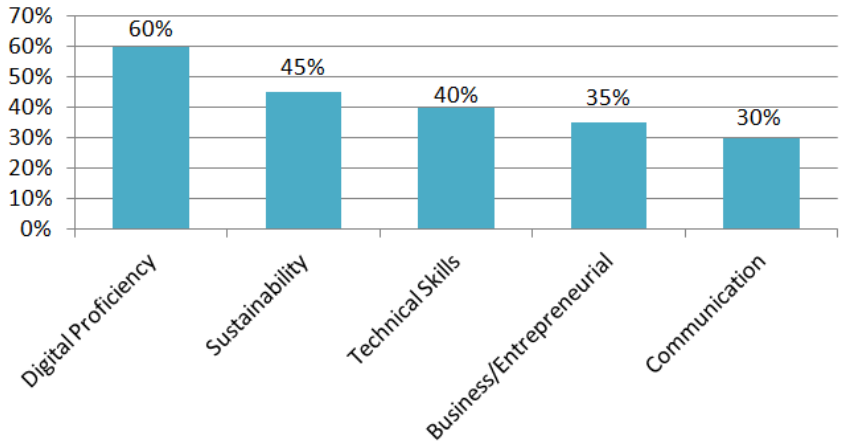


Figure 12. Key Training Needs and Skills Gaps Identified for VET Graduates

With regard to XR-related development, the most frequently recommended training topic was basic XR operation (40%), followed by immersive-experience design (35%), XR marketing (30%), troubleshooting (25%), content creation (20%), and impact evaluation (15%). The distribution suggests that industry respondents place greatest emphasis on foundational and applied uses of XR, while more advanced content-development and evaluative competences were selected less frequently.

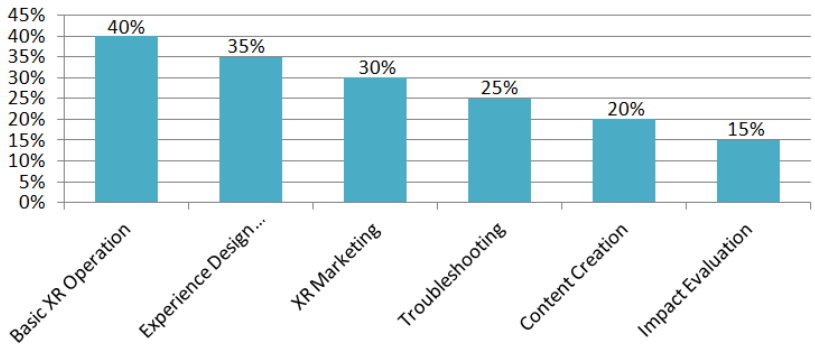


Figure 13. Recommended Training Topics for XR and Related Skills

Digital skills are considered essential by employers, with 70% indicating that they are important "to a large extent." However, graduates appear to meet employers' expectations only partially, with 40% of respondents selecting "Meets Some." Soft skills were assessed more positively, with 45% of respondents indicating that graduates possess adequate soft skills. Nevertheless, 40% identified adaptability as an area requiring further improvement.

Regarding changes needed in VET programmes, respondents most frequently recommended increasing opportunities for practical training (50%), followed by greater integration of technology

(45%), curriculum updates (40%), and improvements in educational resources and infrastructure (35%). Figure 14 presents the skills and competencies considered most important in recruitment.

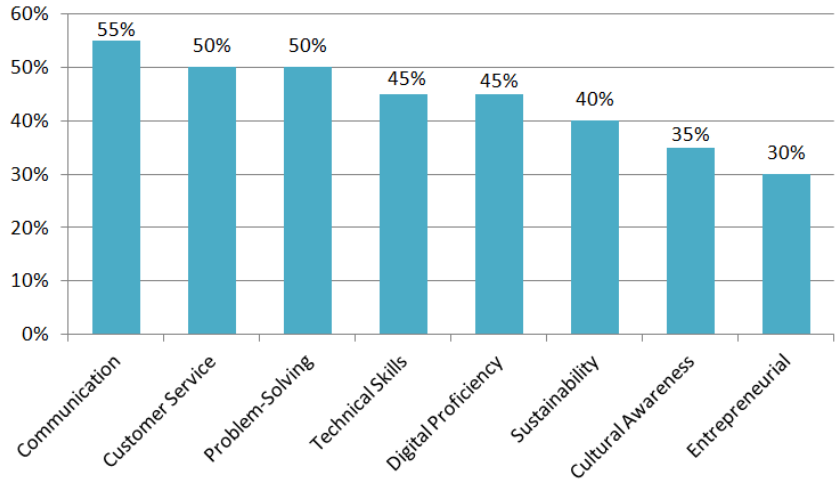


Figure 14. Most Important Recruitment Skills and Competencies

The use of XR technologies in business is most frequently associated with marketing activities (50%), staff training (40%), enhancing customer experiences (35%), product development (30%), and improving operational efficiency (25%). At the same time, several barriers continue to limit XR adoption. The most frequently reported challenges are high implementation costs (70%), lack of relevant expertise (60%), uncertainty regarding return on investment (50%), limited understanding of XR technologies (45%), and integration difficulties (40%).

Sustainability is also an important concern for the surveyed organizations, with 50% describing it as a “major priority.” The most commonly implemented sustainability practices include energy-efficiency measures (60%), waste reduction (55%), support for local communities (50%), cultural preservation initiatives (45%), green certification (40%), and sustainable supply-chain practices (35%). The main challenges associated with sustainability initiatives include costs (55%), lack of knowledge and expertise (50%), operational complexity (45%), and limited market demand (40%).

Overall, the findings indicate that industry representatives perceive notable gaps in both digital and green skills. These observations are broadly consistent with students’ self-assessments; for example, a 60% digital-skills gap identified by industry corresponds with 55% of students assessing their own digital competencies as “Below Average.” Both groups also point to the need for more practical XR-related training, with approximately 40–50% of responses supporting this direction, as well as stronger integration of XR technologies with sustainability-related competencies (45%).

The analysis further indicates an association between the level of XR use within organizations and employers’ assessment of graduates’ entrepreneurial mindset. Organizations reporting a “Moderate use” of XR technologies (30%) tended to assess graduates’ entrepreneurial competencies more positively. Although this relationship should not be interpreted as evidence of causality, it suggests that greater exposure to XR-based learning and training may contribute to the development of competencies relevant to workplace readiness and entrepreneurship.

3.5.3 Key Insights, Common Points, and Implications for Training Needs

Cross-group analysis suggests similar patterns in perceived training needs. Across teachers, students, and industry representatives, XR-related competence or awareness appears limited to moderate, while the perceived importance of XR is relatively high. In broad terms, around 50–60% of responses point to average or below-average levels of XR-related preparedness, whereas 70–80% indicate that XR is considered important or essential. This pattern suggests a widespread need for more practical XR training within VET.

For example, basic XR concepts appear to require further development across all groups. Teachers most frequently assessed their proficiency in this area as “Average” (45%), and students did so even more often (50%). Among industry representatives, 50% reported only “Somewhat” awareness of XR, which indicates moderate familiarity rather than advanced understanding. Taken together, these findings point to the value of introductory XR workshops and foundational training.

A similar pattern can be observed for XR device operation. This area appears particularly weak among students, with 55% assessing themselves as “Below Average”, and among teachers, with 50% selecting the same category. In addition, 40% of industry respondents recommended XR-related training in this area, further underscoring the need for hands-on learning opportunities. These results suggest that practical, experience-based training sessions may be especially important for strengthening XR readiness.

Figure 15 illustrates the gap between XR-related preparedness and the perceived importance of XR across VET teachers, students, and industry representatives.

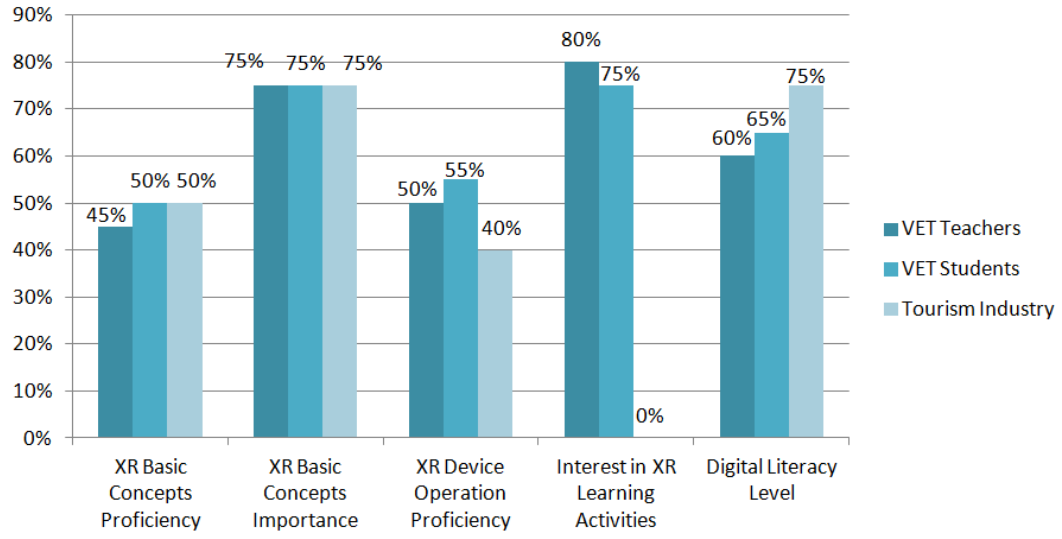


Figure 15. XR Proficiency vs. Importance Across Groups

Common patterns can also be observed in the perceived importance and practical application of XR across the three groups. Marketing and customer engagement emerged as particularly prominent

areas, with 60–65% of teachers and students rating these applications as “Important”, while 50% of industry respondents reported using XR for marketing-related activities. Content creation was identified as a relevant area by approximately 40–50% of respondents across the groups, while troubleshooting was highlighted by around 30–45%.

Overall, these findings suggest a shared emphasis on customer-facing and communication-oriented applications of XR, accompanied by continued interest in content development and technical support skills. Figure 16 presents the priority XR application areas identified across the groups, with particular emphasis on marketing and customer engagement.

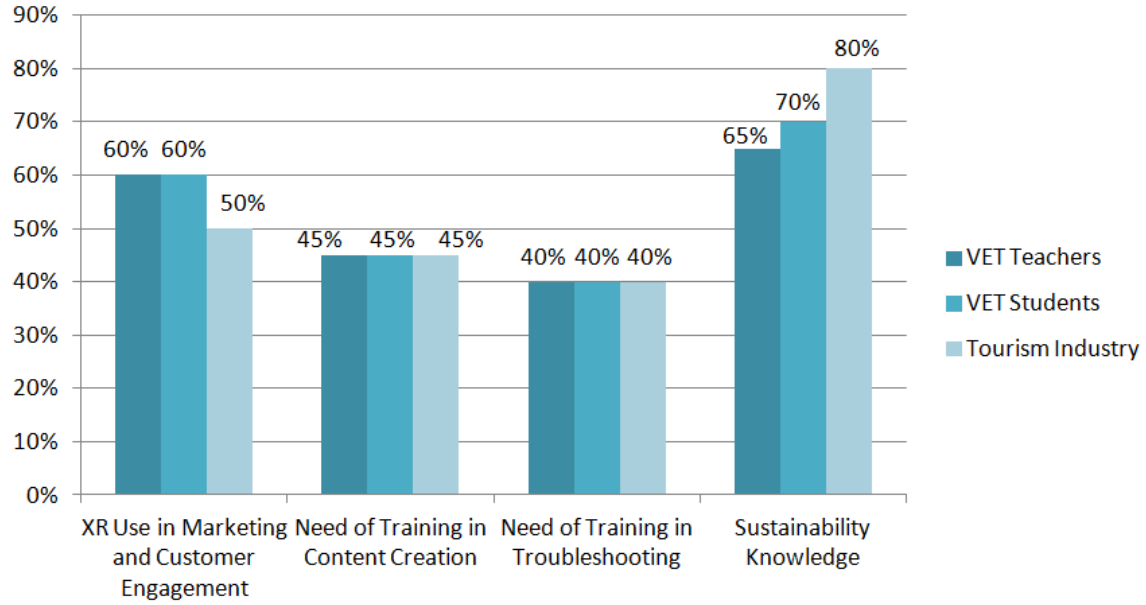


Figure 16. Priorities for XR Applications Across Groups

Common barriers to XR adoption were identified across the three stakeholder groups. Limited access to XR equipment emerged as one of the most frequently reported constraints (70–80%), followed by insufficient training opportunities (60–70%) and time- or curriculum-related constraints (50–65%). The consistency of these findings across teachers, students, and industry representatives suggests that the barriers extend beyond individual skills and may also reflect broader structural and institutional limitations.

These findings point to the potential value of systemic support measures, such as shared access to XR laboratories and equipment, expanded opportunities for practical training, and greater integration of XR activities into VET curricula and training provision. Figure 17 summarizes the main barriers to XR adoption identified across teachers, students, and industry representatives

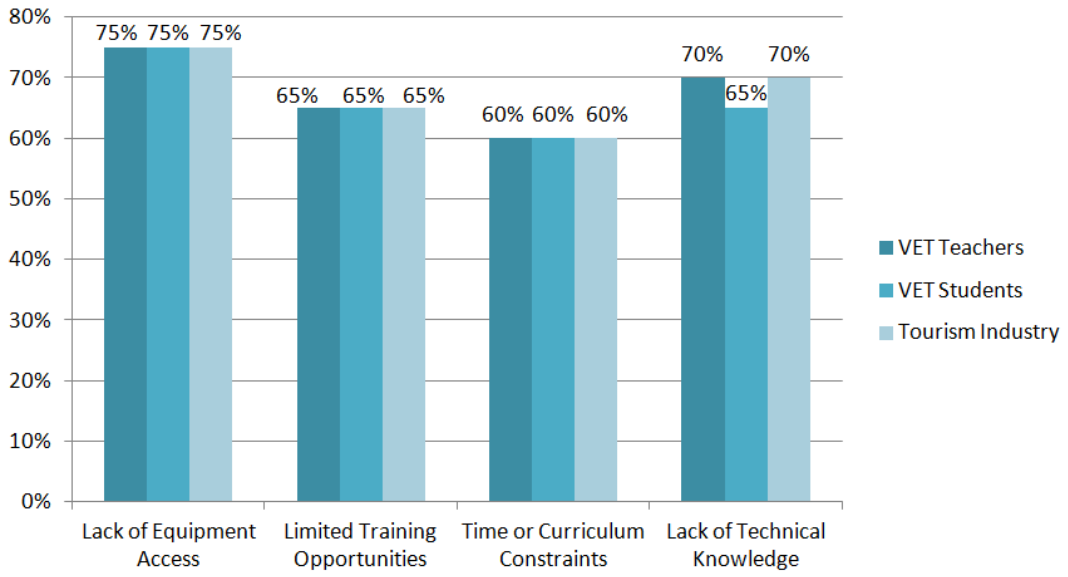


Figure 17. Barriers to XR Adoption Across Groups

Sustainability-related findings also indicate a need for further competence development. Across the stakeholder groups, respondents most frequently reported basic to good levels of sustainability-related knowledge (approximately 50–60%), while sustainability itself was assigned a high level of importance, with up to 80% of respondents describing it as “Essential”. XR was also perceived as a potentially valuable tool for sustainability-related learning by approximately 70% of respondents. Environmental conservation emerged as one of the areas of particular interest, identified by around 45–50% of participants.

Entrepreneurial competences displayed a similar pattern. Students and teachers most frequently assessed their entrepreneurial skills as “Average” (approximately 50%), while 45% of industry respondents evaluated graduates’ entrepreneurial mindset as “Moderate”. Areas identified for further development included business planning (40–45%) and sustainable business practices (30–35%). Taken together, these findings suggest potential value in combining XR-related learning with entrepreneurship and sustainability education, for example through practical activities focused on sustainable tourism business models.

Descriptive patterns across the three stakeholder groups further suggest possible relationships between digital competence, openness to technological change, and perceptions of employability-related skills. Among teachers, higher levels of digital proficiency coincided with more frequent adaptation to technological trends. Among students, 70% perceived XR as having the potential to enhance their future professional prospects. Within the industry sample, organisations reporting greater engagement with XR also tended to provide more positive assessments of graduates’ entrepreneurial competences. These patterns should, however, be interpreted cautiously, as they do not by themselves demonstrate causal relationships.

The findings therefore point to several implications for training design. XR-related modules could place particular emphasis on areas in which the largest competence gaps were identified, including XR device operation and immersive-experience design, reported by approximately 40–55% of respondents. Practical learning opportunities could also be strengthened through cooperation between VET institutions and industry, reflecting the 50–60% support for internships, practical training, and other forms of cross-sector collaboration. In addition, institutional measures addressing access to equipment, implementation costs, and training resources may be important, given that such barriers were reported by approximately 55–70% of respondents.

Overall, the cross-group findings support an integrated approach in which XR is considered not as an isolated technological competence, but as a potential tool connecting digital skills, entrepreneurship, sustainability, and workplace-oriented learning. This may be particularly relevant in green tourism, where immersive simulations could be used to explore scenarios involving sustainable destination management, environmental conservation, resource efficiency, or sustainable business decision-making. Such applications may help create stronger links between VET learning outcomes and the evolving competence requirements of the tourism sector.

Across the dataset, the difference between relatively high perceived importance of XR and lower levels of reported proficiency, in some cases amounting to approximately 20–30 percentage points, indicates a possible implementation gap. Rather than demonstrating motivation directly, this discrepancy suggests that positive perceptions of XR are not yet fully matched by corresponding levels of competence or practical access. This reinforces the case for training models that combine theoretical or online components with hands-on practice.

Taken together, the results suggest that XR has potential to support curriculum development in areas where digital, entrepreneurial, and sustainability-related competences intersect. Frameworks such as GreenComp and EntreComp may provide useful reference points for future curriculum design, for example through XR-supported simulations of sustainable tourism enterprises or destination-management scenarios. However, the present findings do not allow the magnitude of any future reduction in skills gaps to be quantified; evaluating such effects would require dedicated pre- and post-training assessment or an experimental or longitudinal research design.

4 Evaluating Extended Reality for Tourism VET

4.1 Analytical Framework and Evaluation Design

Extended Reality (XR) technologies are increasingly discussed as potential tools for vocational education and training (VET) in tourism. Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) can create learning environments in which students encounter simulated workplaces, reconstructed cultural or natural settings, customer-service situations, safety scenarios, or digitally mediated tourism experiences. Their relevance to tourism VET derives partly from the experiential character of tourism work. Many occupational competences are difficult to develop through declarative instruction alone because they require interaction, situated judgement, communication, spatial understanding, or decision-making in dynamic environments. XR may therefore provide opportunities to connect conceptual learning with simulated professional practice. However, technological immersion should not automatically be equated with educational effectiveness. The central analytical question is not whether XR is innovative, but under what conditions it contributes meaningfully to vocational learning. This distinction is especially important in tourism VET, where technological novelty may attract considerable attention while pedagogical relevance, accessibility, cost, maintenance requirements, and long-term institutional capacity receive less consideration. The analysis presented in this chapter therefore approaches XR as a pedagogical and organisational intervention rather than merely as a technological category. Its purpose is to examine how immersive technologies can be evaluated in relation to learning objectives, professional competence development, institutional feasibility, inclusion, and sustainable implementation.

4.1.1 Objectives of the XR Evaluation Framework

The evaluation framework serves two related purposes. The first is to establish criteria for assessing whether an XR application is educationally appropriate for tourism VET. This requires consideration not only of technical functionality, but also of curriculum relevance, learner interaction, accessibility, cost, organisational feasibility, and available evidence of learning value. The second purpose is to examine the conditions under which immersive technologies can be integrated into vocational learning in a sustainable and scalable manner. This broader perspective is necessary because effective adoption depends on more than the quality of an individual application. Teacher competence, technical support, institutional budgets, available hardware, learner diversity, accessibility requirements, maintenance capacity, and curriculum flexibility all influence whether XR can move beyond isolated experimentation. The analytical framework therefore addresses both tool-level quality and system-level implementation capacity. This distinction is central to the chapter. A technically sophisticated XR application may have limited educational value if it does not support relevant learning outcomes. Conversely, a relatively simple immersive application may be valuable if it is well aligned with occupational tasks, accessible to learners, and feasible for an institution to implement and maintain over time.

4.1.2 Pedagogy Before Technology

The first principle guiding the framework is pedagogy before technology. XR should be introduced where its immersive, interactive, or spatial features contribute meaningfully to a clearly defined learning objective. This principle reverses a common technology-adoption logic. Instead of beginning with the question of how a particular device or application might be incorporated into teaching, educators should first identify the professional problem, competence, or learning outcome to be addressed and then consider whether XR offers a meaningful advantage over alternative methods. The relevant questions concern what competence the learner is expected to develop, why simulation, immersion, augmentation, or spatial interaction are relevant to that competence, what the technology allows learners to practise, observe, or experience that would otherwise be difficult, costly, risky, or impractical to reproduce, and how the activity will connect with feedback, reflection, assessment, and subsequent application in professional practice. This approach positions XR within a broader pedagogical sequence rather than treating it as a stand-alone learning event. For example, a virtual customer-service scenario may be valuable not simply because it is immersive, but because it enables repeated practice, controlled variation of situations, timely feedback, and reflective discussion. Similarly, a virtual heritage environment may support learning when physical access is constrained, but its educational value depends on how learners interpret the content and connect it with competences related to heritage management, guiding, or visitor experience. Pedagogical value therefore arises from the relationship between technology, task design, learner activity, feedback, and intended learning outcomes.

4.1.3 Five Dimensions of XR Evaluation

The framework distinguishes five principal dimensions: pedagogical value, technical quality, accessibility and inclusiveness, economic and organisational feasibility, and evidence of impact. These dimensions should be considered jointly, as a favourable assessment in one dimension cannot automatically compensate for serious limitations in another. Pedagogical value concerns the extent to which an XR application supports relevant vocational learning. Evaluation should consider alignment with curriculum objectives, the authenticity and relevance of the learning task, interactivity, opportunities for feedback, assessment potential, learner engagement, and the potential for learning to transfer to professional practice. Engagement should not, however, be treated as equivalent to learning. An immersive experience may be memorable, enjoyable, or motivating without necessarily producing substantial competence development. Evaluation should therefore distinguish among affective response, participation, perceived usefulness, knowledge acquisition, skill development, and transfer to occupational performance. Particular attention should be paid to learner agency. Applications that allow learners to make decisions, experience consequences, practise procedures, or solve problems may offer different forms of pedagogical value from applications that primarily present immersive content. Both forms can be educationally useful, but they serve different learning purposes and should be evaluated accordingly.

Technical quality concerns the operational reliability and usability of the application. Relevant considerations include stability, usability, compatibility with available hardware and software, update

requirements, technical support, interface quality, connectivity and data requirements, and ease of deployment. In vocational education, technical reliability has direct pedagogical consequences. Repeated technical failures can interrupt learning, reduce teacher confidence, consume instructional time, frustrate learners, and discourage future use. Evaluation should therefore consider not only whether an XR application functions under ideal conditions, but also whether it operates reliably within the actual technological environment of the institution. Technical assessment should additionally include lifecycle considerations. Hardware becomes obsolete, operating systems change, software licences expire, platforms may be discontinued, and applications may require continuous updating. A tool that appears technically impressive at the point of purchase may therefore become difficult or costly to sustain if long-term support, compatibility, or maintenance arrangements are insufficient.

Accessibility and inclusiveness constitute a third core dimension. Immersive technologies can remove some barriers while simultaneously creating others. Virtual access may enable learners or visitors to experience environments that are physically inaccessible, geographically distant, environmentally sensitive, fragile, or hazardous. At the same time, headsets, controllers, visual interfaces, audio design, movement requirements, language, connectivity, and previous digital experience may create new forms of exclusion. Evaluation should therefore consider physical, sensory, cognitive, linguistic, and digital accessibility. Universal-design principles are particularly relevant, and where possible, learners should have access to alternative or adapted modes of participation rather than being required to use a single technological interface. Assessment should also consider human factors such as motion sickness, visual discomfort, anxiety, disorientation, physical fatigue, and cognitive load associated with immersive environments. Accessibility should therefore be incorporated into the initial design, selection, and evaluation process rather than treated as a later adjustment.

Economic and organisational feasibility concerns whether XR can be implemented and sustained under real institutional conditions. The relevant cost of implementation is not limited to initial acquisition. Institutions need to consider software licences, hardware, maintenance, replacement, technical support, content updates, staff time, training, storage, connectivity, infrastructure upgrades, and equipment management. This supports the use of a total-cost-of-ownership perspective. Economic feasibility also depends on scale. A technology may be affordable for a small pilot involving several learners while remaining difficult to implement across an entire programme, department, or institution. Evaluation should therefore distinguish between pilot affordability and sustainable institutional adoption. Organisational capacity is closely connected with economic feasibility. Even where funding is available, implementation may remain limited if responsibility for equipment management, maintenance, teacher support, technical assistance, or pedagogical integration is unclear. The framework therefore treats financial feasibility and organisational readiness as interrelated dimensions of implementation capacity.

The fifth dimension concerns evidence of impact. Evaluation should draw, where possible, on multiple forms of evidence, including learner and teacher feedback, observed performance,

assessment results, technical records, and institutional experience. Particular care is required because XR is frequently associated with strong claims concerning learner engagement, motivation, and educational effectiveness. Positive perceptions are relevant, but they should not be treated as sufficient evidence of learning. A robust evaluation should distinguish among learner engagement, perceived usefulness, knowledge acquisition, skill performance, confidence, behavioural change, transfer to workplace tasks, and longer-term institutional adoption. Different XR applications may reasonably be expected to influence different outcomes. An immersive heritage tour, for example, may primarily support interpretation, spatial understanding, or engagement. A simulation of hotel operations may be evaluated more directly in relation to procedural performance and decision-making. A teacher-training application may need to be assessed through teachers' subsequent capacity to integrate XR meaningfully into their own pedagogical practice. Expected outcomes should therefore be aligned with the purpose and design of the application.

4.1.4 Sustainability and Technological Appropriateness

Sustainability is treated as a cross-cutting consideration within the framework rather than as an assumed benefit of XR. Immersive technologies may contribute to environmental or social objectives in particular contexts. They may support environmental education, reduce the need to access environmentally sensitive locations for selected learning activities, facilitate remote participation, or help learners visualise complex resource-management and sustainability challenges. However, XR technologies themselves have material, environmental, financial, and organisational costs. Devices require production, energy, computing resources, maintenance, replacement, connectivity, and supporting digital infrastructure. Consequently, the relationship between XR and sustainability should be evaluated rather than assumed. This leads to the principle of technological appropriateness. An XR application should be selected when its expected educational value justifies its technical, financial, environmental, and organisational requirements. Where the same learning outcome can be achieved more effectively, inclusively, or efficiently through a simpler method, technological complexity should not be treated as an advantage in itself. Technological appropriateness therefore becomes an element of critical digital judgement: the ability to select technology because it is suitable for a particular learning problem rather than because it represents a more advanced technological option.

4.1.5 Potential Areas of Application in Tourism VET

The framework can be applied across several areas of tourism VET. One area is occupational simulation, where XR may be used to reproduce customer-service encounters, emergency situations, hospitality operations, guiding contexts, or other situations in which learners need to practise decision-making, communication, or professional interaction. A second area concerns cultural and environmental interpretation, as immersive environments may allow learners to examine heritage sites, ecosystems, destination conditions, landscapes, or spatial relationships that are difficult to reproduce in conventional classrooms. A third area is digital storytelling and experience design, where learners can analyse or develop immersive tourism content, thereby combining digital, interpretative, creative, and entrepreneurial competences. A fourth area concerns accessibility and

inclusive tourism. XR can support the exploration and simulation of visitor barriers while simultaneously providing an opportunity for learners to evaluate the accessibility of digital tourism experiences themselves. A fifth area relates to entrepreneurship and problem solving, where immersive environments can provide scenarios in which learners design products, respond to changing conditions, evaluate alternative service solutions, or consider the consequences of different business decisions. Across all these applications, the objective is not to maximise the use of XR, but to identify situations in which immersion, simulation, augmentation, or spatial interaction offer distinctive educational value.

4.1.6 Evaluation Design

The methodological design combines several forms of evidence in order to examine XR from different perspectives. The evaluation protocol envisages a sequence involving mapping, screening, pilot evaluation, stakeholder input, comparative analysis, and the development of implementation guidance. For the purposes of scientific analysis, these stages can be understood as an evaluation pathway rather than as a sequence of administrative project tasks. Mapping consists of identifying XR applications potentially relevant to tourism and hospitality VET. Potential sources include academic literature, industry reports, educational-technology catalogues, existing training initiatives, and contributions from educational and industry partners. The purpose of mapping is exploratory: it establishes the range of available technologies and use cases and identifies applications that may warrant more detailed assessment. Screening then evaluates whether identified applications meet basic requirements for educational consideration, including vocational relevance, availability for educational use, language requirements, hardware and software compatibility, accessibility, data requirements, and feasibility within VET environments. Screening helps prevent resources from being invested in technologies that are clearly unsuitable for the relevant institutional, educational, or learner context.

Applications that progress beyond the screening stage may be subjected to pilot evaluation in order to generate evidence concerning usability, learner interaction, technical performance, accessibility, and pedagogical relevance. Pilot testing should be treated as exploratory unless sample size, research design, measurement procedures, and comparison conditions permit stronger inference. Observation of engagement or positive learner feedback can provide evidence of acceptability, usability, or perceived value, but does not by itself establish superior learning effectiveness. Interpretation of pilot evidence should therefore remain proportionate to the methodological design and the quality of the evidence collected. Stakeholder evaluation adds complementary perspectives. Students can provide information concerning usability, engagement, comfort, accessibility, and perceived learning value. Teachers contribute knowledge about curriculum alignment, instructional feasibility, classroom management, assessment, preparation requirements, and pedagogical integration. Industry stakeholders can provide perspectives on occupational relevance, workplace expectations, and potential applications within tourism practice. Technology providers may contribute technical information, although potential commercial interests should be considered when interpreting claims about effectiveness, scalability, or return on

investment. Stakeholder perspectives should therefore be regarded as complementary rather than interchangeable.

Where similar tools or application types are evaluated across different institutional or national contexts, comparative synthesis can help identify recurring enabling conditions and barriers. The purpose of such comparison should not be to rank countries or institutions according to technological sophistication. More informative questions concern why a particular application may function effectively in one environment but be difficult to implement or sustain in another. Relevant contextual differences may include infrastructure, teacher readiness, language, funding, class size, institutional leadership, learner characteristics, technical support, curriculum flexibility, and cooperation with industry. Comparative analysis can therefore help distinguish characteristics of the technology itself from characteristics of the environment in which it is implemented.

4.1.7 Mixed Evidence and Methodological Triangulation

A multidimensional evaluation of XR benefits from combining quantitative and qualitative evidence. Questionnaires can capture patterns in perceived usability, confidence, usefulness, readiness, and adoption barriers, while interviews and focus groups can provide insight into why particular technologies are accepted, resisted, valued, or difficult to integrate. Observation during pilot activities can identify interaction difficulties, accessibility barriers, classroom-management issues, and technical problems that may not be fully captured through self-report measures. Performance tasks may provide evidence of whether learners can apply specific procedures, skills, or knowledge following an immersive activity, while institutional data can contribute information about cost, maintenance, frequency of use, technical support requirements, and continuation beyond the pilot stage. These forms of evidence should be regarded as complementary. Triangulation is valuable not because different data sources must necessarily produce identical conclusions, but because convergence and divergence can both improve understanding of implementation. Students may, for example, evaluate an application positively while teachers consider it difficult to manage within normal teaching conditions. A tool may produce high engagement while simultaneously requiring extensive technical support, or an institution may be able to finance a small pilot while lacking the resources required for broader deployment. Such divergence is analytically informative rather than inherently problematic.

4.1.8 From Technological Readiness to Pedagogical Readiness

The framework requires a clear distinction between technological and pedagogical readiness. An institution may possess appropriate hardware while lacking teachers with the confidence, competence, or support required to integrate it meaningfully into learning. Conversely, teachers may be willing and pedagogically prepared to use immersive technologies but unable to implement them because equipment, software, infrastructure, or technical support is unavailable. XR adoption therefore depends on the interaction of technical readiness, teacher readiness, curriculum readiness, organisational readiness, accessibility readiness, and financial readiness. This multidimensional perspective helps explain why investment in technology alone may produce limited educational change. The critical implementation question is therefore not simply whether an institution

possesses XR equipment, but whether it has the pedagogical and organisational capacity to use that equipment repeatedly, inclusively, and meaningfully.

4.1.9 From Pilot Adoption to Sustainable Institutionalisation

A further analytical distinction concerns the transition from pilot activity to sustained institutional use. XR initiatives are frequently introduced through temporary projects, grants, experimental laboratories, or the enthusiasm of individual teachers. Such pilots can be valuable for exploration and learning, but their existence does not by itself demonstrate institutional scalability or sustainability. Sustainable institutionalisation requires additional conditions: the technology needs to be aligned with curriculum objectives; teachers require continuing access to training, pedagogical support, and technical assistance; equipment requires maintenance, replacement, and appropriate storage; digital content and software may require updating; accessibility needs to be reviewed over time; funding must extend beyond initial acquisition; and responsibility for equipment, systems, and support needs to be organisationally defined. Evidence concerning educational value should also inform decisions about continuation, modification, expansion, or discontinuation. Scalability should therefore not be interpreted solely as the technical possibility of deploying a tool in additional locations. A more useful concept is institutional sustainability, understood as the capacity of a VET organisation to continue using, maintaining, evaluating, and adapting an educational technology after initial external support, project funding, or technological novelty has diminished.

4.1.10 A Five-Dimensional Evaluation Matrix

The analytical framework can consequently be summarised through five core questions. Pedagogical value asks whether the XR application supports a clearly defined and occupationally relevant learning outcome. Technical quality concerns whether the application can operate reliably within the technological conditions of the institution. Accessibility and inclusion address whether diverse learners can participate meaningfully without unnecessary new barriers being created. Economic and organisational feasibility concerns whether the institution can afford, maintain, support, manage, and scale the application over time. Evidence of impact asks what evidence indicates that the application produces the intended educational or institutional outcomes. These five dimensions are connected by a sixth, overarching question: Is XR the appropriate technology for this learning problem? This final question is fundamental. An application should not be adopted simply because it represents an advanced technological option. It should be selected where immersive, augmented, or spatial functionality offers educational value sufficient to justify the associated costs, constraints, accessibility considerations, and implementation requirements. The framework therefore shifts XR evaluation away from technological enthusiasm and towards pedagogically grounded, evidence-informed, and institutionally responsible adoption. This perspective is consistent with the broader competence model developed in the preceding chapter. For learners, meaningful XR use requires critical digital agency; for teachers, it requires the capacity to design, facilitate, and evaluate immersive learning; and for institutions, it requires adaptive curriculum capacity and implementation capability. XR evaluation therefore becomes not only an

assessment of technology, but also an assessment of whether the surrounding competence ecosystem is capable of transforming technological possibilities into meaningful learning.

4.1.11 Inclusion, Ethics, and Responsible Data Use

Accessibility and ethical considerations form integral components of XR evaluation. Immersive technologies may expand participation in learning, but they can also create new barriers when interfaces, hardware, interaction modes, or content are not designed for diverse users. Evaluation should therefore consider whether learners can navigate an environment clearly, whether alternative forms of interaction are available, and whether the application accommodates differences in physical ability, sensory access, language, previous digital experience, and cognitive load. This extends the principle of accessibility beyond interface usability. Inclusive XR requires attention to the entire learning process, including access to equipment, physical comfort, instructions, interaction design, teacher support, assessment procedures, and alternative routes through the learning activity. A learner who cannot comfortably use a headset or interact with a particular controller should not automatically be excluded from the intended educational objective. The relevant question is whether equivalent or sufficiently comparable participation can be achieved through adapted or alternative modes.

Ethical considerations become particularly important where XR systems collect personal, behavioural, or biometric data. Some applications may record movement, gaze direction, voice, performance, interaction patterns, spatial behaviour, or other data generated during immersive activity. Where biometric or behavioural information is collected, the implications may be more significant than in many conventional digital-learning environments. Evaluation should therefore consider data minimisation, transparency, purpose limitation, storage, access, retention, security, and learner awareness. Participants should understand what information is collected, why it is required, how it is processed, who can access it, how long it is retained, and whether participation depends on consenting to forms of data collection that are not essential to the learning objective. Cloud-based XR environments may introduce additional concerns relating to external providers, data location, account creation, profiling, platform dependence, and institutional control over learner information. Responsible adoption therefore requires not only compliance with applicable data-protection requirements but also ethical proportionality. The collection of detailed behavioural or biometric information should be justified by educational need rather than by the mere technical capability of the application. This introduces another dimension of critical digital agency: the capacity to distinguish between what technology can collect and what an educational institution should collect.

4.1.12 Cross-Context Comparability

The comparative character of the study requires a degree of procedural standardisation across participating national and institutional contexts. Common evaluation templates, shared definitions, harmonised survey and interview protocols, and a consistent taxonomy of XR technologies can improve the comparability of evidence collected across institutions and countries. However, standardisation does not eliminate contextual variation. Differences in VET structures, institutional

resources, teacher experience, language, curriculum design, learner characteristics, access to technology, technical support, and national educational arrangements may influence how the same XR application is perceived, implemented, and sustained. The objective should therefore not be complete equivalence across contexts, but rather structured comparability. Structured comparability means that the same analytical dimensions are examined across cases while contextual conditions remain part of the interpretation. For example, two institutions may evaluate the same application using identical usability criteria while reaching different conclusions because one has dedicated technical support and the other does not. Such differences should not automatically be interpreted as measurement inconsistency, as they may reveal precisely which institutional conditions shape successful or unsuccessful implementation. Harmonised instruments can therefore support comparison, but cross-country interpretation should distinguish carefully between characteristics of the XR application and characteristics of the surrounding VET environment.

4.1.13 Iterative Evaluation and Feedback

XR evaluation is more appropriately understood as an iterative rather than strictly linear process. Pilot use may reveal problems that were not visible during initial screening, teachers may identify pedagogical or organisational constraints after observing learners in practice, students may experience usability, comfort, or accessibility barriers that were not anticipated during design, and technical updates may alter functionality, compatibility, or usability during the evaluation period. The framework should therefore allow evaluation criteria, instruments, and implementation procedures to be refined in response to emerging evidence. This does not mean modifying evaluation criteria opportunistically in order to produce more favourable results. Any changes should be documented, justified, and, where relevant, taken into account when interpreting results. The value of iteration lies in improving the explanatory quality and practical relevance of the evaluation. If repeated observations indicate that learner discomfort significantly affects participation, human-factor criteria may require greater attention. If teachers consistently identify preparation time as a major adoption barrier, organisational feasibility may require more detailed examination. If accessibility differs markedly between learner groups, evaluation may need more differentiated measures and alternative participation pathways. An iterative approach therefore connects evaluation with organisational learning. Institutions do not merely assess an XR application at a single point in time; they develop knowledge about how the technology interacts with teaching practice, learners, infrastructure, and organisational processes, and they adjust implementation accordingly. This process is particularly important in an emerging technological field in which applications, platforms, standards, and institutional experience may change rapidly.

4.1.14 Scope of Inference and Expected Analytical Contribution

The evaluation design can support several forms of analysis. It can identify types of XR applications relevant to tourism VET, compare their pedagogical and technical characteristics, examine barriers and enabling conditions, assess stakeholder perceptions, and identify institutional factors that support or constrain implementation. Where pilot evidence is available, the framework may also provide information about usability, engagement, perceived learning value, accessibility,

and selected performance outcomes. However, the strength of any conclusions must remain proportional to the evidence collected. Pilot studies involving limited samples cannot by themselves demonstrate broad educational effectiveness or European-level scalability. Positive stakeholder feedback cannot be treated as proof of competence development or transfer to professional practice. Similarly, common evaluation templates can improve comparability but cannot eliminate differences between national VET systems, institutional contexts, or participant groups. The methodological contribution of the framework therefore lies less in producing a definitive ranking of XR technologies than in establishing a structured basis for responsible selection, contextual evaluation, and evidence-informed adoption. This is consistent with the wider argument of the monograph. The central question is not whether XR should be mainstreamed simply because it represents technological progress, but whether particular immersive technologies improve or support learning sufficiently, inclusively, feasibly, and sustainably to justify their adoption within specific vocational contexts. The methodological framework developed here is intended to support that judgement.

4.2 Classification of XR Applications in Tourism VET

The rapid development of Extended Reality (XR) has resulted in a heterogeneous range of technologies that differ substantially in technological form, modes of interaction, pedagogical purpose, and degree of institutional integration. In the context of tourism vocational education and training (VET), a meaningful classification cannot therefore be based exclusively on the conventional distinction between Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). Although this distinction remains technically relevant, it provides only limited information concerning the educational function and pedagogical value of a given application. Two VR applications may rely on similar hardware while serving fundamentally different educational purposes: one may provide a largely observational virtual heritage tour, whereas another may require learners to make operational decisions within a simulated hotel environment. Similarly, the same AR technology may support visitor interpretation, environmental education, workplace guidance, or project-based learning. A multidimensional taxonomy is therefore required.

Three complementary dimensions are particularly relevant for the classification of XR applications in tourism VET: technological form, referring to the manner in which physical and digital environments are combined; pedagogical function, referring to the activities expected of learners and the competences that the application is intended to develop; and level of VET integration, referring to the extent to which XR functions as an occasional learning resource, a structured component of a module, an environment for occupational simulation, or an element of a wider curricular and institutional strategy. The analytical value of this approach lies in separating technological characteristics from educational purpose. Technological form determines which modes of interaction are technically possible; pedagogical function determines whether and how those possibilities contribute to learning; and institutional integration determines whether the application remains an isolated experiment or becomes part of sustained vocational education.

4.2.1 Classification by Technological Form

At the most fundamental level, XR applications can be differentiated according to the relationship they establish between the physical and digital environment. This technological classification provides a necessary descriptive foundation, although it should not in itself be regarded as an indicator of educational quality.

Virtual Reality

Virtual Reality creates an immersive digital environment that substantially replaces the user's immediate physical surroundings. Depending on the design of the application, VR may reproduce an existing location, reconstruct a historical environment, simulate an occupational situation, or create an entirely artificial training scenario. In tourism VET, VR may be particularly relevant where learning depends on spatial experience, contextualised decision-making, repeated practice, or access to environments that would be difficult, costly, unsafe, or impractical to reproduce physically. Potential applications include simulated reception and customer-service situations, hotel and hospitality operations, emergency scenarios, guiding environments, heritage interpretation, and environmental education.

The pedagogical value of VR varies considerably according to the degree of learner agency embedded in the application. Some applications are primarily observational and allow learners to explore or inspect a virtual environment. Others require interaction, decision-making, procedural action, or communication. More complex simulations may allow decisions to generate consequences that become part of the learning process. From an educational perspective, these distinctions are more significant than immersion alone. A passive 360-degree environment and an interactive occupational simulation should therefore not be treated as pedagogically equivalent merely because both are delivered through a VR headset. The educational relevance of VR depends on the nature of the task, the level of learner activity, the opportunities for feedback and reflection, and the relationship between the immersive experience and intended vocational learning outcomes.

Augmented Reality

Augmented Reality supplements the physical environment with digital information rather than replacing it. AR can be delivered through smartphones, tablets, smart glasses, or other devices capable of combining perception of the physical world with digitally generated content. This characteristic makes AR particularly relevant to situated learning, as information can be provided in the location in which the learner is expected to interpret, apply, or act upon it.

Within tourism VET, AR may support interactive maps, heritage interpretation, environmental education, guided routes, location-based storytelling, workplace instructions, and field-based assignments. Its pedagogical significance derives from the relationship between digital information and the physical context in which learning occurs. Learners remain situated within the real environment while receiving additional layers of explanation, visualisation, guidance, or contextual information. This may be especially valuable in tourism-related occupations, in which professional competence is frequently place-dependent. Guiding, destination interpretation, hospitality

operations, environmental observation, and visitor management are all embedded in specific physical and social contexts. AR may therefore contribute to connecting conceptual knowledge acquired in the classroom with field-based application.

Its educational usefulness nevertheless depends on several implementation conditions, including interface simplicity, availability and usability of devices, connectivity, geolocation accuracy where relevant, and the extent to which digital information supports rather than distracts from engagement with the physical environment. The presence of an additional digital layer should therefore not be assumed to enhance learning automatically; its value depends on the extent to which it contributes to the intended task and facilitates meaningful interaction with the real-world context.

Mixed Reality

Mixed Reality combines physical and digital elements in ways that allow them to interact dynamically within a shared environment. Compared with conventional forms of AR, MR may enable digital objects or agents to respond to physical space, user actions, or other participants in real time. Its potential relevance to VET lies particularly in collaborative, interactive, and spatially situated simulation.

Learners may interact with digital objects, avatars, or virtual information while retaining awareness of and engagement with the physical learning environment. Such configurations may support collaborative problem solving, service simulations, interactive spatial tasks, or scenarios in which digital and physical resources need to be coordinated. These features may be relevant to vocational learning where competence depends on the integration of spatial awareness, communication, interaction, and operational decision-making.

At the current stage of technological development, however, the use of MR in tourism VET should be approached cautiously. Increased technological sophistication may also entail higher equipment costs, greater implementation complexity, more extensive teacher-training requirements, and increased maintenance and support needs. The capacity of MR to facilitate more complex interaction does not in itself demonstrate superior pedagogical value. Its use should therefore be justified by learning objectives that specifically benefit from or require meaningful interaction between physical and digital elements. In accordance with the principle of technological appropriateness, MR should be selected because its distinctive affordances support the learning task rather than because it represents a more advanced technological option.

Hybrid XR Environments

Some educational applications combine several forms of immersive and digital technology and cannot therefore be classified adequately within a single technological category. A tourism course may, for example, employ VR for preparatory simulation, AR during a field visit, and an online learning environment for subsequent reflection and assessment. Similarly, an immersive heritage project may integrate 360-degree environments, mobile AR, digital maps, conventional web

resources, and non-digital learning activities. Such configurations can be conceptualised as hybrid XR learning environments.

The educational significance of hybrid environments lies in their capacity to distribute learning across different technological, spatial, and pedagogical contexts. XR does not need to function as an isolated or self-contained experience; it can constitute one component of a broader learning sequence. Such a sequence may progress from preparation to immersive simulation, field application, and reflection, or from theoretical instruction to virtual exploration, physical-site activity, and subsequent assessment. This sequencing is particularly relevant to vocational education because it establishes a relationship between digital experience and physical practice rather than treating the two as competing alternatives.

Hybridisation also reinforces the need to distinguish technological sophistication from pedagogical quality. The most educationally developed solution may not involve the most advanced individual device. Instead, it may consist of a deliberately designed combination of technologies, learning activities, workplace experiences, and reflective processes in which each component fulfils a clearly defined pedagogical function. The quality of a hybrid XR environment should therefore be assessed primarily in terms of the coherence of the overall learning sequence rather than the technological novelty of its individual components.

4.2.2 Limits of a Technology-Based Taxonomy

The distinction between VR, AR, MR, and hybrid environments provides a useful technical vocabulary, but it should not constitute the primary basis for evaluating educational value. A technology-based classification explains how an application is delivered, but it does not establish what learners are expected to do, which competences are intended to be developed, or how the activity is embedded within a curriculum and wider learning process. From a VET perspective, these latter dimensions are more consequential.

A comparatively simple smartphone-based AR application may have greater pedagogical value than an expensive immersive simulation if it effectively supports an authentic occupational task. Conversely, a highly realistic VR environment may produce limited educational benefit where learners remain largely passive, the activity lacks clearly defined learning outcomes, or the experience is not connected with feedback, reflection, assessment, or subsequent professional practice. Technological sophistication should therefore not be used as a proxy for pedagogical quality.

The classification proposed in this chapter accordingly treats technological form as only the first analytical dimension. The subsequent dimensions—pedagogical function and level of curricular and institutional integration—provide a more substantive basis for determining the role that XR may play in vocational learning. The central analytical question consequently shifts from the type of technology being used to the nature of the learning process it enables and the extent to which that process contributes to relevant professional competence.

4.2.3 Classification by Pedagogical Function

Technological form provides only partial information concerning the educational relevance of an XR application. In vocational education, a more important analytical question concerns what learners are expected to do within an XR environment and which forms of competence the activity is intended to develop. XR applications can therefore be classified according to their principal pedagogical function.

A functional classification makes it possible to compare technologically different applications that support similar forms of learning and, conversely, to distinguish applications that use similar hardware but serve fundamentally different educational purposes. Five principal pedagogical functions emerge from the analysed material: occupational simulation and skill rehearsal, experiential and interpretative learning, competence assessment in simulated contexts, collaborative and social learning, and awareness-oriented learning and ethical reflection[128].

Occupational Simulation and Skill Rehearsal

The first pedagogical function concerns the simulation of professional tasks, processes, and situations. XR can reproduce workplace contexts in which learners practise procedures, make decisions, interact with customers, respond to operational problems, or manage situations that would be difficult to reproduce repeatedly in authentic workplaces. Potential tourism applications include reception procedures, customer-service encounters, emergency situations, guiding scenarios, safety protocols, hospitality operations, and other occupational tasks whose reproduction in real settings may be costly, logistically difficult, disruptive, or associated with safety risks.

The principal pedagogical advantage of simulation lies in the possibility of controlled and repeatable practice. Learners can perform the same or modified tasks repeatedly, encounter different scenarios, receive structured feedback, and reflect on the consequences of their decisions without exposing real visitors, customers, employees, or organisations to the potential consequences of novice performance. Simulation may therefore create a protected learning environment in which errors become part of the learning process rather than sources of immediate professional risk[129].

This function is particularly relevant where occupational competence requires the simultaneous integration of several forms of knowledge and skill. A simulated reception shift, for example, may require communication skills, use of digital systems, problem solving, cultural sensitivity, emotional regulation, prioritisation, and decision-making. XR may therefore support the development of integrated or hybrid professional competence rather than isolated technical skills.

The degree of visual realism should nevertheless not be equated with educational effectiveness. A highly realistic simulation may still have limited pedagogical value where learners remain passive, feedback is absent, performance is not assessed, or the activity is disconnected from subsequent

[128] J. Radianti, T. A. Majchrzak, J. Fromm, I. Wohlgenannt, “A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda”, Computers & Education, vol. 147, 2020.

[129] Cedefop, Teachers and Trainers in a Changing World: Building up Competences for Inclusive, Green and Digitalised Vocational Education and Training (VET): Synthesis Report, Cedefop Research Paper No. 86, Publications Office of the European Union, Luxembourg 2022.

reflection and workplace practice. The educational effectiveness of simulation depends on the quality of the entire pedagogical sequence, which may be conceptualised as preparation - action - consequence - feedback - reflection - repeated performance. This sequence is more important to competence development than visual fidelity alone.

Experiential and Interpretative Learning

A second pedagogical function concerns the immersive exploration and interpretation of cultural, historical, environmental, and destination-related contexts. XR can provide access to locations that are geographically distant, physically inaccessible, environmentally sensitive, historically reconstructed, fragile, or otherwise difficult to incorporate into conventional classroom learning. In tourism VET, this function may be particularly relevant to heritage interpretation, destination knowledge, environmental education, intercultural learning, and guiding.

The educational value of such applications does not derive simply from the possibility of virtually "visiting" a location. For meaningful learning to occur, learners need to interpret, analyse, contextualise, and critically evaluate what they encounter. A virtual heritage site may, for example, provide the basis for analysing storytelling strategies, authenticity, visitor experience, accessibility, conservation, or the social construction of heritage. Similarly, an immersive representation of a natural environment may support analysis of biodiversity, tourism carrying capacity, visitor behaviour, environmental pressures, conservation strategies, or ecological interpretation.

Immersive environments can consequently function not only as spaces of experience but also as objects of inquiry. This distinction is important because educational value arises from the analytical activity surrounding the immersive experience rather than from immersion itself.

Claims concerning the development of empathy, intercultural awareness, or deeper understanding through immersive technologies should nevertheless be formulated cautiously. A sense of presence or emotional engagement may support attention and reflection, but it does not automatically result in sophisticated cultural understanding or changes in attitudes. Appropriate educational design must connect immersive experience with contextual knowledge, critical discussion, comparison of perspectives, and structured reflection. Experiential XR is therefore most valuable when immersion constitutes the starting point of interpretation rather than its endpoint.

Competence Assessment in Simulated Contexts

XR can create controlled environments in which learners demonstrate professional competence through action rather than exclusively through written, oral, or declarative forms of assessment. A learner may, for example, be required to respond to a customer complaint, manage several competing tasks, make a safety-related decision, communicate with a visitor, or complete an operational procedure within a simulated environment.

Such applications have the potential to increase the authenticity of assessment. Professional competence in tourism frequently depends on situated judgement, communication, timing, prioritisation, interaction, and adaptation to changing circumstances. These dimensions of performance may be difficult to assess adequately through conventional knowledge tests alone. XR

may therefore create opportunities for performance-based assessment in contexts that reproduce selected characteristics of occupational practice[130].

The use of XR for assessment nevertheless requires particularly rigorous methodological design. The assessment process must distinguish between the occupational competence being evaluated and difficulties generated by the technology itself. Limited familiarity with controllers, motion discomfort, usability problems, interface design, connectivity problems, or technical failure should not be interpreted as evidence of insufficient professional competence.

Assessment criteria must also be explicit and transparent. Where communication, problem solving, procedural accuracy, situational judgement, or decision quality are evaluated, each construct should be operationalised through clearly defined indicators. Reliability, validity, accessibility, and comparability become particularly important where XR-based assessment contributes to formal grading, certification, or recognition of competence. The potential of XR to support authentic assessment is therefore significant, but stronger claims concerning formal certification should be made only where the relevant validation procedures, recognition mechanisms, and evidence of assessment quality have been established.

Collaborative and Social Learning

A fourth pedagogical function concerns collaborative and social learning. Multi-user immersive environments can enable learners to solve problems jointly, perform complementary professional roles, coordinate activities, exchange information, and communicate within shared scenarios. This function is particularly relevant to tourism because many occupational tasks are inherently social and organisational rather than purely individual.

Hospitality operations, events, guiding, destination management, customer service, and crisis response frequently require collaboration among multiple actors. XR may therefore provide structured environments in which learners practise teamwork, leadership, communication, negotiation, coordination, conflict management, and collective decision-making.

One potential advantage of collaborative XR lies in making interaction more observable and susceptible to subsequent analysis. Teachers may examine how learners distribute responsibilities, exchange information, make decisions, coordinate activities, respond to uncertainty, or manage disagreement. The immersive activity can subsequently be followed by structured debriefing and reflection in which both task performance and group processes are analysed.

Collaborative XR should not, however, be assumed to be inherently superior to conventional group work. Its pedagogical value depends on whether immersion, spatial interaction, or simulation makes possible a form of collaboration that would otherwise be difficult to reproduce or observe. For some learning objectives, face-to-face role play or other forms of collaborative learning may be simpler, less costly, and equally or more effective. The appropriate question is therefore not whether

[130] C. Redecker, European Framework for the Digital Competence of Educators: DigCompEdu, Y. Punie (ed.), EUR 28775 EN, Publications Office of the European Union, Luxembourg 2017.

XR can facilitate collaboration, but whether it provides additional educational value for a particular collaborative task.

Awareness, Perspective-Taking, and Ethical Reflection

A fifth pedagogical function concerns awareness-oriented learning, perspective-taking, and ethical reflection. Immersive environments can visualise environmental change, visitor pressure, heritage vulnerability, accessibility barriers, resource use, or other consequences of tourism development that may be difficult to communicate through abstract description alone. Such applications may encourage learners to examine the ecological, social, cultural, and ethical implications of tourism activity.

This function is particularly relevant to education for sustainable tourism. Learners may compare alternative tourism-development scenarios, observe simulated environmental pressures, examine accessibility barriers, analyse conflicts between visitor demand and conservation needs, or explore the consequences of different visitor-management decisions. XR can therefore make complex relationships more visible and provide contexts for discussing the consequences of professional and organisational choices.

The educational objective should nevertheless extend beyond emotional impact or awareness alone. An immersive representation of environmental degradation, overtourism, or exclusion may be memorable and emotionally engaging, but professional competence requires learners to identify causes, interpret competing interests, evaluate alternative responses, consider longer-term consequences, and formulate possible interventions.

Awareness-oriented XR should therefore be linked with the development of sustainability judgement and professional responsibility. Its educational purpose is not simply to generate concern, empathy, or emotional engagement, but to support reasoned analysis of consequences, competing values, feasible responses, and the responsibilities associated with professional decision-making in tourism.

4.2.4 Classification by Level of VET Integration

The same technology may function as an isolated demonstration in one institution while constituting a recurring and systematically embedded component of occupational learning in another. It is therefore necessary to distinguish between different levels of curricular and organisational integration. These levels should not, however, be interpreted as a linear maturity hierarchy in which increasing integration is inherently preferable. The appropriate degree of integration depends on the educational purpose of the application, its frequency of use, associated costs, implementation requirements, and the extent to which XR provides identifiable educational added value.

Experimental use represents the first level of integration. At this stage, XR is introduced through short-term pilots, workshops, demonstrations, experimental activities, or externally funded projects. Such use can perform an important exploratory function by enabling institutions to test technologies, develop initial teacher familiarity, identify technical and accessibility-related problems, and examine

learner responses before committing substantial organisational and financial resources. Experimental activities may therefore constitute relatively low-risk environments for institutional learning. Their principal limitation lies in discontinuity. A technology may cease to be used once external funding ends, project objectives have been achieved, or the teacher responsible for the initiative leaves the institution. Consequently, successful completion of a pilot should not be interpreted as evidence of sustainable adoption. The analytically relevant question is rather what the institution learns from experimentation and whether this knowledge informs subsequent pedagogical, organisational, and investment decisions.

Supplementary integration constitutes the second level. In this model, XR complements established teaching within selected modules, activities, or learning sequences. It may support, for example, a virtual site visit, an occupational simulation, an interpretative exercise, or an optional enrichment activity. Such use may be entirely appropriate where immersive learning serves a clearly defined but relatively infrequent educational purpose. Supplementary integration should therefore not be regarded as an inferior stage through which institutions must necessarily progress towards more extensive technological adoption. A limited application can represent responsible and proportionate use of technology where its contribution to learning is clear but broader deployment would offer little additional educational value. The principal vulnerability at this level is dependence on individual teachers. Where only one educator possesses the necessary competence, confidence, or motivation to use XR, continuity may remain fragile. Institutional support, documentation, shared knowledge, and access to technical assistance therefore remain relevant even where XR plays only a supplementary role.

Structured curricular integration represents the third level. Here, XR becomes an explicit component of the curriculum and is linked with defined learning outcomes, planned activities, assessment arrangements, and identified occupational competences. This constitutes a qualitative change in the role of the technology. XR is no longer treated primarily as an optional enhancement but becomes part of the planned architecture of learning. An immersive hospitality simulation, for example, may be systematically linked with customer-service competence, resource management, communication, or operational decision-making. Structured integration requires stronger pedagogical justification because educators need to identify why XR is being used, what learners are expected to achieve through the activity, how their performance or learning will be assessed, and how the immersive experience relates to classroom instruction and workplace learning. It also increases the importance of institutional reliability, as interruptions in access to hardware, software, licences, or technical support may directly affect delivery of the formal curriculum.

Institutional embedding constitutes the fourth level. At this stage, XR forms part of a broader organisational capability rather than a series of isolated technological initiatives. Infrastructure, teacher professional development, technical support, curriculum planning, accessibility procedures, procurement, maintenance, assessment, and cooperation with external partners are coordinated within a more systematic implementation model. Institutional embedding does not imply that XR should be used across all subjects or learning activities. Rather, it means that the organisation

possesses the competence and organisational capacity to determine where XR is pedagogically appropriate and to support its sustainable use in those contexts where educational value has been demonstrated. This distinction is essential because the objective is not technological saturation. An institution with a well-developed XR capability may still conclude that immersive technologies are unnecessary or disproportionate for many learning tasks. Institutional maturity should therefore be reflected in selective, pedagogically justified, and evidence-informed use, rather than in the maximum possible intensity of technology adoption.

4.2.5 Integration Maturity and Institutional Readiness

The four levels of integration demonstrate that technological adoption and institutional readiness are related but analytically distinct. An institution may experiment with highly sophisticated equipment while possessing limited capacity for long-term implementation. Conversely, another institution may rely on comparatively simple AR applications while integrating them effectively into curriculum design, teacher development, assessment, and routine learning practice. Institutional maturity should therefore be assessed not according to the number, cost, or technological sophistication of XR devices, but according to the quality and sustainability of the conditions surrounding their educational use.

Relevant dimensions of institutional readiness include curricular alignment, teacher competence, technical support, accessibility, maintenance capacity, continuity of funding, integration with assessment, and established mechanisms for evaluation, feedback, and improvement. These conditions determine whether XR can be used consistently and meaningfully rather than merely demonstrated or temporarily introduced. Such an approach shifts analytical attention away from technology ownership towards implementation capability. The central question is therefore not how much XR an institution uses, but rather how capable the institution is of using XR purposefully, repeatedly, inclusively, and critically in those contexts in which it provides demonstrable educational value.

This distinction is particularly important in vocational education, where sustainable technological integration depends on the interaction between infrastructure, teacher competence, curriculum design, organisational procedures, and occupational relevance. Readiness should consequently be understood as a multidimensional institutional property rather than as a simple indicator of access to advanced equipment.

4.2.6 Contextual Patterns and the Limits of National Generalisation

The comparative material suggests that patterns of XR adoption may reflect broader characteristics of tourism environments, institutional settings, and national VET systems. Heritage-intensive destinations may, for example, create stronger demand for immersive reconstruction, digital interpretation, or cultural-heritage applications, while institutions with more developed digital infrastructure may be better positioned to experiment with complex simulations, multi-user environments, or data-intensive technologies. Conversely, resource-constrained VET providers may encounter greater difficulty in progressing beyond small-scale or project-based experimentation.

Such patterns nevertheless require cautious interpretation. National context constitutes only one possible explanatory factor. Institutional leadership, teacher expertise, funding arrangements, partnerships with industry and technology providers, local tourism specialisation, learner characteristics, organisational priorities, and access to technological infrastructure may generate substantial differences between institutions operating within the same country. Observed differences should therefore not automatically be attributed to national characteristics.

For this reason, comparative analysis should prioritise institutional and contextual conditions rather than categorising countries as technologically advanced or technologically lagging. This is particularly important in an emerging technological field such as XR, where adoption may be concentrated within individual institutions, research projects, specialised laboratories, or externally funded initiatives and may therefore not be representative of the wider national VET system. Cross-country comparison is most analytically useful when it identifies recurring mechanisms, enabling conditions, implementation barriers, and contextual differences rather than producing rankings of technological maturity. Such an approach is also consistent with the principle of structured comparability developed in the preceding evaluation framework.

4.2.7 A Dynamic and Extensible Taxonomy

XR constitutes a rapidly evolving technological domain in which the boundaries between Virtual Reality, Augmented Reality, Mixed Reality, mobile computing, artificial intelligence, sensor technologies, learning analytics, digital twins, and related digital systems are becoming increasingly permeable. A classification intended for analytical and educational use must therefore remain sufficiently flexible to incorporate new technological configurations without requiring continuous reconstruction of its conceptual foundations.

The three dimensions proposed in this chapter—technological form, pedagogical function, and level of educational integration—provide a comparatively durable analytical structure because they are not dependent on particular commercial platforms, hardware generations, or software products. New technologies can therefore be incorporated into the taxonomy without altering its underlying logic. An AI-supported immersive simulation, for example, can still be analysed in terms of its technological configuration, the pedagogical function it performs, and the extent to which it is integrated into vocational education.

Additional analytical dimensions may be introduced where they contribute to the specific purpose of an evaluation. Such dimensions may include the intensity of data processing, degree of learner agency, level of immersion, accessibility requirements, dependence on external infrastructure, interoperability, or the extent of automated decision-making. These additional variables should supplement rather than replace the three principal axes.

The proposed taxonomy should consequently be understood as dynamic but conceptually stable. Technologies, devices, platforms, and forms of interaction are likely to continue changing rapidly, but the fundamental analytical questions concerning technological configuration, educational function, and institutional integration can remain comparatively durable. This provides a

basis for classification that is less vulnerable to technological obsolescence and more suitable for longitudinal and comparative analysis.

4.2.8 The Three-Axis Model of XR in Tourism VET

The resulting classification can be represented through three complementary analytical axes. Axis I: technological form describes the relationship between digital and physical environments and encompasses VR, AR, MR, and hybrid configurations. Axis II: pedagogical function identifies the principal form of learning supported by the application, including occupational simulation and skill rehearsal, experiential and interpretative learning, performance-based assessment, collaborative and social learning, and awareness-oriented learning and ethical reflection. Axis III: degree of educational integration identifies the position of the application within the wider learning and institutional environment, ranging from experimental intervention and supplementary use to structured curricular integration and institutional embedding.

The three axes should be analysed jointly because none provides a sufficient basis for evaluating an XR intervention independently. Technological form does not determine pedagogical value; pedagogical function does not determine organisational feasibility; and curricular integration does not in itself demonstrate educational effectiveness. A comprehensive analysis therefore concerns the specific configuration produced by the interaction of all three dimensions.

For example, an institution may employ VR + occupational simulation + structured curricular integration in hotel-service training, AR + interpretative learning + supplementary integration during heritage fieldwork, or hybrid XR + collaborative problem solving + experimental use within an interdisciplinary destination-management project. Each configuration represents a different educational intervention even where some technological components overlap.

This configurational approach avoids the assumption that any single XR category constitutes a universally superior educational model. The value of an application depends instead on the degree of fit between technological affordances, pedagogical function, competence objectives, learner characteristics, accessibility requirements, and institutional capacity. Classification therefore becomes relational rather than hierarchical: it identifies how particular technological and educational characteristics combine within a specific vocational context.

4.2.9 From Taxonomy to Pedagogical Decision-Making

The principal value of the proposed taxonomy lies not in assigning descriptive labels to technologies, but in supporting systematic pedagogical and institutional decision-making. A VET provider considering the introduction of an XR application should therefore examine three consecutive questions. The first concerns the technological characteristics of the application and the forms of interaction they make possible. The second concerns the form of learning and competence development the application is expected to support. The third concerns the level of curricular and organisational integration justified by its educational value, expected frequency of use, and implementation requirements.

These questions should subsequently be examined through the multidimensional evaluation framework developed in Section 3.1, which addresses pedagogical value, technical quality, accessibility and inclusiveness, economic and organisational feasibility, and evidence of impact. The classification and evaluation frameworks thus perform complementary analytical functions. The taxonomy identifies the type and configuration of the XR intervention under consideration, whereas the evaluation framework determines whether that intervention is pedagogically appropriate, technically viable, inclusive, economically and organisationally feasible, and supported by sufficient evidence.

Together, the two frameworks shift XR adoption away from technology-led experimentation towards purpose-driven, pedagogically grounded, and evidence-informed design. This perspective reinforces the broader argument of the study that digital innovation in VET should not be assessed according to the presence or sophistication of advanced technologies alone. Its educational significance depends on whether technologies contribute to the development of relevant professional competences, whether learners can participate inclusively, whether teachers possess the capacity to integrate them meaningfully into learning, and whether institutions can maintain and adapt them responsibly over time.

XR should therefore be regarded as educational innovation only when technological possibilities are translated into meaningful, accessible, and sustainable learning processes. The central analytical criterion is not technological novelty itself, but the extent to which a particular configuration of technology, pedagogy, and institutional capacity contributes to the objectives of vocational education.

4.3 Pedagogical and Operational Value of XR in Tourism VET

The growing interest in Extended Reality (XR) within vocational education and training is closely associated with its capacity to reproduce situations that are difficult, costly, unsafe, or impractical to create within conventional classroom environments. In the context of tourism VET, this potential is particularly relevant because occupational competence frequently depends on interaction, situated decision-making, customer-service encounters, spatial awareness, cultural interpretation, and the ability to respond appropriately to dynamic and context-dependent situations. Virtual Reality, Augmented Reality, and Mixed Reality may therefore provide learning environments in which learners can practise, observe, interpret, and experiment with professional situations either prior to or alongside participation in authentic workplace settings[131].

The pedagogical value of XR should not, however, be inferred from technological immersion alone. The evidence considered in this study points to a range of potential and perceived benefits, but the extent to which these benefits are realised depends on the type of application, the quality of pedagogical design, learner characteristics, institutional conditions, and the methods used to

[131] R. Yung, C. Khoo-Lattimore, “New realities: a systematic literature review on virtual reality and augmented reality in tourism research”, Current Issues in Tourism, vol. 22, no. 17, 2019, pp. 2056–2081.

evaluate outcomes. XR should therefore be assessed in relation to the specific learning processes it enables rather than according to the technological sophistication of the application itself. For analytical purposes, it is useful to distinguish between pedagogical value for learners and operational value for VET institutions, while recognising that these two dimensions remain closely interdependent. Pedagogical value concerns the extent to which XR supports meaningful competence development and learning processes, whereas operational value concerns the extent to which the technology can be implemented, supported, maintained, and integrated into institutional practice in a sustainable manner.

4.3.1 Experiential Learning and Situated Practice

One of the principal arguments supporting the use of XR in vocational education concerns its potential to facilitate experiential and situated learning. Immersive environments may enable learners to engage with situations that resemble professional contexts rather than limiting learning to verbal explanation, textual description, or abstract conceptualisation. In tourism education, such contexts may include customer-service interactions, hospitality operations, emergency procedures, destination interpretation, guiding scenarios, environmental situations, and culturally specific settings.

The educational value of such environments lies primarily in their capacity to connect knowledge with action. Learners may be required to make decisions, communicate with other actors, follow procedures, identify problems, interpret situations, prioritise competing demands, or respond to changing conditions. XR may therefore be particularly relevant where intended learning outcomes depend on situated judgement and applied performance rather than on the reproduction of factual knowledge alone. This is especially important in tourism occupations, where professional competence often involves the simultaneous integration of procedural, interpersonal, cultural, digital, and contextual knowledge[132].

Simulation may also reduce some of the practical limitations associated with authentic workplace learning. Scenarios can be repeated, paused, modified, or reconstructed, allowing learners to encounter situations that may arise only infrequently during an internship or that would be inappropriate, disruptive, or unsafe to reproduce with real customers, visitors, or employees. Such characteristics may support deliberate practice by providing repeated opportunities to perform selected tasks, examine the consequences of decisions, and refine performance over time.

Immersion itself does not, however, guarantee experiential learning. A learner who primarily observes a virtual environment is likely to engage in a different learning process from one who is required to make decisions, solve problems, interact with others, and respond to the consequences of his or her actions. The central pedagogical variable is therefore not immersion as such, but the quality, relevance, and cognitive demands of learner activity within the immersive environment. The

[132] G. Makransky, S. Klingenberg, “Virtual reality enhances safety training in the maritime industry: An organizational training experiment with a non-WEIRD sample”, Journal of Computer Assisted Learning, vol. 38, 2022, pp. 1127–1140.

strongest educational potential is likely to arise where XR is embedded within a broader learning cycle that combines preparation, active performance, feedback, reflection, and subsequent opportunities for further practice. In this perspective, immersive experience constitutes one element of a structured pedagogical process rather than an educational outcome in itself.

4.3.2 Bridging Classroom Learning and Workplace Performance

XR may also contribute to reducing the distance between classroom-based instruction and performance in authentic workplace settings. This function is particularly relevant in relation to the theory–practice gap identified in the stakeholder research. Learners may understand general principles of customer service, sustainability, safety, digital operations, or destination management without having sufficient opportunities to apply these principles in situations that require contextual judgement and professional action.

Immersive simulation can provide an intermediate learning environment between conceptual instruction and authentic workplace experience. This intermediate space may be particularly valuable for novice learners because it allows them to practise professional tasks without being exposed immediately to the full consequences of errors in real-world settings. Learners can encounter complex or demanding situations, receive feedback, repeat difficult tasks, and develop greater familiarity with occupational routines before entering high-pressure professional environments.

Such preparation may contribute to increased perceived confidence, familiarity, and preparedness. These outcomes should nevertheless be distinguished from demonstrated professional competence. Increased confidence does not necessarily imply improved performance, and successful task completion within a simulated environment cannot automatically be assumed to transfer to workplace behaviour. The extent to which learning acquired in XR environments is transferred to authentic occupational contexts requires separate empirical assessment.

XR should therefore be conceptualised as a potential bridge to practice rather than as a substitute for workplace learning. Its educational role is strongest when simulation is connected systematically with authentic professional experience. A coherent learning sequence may therefore take the form of conceptual preparation - immersive simulation - workplace practice - structured reflection. Within such a model, XR supports learners in preparing for workplace participation, experimenting with professional decisions, and reflecting on subsequent authentic experience.

This approach also reinforces the complementary relationship between immersive learning and work-based education. Apprenticeships, internships, placements, and other forms of workplace learning remain essential because they expose learners to real organisational cultures, interpersonal relationships, customer expectations, uncertainty, and professional responsibility. XR can complement these forms of learning by providing structured opportunities for preparation,

rehearsal, and reflection, but it should not be treated as an equivalent replacement for authentic occupational experience[133].

4.3.3 Development of Professional Competences and Broader Educational Value

Beyond the development of occupation-specific skills, XR may support a broader range of transversal professional competences that are particularly relevant to tourism and hospitality. Role-based and multi-user simulations can create opportunities to practise communication, teamwork, leadership, conflict management, decision-making, intercultural interaction, and collaborative problem solving. Such competences are difficult to develop through declarative instruction alone because they emerge through situated interaction and require learners to respond dynamically to changing circumstances. A simulated customer complaint, service failure, intercultural misunderstanding, or emergency situation may require learners not merely to reproduce theoretical knowledge but to interpret a context, select an appropriate course of action, communicate with others, and respond to the consequences of their decisions.

The educational value of such scenarios depends on their pedagogical design rather than on the degree of technological immersion alone. An immersive role-play is unlikely to contribute substantially to interpersonal competence if learners are not required to make meaningful choices or if their behaviour is not subsequently examined. Structured reflection and debriefing are therefore essential components of simulation-based learning. Learners should have opportunities to analyse not only whether a task was completed successfully, but also how they communicated, why particular decisions were made, how responsibilities were distributed, and how alternative responses might have influenced the outcome. XR can consequently support transversal competence development where it makes professional interaction observable, repeatable, and available for systematic reflection.

A related pedagogical advantage concerns the possibility of rehearsing demanding, infrequent, or potentially high-risk situations. Relevant applications in tourism may include emergency evacuation, health and safety procedures, crisis response, difficult customer interactions, crowd management, or operational decisions involving environmental resources. XR can enable learners to encounter such situations without placing visitors, colleagues, physical assets, or the learners themselves at unnecessary risk. It may also allow scenarios to be repeated and their complexity to be increased progressively. Such applications are particularly valuable where important professional situations occur too infrequently in real workplaces to ensure that every learner encounters them during training. Nevertheless, simulated performance should not be treated as equivalent to real-world mastery. Virtual environments cannot reproduce every physical, emotional, organisational, and interpersonal characteristic of authentic events. Their appropriate function is therefore preparation and rehearsal rather than substitution for real-world professional experience.

[133] D. Hamilton, J. McKechnie, E. Edgerton, C. Wilson, “Immersive virtual reality as a pedagogical tool in education: A systematic literature review of quantitative learning outcomes and experimental design”, Journal of Computers in Education, vol. 8, 2021, pp. 1–32.

The pedagogical potential of XR also extends to sustainability and environmental learning. Many tourism-related environmental processes are spatially dispersed, temporally extended, difficult to observe directly, or inappropriate to demonstrate through actual intervention. Simulation and visualisation can make selected processes more tangible by enabling learners to compare visitor-flow scenarios, examine representations of environmental pressure, analyse alternative destination-development strategies, or explore the consequences of resource-management decisions. Such applications may help connect abstract sustainability principles with specific tourism contexts. However, emotional engagement with an immersive representation should not be confused with sustainability competence. Experiences depicting overtourism, biodiversity loss, climate-related risks, or environmental degradation may raise awareness, but professional competence requires learners to interpret causes, identify relevant stakeholders, evaluate trade-offs, compare interventions, and justify decisions. XR therefore has the greatest educational relevance when it contributes to the development of sustainability judgement rather than awareness alone.

The same critical perspective should be applied to the environmental implications of XR itself. Technologies used to teach sustainability should not automatically be regarded as sustainable. Hardware production, energy consumption, computing requirements, maintenance, equipment replacement, and supporting infrastructure form part of the environmental and organisational costs of implementation. The sustainability of an educational application should therefore be evaluated in relation to the learning value it generates and the resources required to maintain it.

Cultural heritage represents another important area of educational application. XR can provide access to cultural, historical, or heritage environments that are geographically distant, physically inaccessible, fragile, reconstructed, or otherwise difficult to incorporate into regular field-based learning. Virtual heritage environments may support guiding practice, historical interpretation, destination knowledge, storytelling, and critical discussion of heritage representation. Their pedagogical value lies not only in expanding the range of contexts available to learners, but also in creating opportunities for critical examination of how heritage is represented digitally. Reconstructions necessarily involve decisions concerning what is included, how uncertainty is communicated, and how documented evidence is distinguished from interpretation. XR can therefore support the development of critical heritage literacy, for example by asking learners to assess the credibility of reconstructions, identify interpretative choices, compare digital representations with documentary evidence, or design visitor narratives that distinguish established knowledge from hypothesis. Immersive heritage should in this sense function as an object of critical inquiry rather than as a technological substitute for physical visitation.

Accessibility introduces a further dimension of educational value. XR may extend access to environments that are geographically, physically, or environmentally difficult to reach and may offer alternative forms of participation for learners who are unable to take part in selected field activities. Digital environments can also support repetition, individual pacing, subtitles, language assistance, or differentiated task complexity. These affordances may contribute to more flexible forms of learning. Claims concerning inclusivity nevertheless require caution because XR can create new barriers as well

as remove existing ones. Head-mounted displays may be unsuitable for some users; controllers can generate physical-access difficulties; visual or auditory interfaces may exclude learners with sensory disabilities; and motion sickness, anxiety, cognitive load, limited digital confidence, or lack of appropriate hardware may constrain participation. Inclusive XR should therefore be designed according to universal-design principles and should provide alternative routes to participation where immersive interaction is inaccessible or pedagogically inappropriate. Its value lies not in any inherent inclusiveness of the technology, but in the extent to which accessibility is incorporated into design and implementation[134].

Learner engagement and motivation should be interpreted within the same analytical framework. Immersive technologies are frequently perceived as engaging because of their interactivity, novelty, sense of presence, and game-like characteristics. Such responses are educationally relevant because attention and willingness to participate influence the learning process. They should not, however, be used as direct indicators of learning effectiveness. High engagement may coexist with limited competence development, and positive responses during early implementation may partly reflect a novelty effect. Evaluation should consequently distinguish among engagement, satisfaction, motivation, learning performance, retention, and transfer to professional practice. These outcomes may be related, but they are conceptually and empirically distinct. Claims concerning long-term retention, lower dropout, improved occupational performance, or sustained motivational effects require appropriately designed comparative or longitudinal evidence.

4.3.4 Operational and Institutional Value of XR

The value of XR in tourism VET is not exclusively pedagogical. Immersive technologies may also generate operational benefits by making selected forms of practice repeatable, comparatively standardised, and potentially reusable across different groups of learners. Once an immersive scenario has been developed and the necessary infrastructure is available, the same learning environment may be used by successive cohorts, allowing learners to revisit professional situations, practise individually or collaboratively, and encounter comparable initial conditions. This may be particularly useful for situations that are difficult to organise repeatedly in physical settings.

Repeatability can also support structured feedback and assessment. Teachers may be able to observe different learners responding to comparable scenarios and analyse aspects of their performance more systematically. At the same time, repeatability should not be interpreted as cost-free reuse. Software licences, hardware maintenance, technical support, content revision, updates, equipment replacement, staff preparation, and infrastructure continue to generate costs throughout the lifecycle of the technology. Operational value should therefore be assessed in relation to sustained use rather than initial acquisition alone.

[134] G. Makransky, G. B. Petersen, “The Cognitive Affective Model of Immersive Learning (CAMIL): A Theoretical Research-Based Model of Learning in Immersive Virtual Reality”, Educational Psychology Review, vol. 33, 2021, pp. 937–958.

Claims concerning cost efficiency require similar caution. XR may reduce selected recurring costs where conventional training requires travel, specialist facilities, consumable materials, repeated access to particular locations, or complex logistical arrangements. However, such savings cannot be assumed. Immersive systems may require significant investment in hardware, software, licensing, content development, staff development, technical assistance, maintenance, and replacement. The appropriate economic comparison is therefore based on the total cost of ownership of an XR solution relative to realistic pedagogical alternatives. Cost-effectiveness depends on factors such as frequency of use, number of learners, lifespan of equipment, availability of reusable content, required technical support, and the extent to which the technology replaces or complements existing activities. A pilot financed through external funding may appear affordable while producing a substantially different cost structure when expanded to institutional scale.

XR can also contribute to greater consistency in selected forms of training. Learners may encounter the same core scenario, sequence of events, or operational problem, thereby facilitating comparison, feedback, and selected forms of performance assessment. Standardisation may be useful particularly where programmes are delivered across multiple groups or locations. Consistency, however, should not be equated with educational quality. A poorly designed scenario reproduced consistently merely standardises a weak learning experience. Moreover, professional competence in tourism frequently depends on adaptation to uncertainty, diversity, and changing customer needs. Over-standardised simulations may therefore inadequately prepare learners for the variability of authentic professional environments. Effective design requires an appropriate balance between comparability and variability: some scenarios may employ common parameters for assessment purposes, while others should deliberately introduce changing conditions in order to develop adaptive professional agency.

Flexibility and scalability constitute further potential operational advantages, although both are highly dependent on technological and institutional architecture. Some XR applications may support individual practice, asynchronous learning, blended delivery, or participation from dispersed locations. These characteristics may be valuable for apprentices, adult learners, continuing professional development, and institutions operating across multiple sites. Scalability nevertheless differs substantially between technological configurations. A mobile AR application accessible through commonly available devices presents different requirements from a high-end VR laboratory requiring dedicated headsets, physical space, supervision, and technical support. Device availability, licence conditions, concurrent-user limits, teacher workload, maintenance, and technical assistance all influence the realistic scale of implementation. Scalability should therefore be understood as institutional scalability, namely the capacity to expand use without disproportionate deterioration in educational quality, accessibility, technical support, or financial sustainability[135].

[135] Cedefop, Teachers and Trainers in a Changing World: Building up Competences for Inclusive, Green and Digitalised Vocational Education and Training (VET): Synthesis Report, Cedefop Research Paper No. 86, Publications Office of the European Union, Luxembourg 2022.

Teacher capability remains central to the operational value of XR. Simulated environments may make learner decision-making more visible and generate additional information for formative assessment. Depending on the application, teachers may observe task completion, choices, patterns of interaction, response times, or recurring errors. Such information can potentially inform feedback and subsequent learning activities. Greater availability of data does not, however, automatically produce better teaching. Educators need to determine which information is pedagogically meaningful, how it should be interpreted, and which forms of monitoring are proportionate to the educational objective. Effective use of XR therefore requires competence in scenario selection, learning design, facilitation, debriefing, assessment, accessibility, and responsible interpretation of learner data. Without adequate pedagogical and technical support, the introduction of XR may increase rather than reduce teacher workload.

Institutional value may also arise from stronger collaboration between VET providers and tourism organisations. Employers can contribute authentic workplace scenarios, operational procedures, customer-service problems, destination-specific challenges, and information concerning emerging competence needs. Educational institutions can translate these inputs into structured learning activities, while technology providers may contribute specialist development expertise. Such cooperation can strengthen occupational relevance and create a more direct feedback relationship between tourism practice and curriculum development. Nevertheless, co-design should not reduce VET to company-specific procedural training. Vocational education must preserve the development of transferable competences that remain applicable across employers and organisational contexts. The most valuable co-designed scenarios are therefore those that combine authentic industry challenges with broader learning objectives and professional competences.

4.3.5 Conditional Value and Educational Additionality of XR

The analysis indicates that the pedagogical and operational value of XR should be understood as conditional rather than inherent. XR is particularly relevant where it enables forms of learning that would otherwise be difficult, unsafe, costly, infrequent, geographically inaccessible, or organisationally complex. It may support repeated practice, feedback, access to distant or fragile environments, collaborative problem solving, spatial analysis, interpretation of complex environmental processes, and the connection of conceptual knowledge with situated professional action. Its value is substantially weaker where immersive technology merely reproduces information or activities that could be delivered as effectively, inclusively, and economically through simpler educational methods.

The same conditional logic applies to operational benefits. Repeatability, flexibility, standardisation, reusable digital resources, and new forms of assessment may create institutional value, but these advantages depend on utilisation rates, infrastructure, teacher competence,

accessibility, technical reliability, maintenance capacity, and total cost of ownership. Technological capability alone is therefore insufficient to establish the value of an XR intervention[136].

For analytical purposes, this relationship may be expressed heuristically as:

XR value = pedagogical additionality × implementation capacity × contextual fit

This expression should be understood as a conceptual model rather than a mathematical formula. It emphasises that the three dimensions are mutually dependent. Where pedagogical additionality is limited, sophisticated technology may generate little educational benefit. Where implementation capacity is insufficient, promising applications may remain isolated pilots. Where contextual fit is weak, a technically successful solution may fail to respond to the actual needs of learners, teachers, curricula, or institutions.

The concept of educational additionality therefore provides a more rigorous basis for evaluating XR than general claims concerning technological benefit. Educational additionality asks what the technology enables that would be substantially more difficult, less safe, less accessible, less repeatable, or pedagogically less effective through alternative methods. This constitutes a stricter criterion than learner enjoyment, technological novelty, or perceived innovativeness.

An XR application demonstrates meaningful educational additionality where its distinctive technological affordances enable relevant forms of practice, feedback, access, representation, collaboration, interpretation, or decision-making that contribute directly to occupational competence. Where such additionality cannot be identified, a simpler pedagogical solution may be preferable. This principle also provides a conceptual connection between the classification framework developed in the preceding section and the subsequent analysis of adoption barriers and institutional readiness.

The central evaluative question is therefore not whether XR produces benefits in the abstract, but which educational and operational benefits can be demonstrated, under what conditions, for which learners and learning outcomes, and whether these benefits justify the resources, organisational capacity, and institutional changes required for sustainable implementation.

4.4 Barriers to XR Adoption and Institutional Readiness

The potential educational value of Extended Reality (XR) does not automatically translate into sustained adoption within vocational education and training. Across the analysed material, immersive technologies frequently appear in the form of pilots, externally funded projects, workshops, or isolated modules rather than as stable components of VET provision. This pattern indicates that the principal challenge is not technological availability alone. Sustainable adoption depends on the interaction between financial resources, technical infrastructure, teacher

[136] D. A. Guttentag, "Virtual Reality: Applications and Implications for Tourism", Tourism Management, vol. 31, no. 5, 2010, pp. 637–651; D. Hamilton, J. McKechnie, E. Edgerton, C. Wilson, "Immersive Virtual Reality as a Pedagogical Tool in Education: A Systematic Literature Review of Quantitative Learning Outcomes and Experimental Design", Journal of Computers in Education, vol. 8, 2021, pp. 1–32.

competence, curriculum design, organisational support, accessibility, evidence of educational value, and wider policy conditions. The barriers to XR implementation should therefore be interpreted not as isolated obstacles but as interrelated dimensions of institutional readiness. An institution may possess advanced equipment while lacking pedagogical capability, employ motivated teachers without sufficient technical support, or operate a successful pilot without being able to maintain the technology after external funding ends. XR readiness is consequently systemic rather than technological in a narrow sense.

4.4.1 Financial, Technical, and Lifecycle Readiness

Financial capacity constitutes one of the most visible constraints on XR adoption. Implementation may require investment in headsets, mobile devices, computers, software licences, digital content, connectivity, storage, maintenance, technical support, physical space, and staff development. Initial acquisition costs therefore represent only part of the economic burden. A more appropriate assessment requires a total cost of ownership perspective that includes hardware replacement, software updates, licensing, teacher preparation, content revision, device management, infrastructure upgrades, and continuing technical support. This distinction is particularly important where initial acquisition is supported through temporary project or grant funding. A pilot may appear financially feasible because external resources cover equipment purchase, while long-term institutional use generates recurring costs that ordinary budgets are unable to absorb. The relevant question is therefore not simply whether XR can be purchased, but whether it can be maintained without disproportionate dependence on temporary financing.

Technical readiness is similarly broader than access to hardware or connectivity. Depending on the application, XR may require sufficient bandwidth, compatible computing infrastructure, charging and storage facilities, appropriate physical space, software management procedures, device security, and rapid access to technical assistance. Reliability is particularly important because persistent setup difficulties or technical failures may consume instructional time, reduce teacher confidence, and discourage repeated use. Technical support should therefore be treated as part of pedagogical feasibility. Institutions need clearly defined responsibility for troubleshooting, maintenance, updates, and equipment management rather than relying on teachers to perform simultaneously as educators and technical specialists. This distinction reinforces the difference between technology ownership and technology readiness.

A further dimension concerns technological obsolescence and lifecycle risk. XR hardware, operating systems, software platforms, and compatibility requirements evolve rapidly, creating uncertainty about the long-term usability of particular solutions. These risks become especially significant where applications depend on proprietary ecosystems or where learning content cannot be transferred easily between devices or platforms. Responsible investment therefore requires consideration of interoperability, vendor dependence, exportability of content, update policies, and expected hardware lifespan. Institutional decision-making should evaluate not only what a technology can provide at the moment of acquisition, but whether it can remain technically and

organisationally supportable over time. The greater the lifecycle risk associated with a particular solution, the stronger the pedagogical and institutional justification required for its adoption.

4.4.2 Pedagogical, Curricular, and Teacher Readiness

A central barrier to meaningful XR adoption arises when technological innovation is introduced without sufficient alignment with educational objectives. This may be described as a technology–pedagogy alignment gap. Where immersive technologies are adopted primarily because they appear innovative, teachers may receive access to equipment without a clear understanding of the learning outcomes it is intended to support. XR can then become an occasional demonstration, motivational activity, or technological novelty rather than an integrated component of competence development. Such experiences may reinforce scepticism if teachers and institutional leaders perceive the technology as expensive, difficult to manage, and educationally marginal. In these cases, the underlying problem may lie less in the technology itself than in inadequate pedagogical integration.

The principle of pedagogy before technology is therefore particularly important in analysing adoption barriers. Implementation should begin with occupational learning objectives and competence requirements and proceed towards technological selection, rather than the reverse. XR is most defensible where its distinctive features support forms of practice, interaction, visualisation, or simulation that cannot be achieved as effectively through simpler methods.

Curriculum integration represents a related condition of institutional readiness. Where immersive activities remain disconnected from learning outcomes, assessment, qualification structures, or formal programme objectives, they are more likely to be perceived as peripheral. Teachers may be reluctant to invest significant preparation time in activities that make no identifiable contribution to formal learning outcomes, while learners may interpret XR activities as interesting but secondary to the curriculum. Curricular integration can therefore provide institutional legitimacy. This does not imply that XR should be incorporated into every programme or module. Supplementary use may remain entirely appropriate where the educational purpose is specific and occasional. The barrier arises when potentially valuable applications cannot be connected with existing curriculum structures even where educational additionality is evident. Adaptive curriculum capacity consequently becomes an important element of readiness, particularly in sectors undergoing rapid technological and occupational change.

The available evidence base also affects institutional decision-making. XR pilots frequently report positive perceptions of engagement, motivation, confidence, or usefulness, but these outcomes should not be treated as direct evidence of competence development. Responsible evaluation requires differentiation between engagement, knowledge acquisition, skill performance, retention, transfer to workplace practice, and sustained institutional use. The relevant outcome measures should reflect the purpose of the application. A customer-service simulation, for example, requires different evaluation criteria from an immersive cultural-heritage experience. The evidence gap therefore concerns not only the limited scale of some studies but also the alignment between intervention objectives and evaluation design. Evidence requirements should also be proportionate to the level of adoption proposed: a small pilot may justify further experimentation on the basis of

exploratory evidence, while curriculum-wide implementation or formal assessment requires a stronger empirical foundation.

Teacher readiness is central to all of these processes. Technical familiarity alone is insufficient. Educators need to understand how to select appropriate applications, design scenarios, facilitate immersive activities, conduct debriefing, assess learner performance, address accessibility, interpret relevant data, troubleshoot basic problems, and recognise situations in which XR is pedagogically unnecessary. This combination of capabilities may be understood as XR pedagogical competence. Where professional development is insufficient, technology may remain unused, activities may focus on novelty rather than learning, accessibility issues may be overlooked, and technical problems may dominate classroom time. Professional development should therefore accompany technology acquisition from the beginning. Peer learning, collaborative lesson design, mentoring, shared repositories, and accessible technical support can also reduce dependence on individual enthusiasts. Sustainable adoption requires competence to be distributed across the institution rather than concentrated in a single highly motivated teacher.

4.4.3 Organisational, Accessibility, and Equity Conditions

Even where teachers possess appropriate competence and motivation, organisational arrangements can facilitate or constrain XR adoption. Procurement procedures, timetabling, room allocation, device management, data-protection requirements, IT policies, technical responsibilities, and budgetary approval may all influence implementation. These procedures should not automatically be interpreted as bureaucratic resistance to innovation. They often reflect legitimate institutional responsibilities. Difficulties arise when existing governance structures are poorly adapted to technologies that simultaneously involve pedagogy, digital infrastructure, procurement, privacy, accessibility, and external service providers.

XR frequently cuts across traditional divisions of institutional responsibility. IT departments may control infrastructure and security, teachers may control pedagogical design, management may allocate budgets, while external providers may control software licences, platforms, or data environments. Without an appropriate governance structure, responsibilities can become fragmented. Institutional readiness therefore requires mechanisms for coordinated decision-making, clear allocation of responsibilities, and procedures through which pedagogical, technical, financial, legal, and accessibility considerations can be assessed jointly.

Accessibility forms an integral component of this organisational readiness. XR can expand access to locations or learning experiences that would otherwise be difficult to reach, but it can simultaneously create new forms of exclusion. Motion sickness, eye strain, disorientation, anxiety, sensory barriers, cognitive overload, difficulties using controllers, or limited digital confidence may restrict participation. These factors should not be treated merely as usability problems because they directly affect learners' ability to engage with the educational task. Institutional readiness should therefore include accessibility readiness: the capacity to evaluate applications before adoption, identify potential barriers, provide alternative modes of participation, and ensure that learners are

not disadvantaged because they cannot use a particular interface. Accessibility should be treated as a precondition of responsible implementation rather than as a later modification.

Differences in institutional capacity also create an equity challenge. Larger or better-resourced organisations may have access to specialist personnel, innovation projects, technology partners, and dedicated infrastructure, while smaller, rural, or under-resourced providers face substantially greater implementation barriers. This may contribute to a second-order digital divide. The first-order divide concerns access to technology itself; the second concerns the capacity to use available technologies effectively. Two institutions may possess similar hardware while differing substantially in teacher competence, technical assistance, curriculum integration, leadership, and organisational readiness. Equipment distribution alone is therefore unlikely to ensure equitable adoption.

Policy and institutional responses to this inequality may include shared infrastructure, regional support centres, teacher networks, mobile laboratories, common repositories of learning resources, and collaborative procurement. The relevant principle is that equity in XR adoption requires access not only to devices, but also to the institutional capabilities necessary to use them pedagogically and sustainably.

Cultural and professional factors should also be recognised. Resistance to XR should not automatically be characterised as irrational reluctance to innovate. Teachers, administrators, learners, and industry stakeholders may have legitimate concerns regarding educational value, loss of human interaction, workload, privacy, accessibility, cost, or technical reliability. Such concerns are particularly relevant in tourism education, where hospitality, guiding, intercultural communication, and customer service depend heavily on relational competence. Where immersive technologies are perceived as replacing rather than supporting human interaction, resistance may reflect a defensible pedagogical concern. Professional development should therefore foster pedagogical ownership and critical participation rather than position teachers as passive users of externally selected technologies.

4.4.4 Institutional Sustainability, Partnerships, and Policy Support

Dependence on temporary external funding represents a recurring structural challenge. Project funding may enable experimentation, equipment acquisition, teacher development, and partnership building, but it can also create a project sustainability trap in which institutions become capable of initiating XR activities without developing the capacity to sustain them. Once project financing ends, software licences may expire, equipment may no longer be maintained, specialist personnel may leave, and learning activities may be discontinued. Pilot success should therefore not be equated with institutional sustainability.

A transition from project capacity to institutional capacity requires an explicit post-project strategy. Institutions need to determine how recurring costs will be financed, who will maintain equipment, how content will be updated, how teachers will receive continuing support, and how the educational value of the intervention will be reviewed over time. Sustainable innovation depends not

simply on the successful completion of projects but on the institutionalisation of knowledge, responsibilities, and resources developed through them.

Cross-sector partnerships can contribute significantly to this process. Technology providers, tourism enterprises, universities, cultural institutions, environmental organisations, and public bodies may provide technical expertise, authentic occupational scenarios, infrastructure, specialist content, or access to emerging technologies. Partnerships may therefore reduce implementation barriers, but dependence on external partners can also create new vulnerabilities. Institutions may lose access to applications when projects terminate or become dependent on commercial providers for essential learning infrastructure.

Partnerships should consequently strengthen rather than replace internal institutional capability. A mature model involves capacity transfer, in which external specialists contribute expertise while educators and institutions progressively develop sufficient internal competence to evaluate, adapt, manage, and govern the technology independently. This is particularly important where commercial providers are involved, because VET institutions need enough expertise to assess claims relating to educational effectiveness, scalability, cost, and data governance critically.

Policy frameworks can further influence implementation through funding schemes, digitalisation strategies, teacher-development programmes, qualification regulations, procurement guidance, infrastructure investment, and shared support mechanisms. Policy recognition of XR or immersive technologies, however, should not be confused with implementation capacity. Institutions may operate within policy environments that promote digital innovation while continuing to lack equipment, professional development, technical support, accessibility procedures, or sufficient time for pedagogical design. The most effective policy approaches are therefore likely to focus on strengthening institutional capability rather than merely stimulating technology acquisition[137].

Cross-country differences should also be interpreted within this institutional framework. Financial, infrastructural, pedagogical, and organisational barriers may vary across national contexts, but national labels can conceal substantial variation between institutions. A well-resourced institution in a relatively resource-constrained system may possess greater implementation capacity than an under-supported provider located within a highly digitalised national environment. Institutional readiness consequently provides a more useful analytical unit than national technological ranking. Cross-country analysis remains valuable where it identifies recurring contextual mechanisms—such as funding structures, curriculum flexibility, teacher-development arrangements, or infrastructure conditions—rather than categorising countries as leaders or laggards.

[137] S. Cossio, S. Chiappinotto, S. Dentice, C. Moreal, G. Magro, G. Dussi, A. Palese, A. Galazzi, “Cybersickness and Discomfort from Head-Mounted Displays Delivering Fully Immersive Virtual Reality: A Systematic Review”, Nurse Education in Practice, vol. 85, 2025.

4.4.5 A Multidimensional Model of XR Readiness and Responsible Adoption

The preceding analysis suggests that sustainable XR adoption depends on six interconnected dimensions of institutional capacity. Financial readiness concerns the ability to meet both initial and recurring costs. Technical readiness concerns infrastructure, interoperability, reliability, maintenance, and technical support. Pedagogical readiness concerns clearly defined learning objectives, teacher competence, evidence-informed design, and curriculum integration. Organisational readiness concerns governance, leadership, coordination, administrative procedures, and allocation of responsibility. Accessibility and ethical readiness concerns inclusive participation, human factors, privacy, responsible data use, and alternative modes of access. Strategic readiness concerns evidence, sustainable financing, partnerships, lifecycle planning, and long-term institutional development[138].

These dimensions are interdependent. An institution may be financially prepared but pedagogically unready; it may possess strong pedagogical ambitions but insufficient technical infrastructure; or it may own advanced equipment while lacking accessibility procedures or sustainable organisational support. XR readiness should therefore not be conceptualised as a binary condition. It is better understood as a configuration of institutional capacities that determines whether a particular technology can be selected, introduced, maintained, evaluated, and adapted responsibly.

This perspective also changes the interpretation of barriers. The purpose of barrier analysis is not simply to identify obstacles that should be removed so that XR can diffuse as rapidly as possible. Some barriers provide legitimate reasons for caution. High cost may indicate insufficient educational additionality; teacher resistance may reveal weak pedagogical justification or excessive workload; accessibility limitations may make a particular application inappropriate for some learners; and insufficient evidence may justify continuation at pilot level rather than full curricular integration. A barrier should therefore be interpreted as a decision criterion, not automatically as a problem to be overcome.

The appropriate objective is responsible adoption rather than unconditional mainstreaming. Responsible adoption occurs where the institution can demonstrate that the technology addresses a relevant educational problem, teachers possess the competence required to use it pedagogically, learners can participate inclusively, costs are sustainable, technical support is available, ethical and data-related risks can be managed, and the evidence base is proportionate to the intended level of integration. In some cases, such an assessment may justify modification of an application, continuation as a limited pilot, postponement of implementation, or rejection of the technology altogether. Institutional maturity is therefore demonstrated not by adopting XR whenever technically

[138] UNESCO, Global Education Monitoring Report 2023: Technology in Education – A Tool on Whose Terms?, UNESCO, Paris 2023.

possible, but by possessing the capacity to determine when adoption is educationally and organisationally justified and when it is not[139].

The readiness model also reinforces the broader competence-ecosystem perspective developed in this study. Sustainable XR adoption depends on the interaction of learners, teachers, institutional leaders, technology providers, employers, policymakers, and support organisations. Learners require critical digital agency; teachers require XR pedagogical competence; curricula require adaptive capacity; institutions require implementation readiness; partnerships require governance and knowledge transfer; and policy systems require mechanisms that support sustainable institutional capability. XR adoption is therefore not reducible to the availability of technology. It depends on whether the surrounding competence ecosystem is capable of selecting, integrating, maintaining, evaluating, and, where appropriate, rejecting technological solutions.

This multidimensional understanding provides the basis for moving from the identification of implementation barriers towards a structured model of institutional readiness and the conditions required for responsible and sustainable XR adoption in tourism VET.

4.5 Operationalising Institutional Readiness for XR Integration

The preceding analysis demonstrates that successful XR adoption depends on a configuration of institutional capacities rather than on access to technology alone. Institutional readiness can therefore be understood as the ability of a VET organisation to select, introduce, support, evaluate, and sustain XR applications in ways that are pedagogically justified, technically reliable, economically viable, accessible to learners, and compatible with curriculum objectives. This definition deliberately distinguishes readiness from technological advancement. An institution equipped with immersive hardware is not necessarily prepared for meaningful XR integration, while an organisation with relatively limited technological resources may demonstrate substantial readiness if it possesses strong teacher competence, clearly defined educational objectives, effective governance, appropriate partnerships, evaluation mechanisms, and a realistic implementation strategy. Readiness should consequently be assessed through the interaction of several institutional dimensions rather than through a binary distinction between technologically advanced and less advanced organisations.

4.5.1 Technical, Financial, and Infrastructural Readiness

The first dimension concerns the technical and material conditions required for sustained XR use. Relevant infrastructure may include immersive devices, compatible computers or mobile technologies, reliable connectivity, charging and storage facilities, suitable physical learning spaces, software licences, cloud services, cybersecurity arrangements, and access to technical support. The presence of equipment constitutes only an initial condition. Institutional readiness depends on whether technologies can be used reliably within routine teaching, whether devices are available when required, whether software remains compatible, and whether technical failures can be

[139] H. G. van de Werfhorst, E. Kessenich, S. Geven, “The Digital Divide in Online Education: Inequality in Digital Readiness of Students and Schools”, Computers and Education Open, vol. 3, 2022.

resolved without consuming a disproportionate amount of instructional time. Maintenance capability is therefore a central indicator of readiness. Where malfunctioning devices remain unused because responsibility for support is unclear, technological acquisition has not translated into institutional capability.

Technical readiness should be assessed in relation to the actual requirements of a particular application rather than according to a universal technological benchmark. Different forms of XR impose different infrastructure demands, and the feasibility of implementation may therefore vary considerably between institutions. Stable connectivity and cloud-based services may be essential for some applications but largely irrelevant for others. Similarly, high-end immersive environments may require dedicated spaces, specialised computers, supervision, and technical support, while mobile AR may rely primarily on learners' personal devices and local connectivity. Readiness is thus application-specific rather than reducible to the general level of digitalisation within an institution.

Financial sustainability forms an integral part of this dimension. Initial purchase costs represent only one component of XR expenditure. Sustainable implementation requires consideration of software licences, maintenance, equipment replacement, content updates, teacher development, technical support, storage, accessibility adaptations, and infrastructure upgrades. A total cost of ownership perspective is therefore more appropriate than an assessment based on acquisition cost alone. This is particularly important where pilot initiatives are funded through temporary projects or external grants. Institutions may possess sufficient project capacity to introduce XR without possessing the financial capacity to sustain its use once external financing ends[140].

Financial readiness does not imply that all expenditure must be covered from core institutional budgets. Regional programmes, shared facilities, joint procurement, external partnerships, or public funding may legitimately contribute to implementation. The critical issue is whether recurring costs can be anticipated and whether the institution has a credible strategy for maintaining activities beyond the initial funding cycle. Financial and technical readiness are therefore closely interconnected with lifecycle planning, interoperability, vendor dependence, and the long-term supportability of the selected technological solution.

4.5.2 Pedagogical, Evaluative, and Teacher Readiness

A second group of readiness conditions concerns the institution's ability to transform technological possibilities into meaningful learning processes. Pedagogical readiness exists where XR activities are connected with clearly defined occupational competences, learning outcomes, assessment processes, feedback, and subsequent application. Institutions need to determine what learners are expected to achieve, why XR is appropriate for a particular objective, how immersive activities relate to other teaching methods, and how their educational value will be evaluated[141].

[140] L. Yan, W. A. R. Wan Mohd Isa, A. F. Harun, L. Shuib, "Technology-Organization-Environment (TOE) Framework for Educational Technology Adoption at the Institutional Level: A Cross-Technology Systematic Review (2020–2024)", Discover Education, 2026.

[141] UNESCO, Global Education Monitoring Report 2023: Technology in Education – A Tool on Whose Terms?, UNESCO, Paris 2023.

Pedagogical readiness should not be equated with maximum curricular integration. A supplementary XR activity may be entirely appropriate where it serves a specific learning purpose effectively. The relevant criterion is whether its position within the curriculum is intentional and pedagogically justified. Conversely, XR remains educationally peripheral when introduced as an occasional demonstration or isolated workshop without clear links to learning outcomes or occupational competence. Readiness therefore includes the capacity to adapt pedagogical practice as well as formal curriculum structures.

Closely related to pedagogical readiness is evaluative readiness, understood as the capacity to generate and interpret evidence concerning whether XR produces its intended educational and operational value. Institutions require mechanisms for assessing usability, accessibility, learner experience, knowledge and skill development, technical performance, teacher workload, implementation cost, and—where relevant—transfer to workplace practice. Evaluation requirements should be proportionate to the scale and consequences of adoption. An exploratory workshop may justify continuation on the basis of usability evidence and teacher reflection, whereas structured curricular integration requires stronger evidence of pedagogical value. Use of XR for formal assessment or certification requires more demanding evidence concerning validity, reliability, fairness, and accessibility[142].

Evaluative readiness also entails the capacity to redesign or discontinue technologies that fail to demonstrate sufficient educational additionality. Institutional competence is reflected not only in the ability to introduce innovation, but also in the ability to determine when technological complexity is not justified by educational benefit. Readiness therefore includes the capacity to reject or limit an application where the available evidence does not support broader implementation.

Teacher readiness represents a central component of this process because educators operate at the interface between technology, curriculum, and learner experience. Effective XR integration requires a combination of technical familiarity and pedagogical competence that can be described as pedagogical-technical mediation. Teachers need to understand not only how an application functions but also how to position it within a learning sequence, prepare learners, scaffold participation, facilitate interaction, conduct debriefing, assess performance, address accessibility barriers, and provide alternatives where immersive participation is inappropriate[143].

Sustainable teacher readiness requires more than one-off workshops. Continuous professional development, peer learning, collaborative lesson design, mentoring, observation, communities of practice, and cooperation with external experts can support gradual competence development. Teacher capability should also be distributed rather than concentrated in individual enthusiasts. Where all XR expertise resides in one highly motivated educator, institutional capacity remains

[142] P. Mishra, M. J. Koehler, “Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge”, Teachers College Record, vol. 108, no. 6, 2006, pp. 1017–1054.

[143] Cedefop, Teachers and Trainers in a Changing World: Building up Competences for Inclusive, Green and Digitalised Vocational Education and Training (VET): Synthesis Report, Cedefop Research Paper, no. 86, Publications Office of the European Union, Luxembourg 2022.

vulnerable to staff turnover, workload changes, or shifting priorities. Shared resources, documented practices, and distributed competence increase organisational resilience.

Teacher attitudes should similarly be interpreted as part of professional judgement rather than on a simple continuum between resistance and enthusiasm. Scepticism may reflect legitimate concerns regarding educational value, workload, accessibility, privacy, human interaction, or technological reliability. A highly ready institution should therefore create conditions for informed professional ownership, enabling teachers to test, critique, adapt, and, where justified, reject particular technologies. Professional openness should be understood as willingness to evaluate emerging technologies critically rather than willingness to adopt innovation unconditionally.

4.5.3 Organisational, Partnership, Accessibility, and Ethical Readiness

XR integration requires organisational structures capable of coordinating responsibilities distributed across teaching staff, IT services, institutional management, procurement, accessibility support, data-protection functions, external providers, and industry partners. Without effective coordination, responsibility can become fragmented. Organisational readiness therefore concerns governance, allocation of responsibilities, resource coordination, institutional leadership, and the capacity to translate individual experimentation into sustained organisational practice.

A key distinction concerns individual initiative versus institutional capability. Educational innovations often originate with highly motivated teachers, and such experimentation may play an important role in introducing new approaches. However, implementation remains fragile where knowledge, access, and responsibility are concentrated in one person. Institutional readiness increases when successful experimentation is transformed into shared procedures, professional-development arrangements, curriculum decisions, support mechanisms, and organisational learning. Leadership is relevant not because every VET provider requires a separate XR strategy, but because institutions need mechanisms through which promising innovations can move from individual initiative to collective capability.

Partnership readiness constitutes another component of institutional capacity. Tourism-related XR applications often require knowledge extending beyond the traditional expertise of VET providers. Tourism enterprises can contribute authentic occupational scenarios, museums and heritage institutions may provide cultural expertise, environmental organisations can support sustainability-oriented applications, technology providers may offer development capability, and universities or research institutions may contribute evaluation expertise. Partnerships can therefore broaden institutional capacity and strengthen the occupational relevance of learning environments.

The quality of such cooperation is nevertheless crucial. External collaboration should strengthen educational capability rather than create permanent dependency. Co-design with industry may increase authenticity, but occupational scenarios should retain sufficient transferability to remain relevant beyond the practices of a single organisation. Cooperation with technology companies can provide specialist expertise, but institutions require sufficient internal competence to evaluate commercial claims, maintain pedagogical control, and assess implications for data governance, cost,

and long-term sustainability. A central indicator of partnership readiness is therefore whether collaboration produces knowledge transfer and institutional learning, rather than merely temporary access to external resources.

Accessibility constitutes a further dimension of readiness. The presence of immersive technology does not guarantee equitable participation. Institutions need mechanisms for identifying physical, sensory, cognitive, linguistic, technological, and economic barriers associated with XR applications. Relevant considerations include subtitles, audio alternatives, interface clarity, alternative controls, adjustable interaction modes, and compatibility with diverse learner requirements.

Accessibility readiness extends beyond features embedded within individual applications. Institutions must also determine what happens when immersive participation itself is unsuitable or inaccessible for a particular learner. Equivalent routes to the intended learning objective should therefore be available. The relevant criterion is not identical technological experience but an equitable opportunity to develop the intended competence. This represents a shift from access to technology towards access to learning.

Ethical and data-governance readiness are equally important. XR applications may collect substantial information about users, including movement, gaze, voice, interaction patterns, performance data, or potentially biometric information. Institutions need to understand what data are collected, where and by whom they are processed, how long they are retained, and whether their collection is proportionate to the educational purpose. This requires coordination between pedagogy, IT governance, procurement, privacy functions, and external technology providers.

Ethical readiness extends beyond formal regulatory compliance. Institutions should be able to evaluate proportionality, learner autonomy, fairness, privacy, and trust. The technological possibility of collecting detailed behavioural information does not itself justify its use. The relevant question is whether data collection is necessary for and proportionate to the learning or assessment objective. Institutional readiness therefore includes the capacity to distinguish between technically available functionality and ethically justified educational practice.

4.5.4 The XR Institutional Readiness Framework

The preceding analysis supports a multidimensional model of institutional readiness. Readiness should not be represented as a single linear maturity scale because institutions may display very different configurations of strengths and limitations. One provider may possess strong infrastructure but weak pedagogical integration; another may have highly competent teachers but limited technological resources; a third may benefit from substantial project funding while lacking long-term financial sustainability; and another may be organisationally prepared but constrained by curriculum regulation. Institutional readiness is consequently better represented as a multidimensional profile.

For analytical purposes, the XR Institutional Readiness Framework can be organised around seven interconnected dimensions: technical and infrastructural readiness, encompassing equipment, connectivity, reliability, maintenance, and technical support; pedagogical readiness, including

learning objectives, curriculum integration, experiential design, assessment, and reflective learning; evaluative readiness, concerning the capacity to collect and interpret evidence of educational and operational value; teacher readiness, including technical familiarity, pedagogical-technical mediation, professional development, and distributed expertise; organisational and partnership readiness, covering leadership, governance, responsibility, collaboration, and knowledge transfer; financial readiness, encompassing total cost of ownership, funding continuity, and lifecycle planning; and accessibility, ethical, and systemic readiness, covering equitable participation, responsible data governance, and compatibility with wider regulatory and policy conditions.

These dimensions are analytically distinguishable but mutually dependent. Teacher development requires organisational support, pedagogical integration may depend on curriculum flexibility, accessibility can create additional technical and financial requirements, evaluation can affect funding and continuation decisions, and partnerships may increase technical capacity while simultaneously introducing governance or data-related risks. XR readiness is therefore best understood as an ecosystem property rather than a technological attribute.

The framework should not be used to classify institutions as simply ready or unready. A more appropriate question is: ready for what form of XR, for which educational purpose, at what level of integration, and under which institutional conditions? This contextualised approach is consistent with the broader principle of technological appropriateness developed earlier in the analysis. It also avoids interpreting greater technological intensity as equivalent to greater institutional maturity.

4.5.5 From Readiness Assessment to Responsible Adoption

The purpose of institutional readiness assessment is not to move all VET providers towards a predetermined level of XR adoption. Its purpose is to improve the quality of technology-related decision-making. Institutions should be able to determine whether a proposed application addresses a relevant educational problem, whether teachers and learners can use it meaningfully, whether appropriate technical and organisational support is available, whether accessibility and ethical requirements can be satisfied, and whether implementation can be sustained financially and organisationally.

A further criterion is educational additionality: the extent to which the expected value of XR justifies the technological complexity, cost, and level of curricular integration involved. Readiness assessment may consequently lead to several equally legitimate outcomes. An institution may proceed to structured implementation, continue experimental use while developing additional capability, select a simpler technological alternative, postpone adoption, or conclude that a particular XR application does not provide sufficient educational value.

These outcomes should not be interpreted as different positions on a linear continuum from technological backwardness to technological maturity. Choosing not to implement XR may constitute a mature institutional decision where pedagogical value is insufficient, accessibility cannot be ensured, costs are disproportionate, the evidence base is inadequate, or a simpler educational method can achieve the same learning objective more effectively. Institutional readiness therefore

culminates not in technological mainstreaming but in the capacity for evidence-informed, context-sensitive, and responsible technology governance.

Contextual variation should be interpreted within the same framework. VET institutions differ substantially in infrastructure, access to funding, teacher preparation, curriculum flexibility, technical support, organisational leadership, and previous experience with digital innovation. Such variation should not be converted into a simple hierarchy of national systems. Institutions operating within the same country may differ considerably in their capacity to adopt and sustain XR, while individual projects or particularly well-resourced organisations may not be representative of national VET provision as a whole.

Cross-country comparison is therefore most useful when it identifies recurring configurations of enabling and constraining conditions. Some institutions may operate within strong digital infrastructures while continuing to face difficulties related to pedagogical integration or long-term financing. Others may demonstrate innovative curriculum practices despite comparatively limited technological resources, while still others may benefit from temporary project funding without developing the teacher competence or organisational structures required for sustained implementation. No single factor—hardware availability, funding, policy recognition, or teacher enthusiasm—is sufficient to establish readiness.

The analytically relevant question is therefore not how far an institution has progressed towards technological mainstreaming, but whether it possesses the capacity to make informed decisions about XR and to sustain those applications for which meaningful educational additionality can be demonstrated. Cross-context comparison should consequently focus on institutional conditions, implementation mechanisms, and transferability of capacity rather than technological ranking.

4.6 Strategic Directions for Responsible XR Development in Tourism VET

The analysis developed throughout this chapter indicates that the future role of Extended Reality in tourism vocational education and training should not be framed primarily in terms of technological expansion or the progressive replacement of conventional learning environments. The central strategic question concerns whether immersive technologies can be integrated into vocational learning in ways that are pedagogically justified, inclusive, environmentally and financially sustainable, and institutionally manageable. From this perspective, the development of XR in tourism VET requires a shift from technology-centred innovation towards responsible XR development, understood as the selective, evidence-informed, and context-sensitive use of immersive technologies where they provide demonstrable educational additionality.

4.6.1 Curriculum Design and Pedagogical Mechanisms

Future curriculum development should begin with occupational learning problems rather than with technological solutions. Instead of asking where VR, AR, or MR can be inserted into existing programmes, curriculum designers should identify situations in which learners require forms of practice that are difficult, unsafe, costly, infrequent, geographically inaccessible, or otherwise difficult to provide through conventional methods. XR may be particularly appropriate where

students need repeated rehearsal, controlled variation of scenarios, access to distant or fragile environments, spatial visualisation, or the safe simulation of demanding professional situations.

Integration should therefore be linked explicitly to learning outcomes and professional competence. This does not imply that XR should become a core methodology across all areas of tourism VET. Conventional role play, fieldwork, workplace learning, case analysis, or less complex digital tools may remain more appropriate for many learning objectives. Curricular maturity is demonstrated not by the intensity of XR use but by the capacity to select immersive technologies where their educational additionality can be justified.

This principle has important implications for scalability. The objective should not be the direct replication of particular applications across institutions regardless of context. Differences in infrastructure, language, curriculum structure, learner characteristics, teacher capability, tourism specialisation, and financial resources make simple technological replication problematic. A more transferable object is the underlying pedagogical mechanism.

Such mechanisms may include sequences such as safe rehearsal → feedback → reflection → workplace transfer, immersive representation → critical interpretation → evidence-based discussion, scenario visualisation → stakeholder analysis → decision → consequence, or collaborative simulation → role negotiation → shared problem solving → debriefing. These learning mechanisms can be implemented through different technological configurations according to institutional conditions. This approach strengthens transferability because it focuses on the educational process rather than on specific hardware, software, or commercial platforms.

The strategic objective should therefore be understood as mechanism scaling rather than technology scaling. What should be transferred between institutions are pedagogically validated patterns of learning, together with information about the conditions under which they operate effectively. This reduces dependence on technological uniformity and makes innovation more resilient to rapid technological change.

4.6.2 Accessibility, Sustainability, and Competence Ecosystems

Responsible XR development requires accessibility to be incorporated from the outset rather than treated as a corrective measure after implementation. Learners differ in physical, sensory, cognitive, linguistic, digital, and economic circumstances. Immersive technologies may extend access for some learners while simultaneously creating new barriers for others. Universal-design principles should therefore inform application selection, content development, interaction design, assessment, and implementation.

Relevant accessibility features may include captions, audio alternatives, multilingual support, adjustable pacing, adaptable interfaces, alternative control methods, and non-immersive routes to equivalent learning outcomes. The strategic objective should not be technological equality understood as requiring every learner to use an identical interface. A more meaningful criterion is equitable participation in competence development. This distinction is particularly important in

vocational education, where inability to use a particular technological interface should not result in exclusion from the professional competence that the activity is intended to develop.

XR also needs to be positioned critically within the wider digital and green transformations affecting tourism. Immersive technologies can support environmental education, visitor-flow analysis, heritage interpretation, digital storytelling, scenario modelling, and the simulation of sustainability-related decisions. They may therefore contribute to the development of competences situated at the intersection of digitalisation and sustainability.

The relationship between XR and sustainability is nevertheless not inherently positive. Hardware production, computing requirements, data infrastructure, electricity consumption, maintenance, and device replacement all generate environmental costs. VET programmes should therefore prepare learners to evaluate technological solutions according to sustainability criteria rather than treating technological innovation as automatically compatible with environmental objectives.

XR may be particularly valuable where it supports the development of sustainability judgement. Environmental simulations should move beyond awareness raising and require learners to interpret evidence, identify stakeholders, analyse trade-offs, compare alternative interventions, and justify professional decisions. The relevant educational objective is not merely to experience or visualise an environmental problem, but to develop the competence required to respond to it.

Sustainable implementation also requires cooperation among multiple actors. VET institutions rarely possess all the technological, occupational, pedagogical, cultural, environmental, and evaluative expertise necessary to design and maintain high-quality immersive learning independently. Technology providers may contribute development expertise, tourism enterprises can provide authentic occupational scenarios, cultural institutions may support heritage-related content, environmental organisations can contribute specialist knowledge, research institutions may support evaluation, and local communities may provide contextual knowledge and perspectives.

Such collaboration is best understood as a competence ecosystem rather than a collection of contractual relationships. The strategic purpose of partnerships should be mutual learning, co-design, capacity development, and knowledge transfer. External cooperation should strengthen the capacity of VET institutions to make independent pedagogical and technological decisions rather than create long-term dependence on providers. Shared governance and capacity transfer are therefore more important to sustainable implementation than access to technology alone.

4.6.3 Teacher Professionalisation, Institutional Capacity, and Sustainable Financing

Teacher development constitutes one of the most important strategic priorities for responsible XR integration. Introductory workshops may increase familiarity with immersive technologies, but they are unlikely to provide the competence required for sustained pedagogical use. Educators need opportunities to develop pedagogical-technical mediation competence over time.

This includes the capacity to identify appropriate learning problems, determine whether XR provides sufficient educational additionality, select suitable technologies, design scenarios, scaffold learner participation, facilitate interaction, conduct debriefing, assess performance, address

accessibility, and evaluate whether immersive methods produce sufficient educational value. Teacher development should therefore integrate technical and pedagogical dimensions rather than treat software operation as the principal competence required for XR implementation.

Peer-learning networks, collaborative design activities, observation of practice, mentoring, industry exposure, communities of practice, and participation in evaluation processes can support deeper competence development than isolated software training. The long-term institutional objective should be distributed expertise rather than dependence on individual technology enthusiasts. Sustainable implementation requires competence to become embedded within organisational structures, shared practices, and professional communities.

Financial sustainability must be addressed in parallel. Temporary funding can stimulate experimentation and reduce barriers to initial adoption, but repeated dependence on short project cycles may prevent institutionalisation. Future implementation models should therefore account for lifecycle costs, including acquisition, licences, maintenance, technical support, software and content updates, teacher development, accessibility adjustments, storage, infrastructure, and equipment replacement.

Investment should also remain proportionate to the proposed level of curricular integration. A short-term exploratory pilot requires a different financial and organisational commitment from a simulation environment on which formal curriculum delivery depends. Funding decisions should consequently be linked to expected usage and demonstrated educational additionality rather than technological ambition.

Where individual institutions cannot sustain complex XR environments independently, alternative models may include shared infrastructure, regional support centres, institutional consortia, jointly developed learning content, collaborative procurement, or other arrangements that distribute costs and expertise. Such models may be particularly important for preventing disparities between well-resourced and resource-constrained VET providers.

4.6.4 Research, Continuous Evaluation, and Cross-Context Learning

The existing evidence base provides sufficient grounds for continued investigation of XR in vocational education, but it also demonstrates the need for more rigorous and differentiated evaluation. Many studies and pilot projects emphasise learner engagement, motivation, satisfaction, or perceived usefulness. These outcomes are relevant, but they do not establish competence acquisition, transfer to workplace behaviour, employability effects, or long-term institutional sustainability.

Future research should therefore distinguish more carefully among short-term learner experience, measurable learning outcomes, transfer, and institutional effects. Comparative studies should examine whether XR improves learning or performance relative to plausible alternative methods rather than only relative to no intervention. Research should investigate the transfer of simulated performance to authentic workplace behaviour, differential effects across learner groups,

accessibility, teacher workload, cost-effectiveness, and the persistence of implementation after pilot funding and novelty effects diminish.

The relevant research question should consequently move beyond the general formulation "Does XR work?" A more analytically useful formulation is: For which learners, learning problems, institutional contexts, and implementation models does XR generate sufficient educational additionality to justify adoption?

Evaluation should also continue after an application has been adopted. Emerging technologies change rapidly, and an application judged appropriate at one point may later become obsolete, inaccessible, unsupported, unnecessarily expensive, or pedagogically inferior to newly available alternatives. Responsible technology governance therefore requires periodic reassessment of learning outcomes, accessibility, cost, reliability, teacher workload, and the availability of simpler or more effective solutions.

Adoption should not be treated as permanent. A mature VET institution should be capable of introducing, adapting, scaling, reducing, replacing, or discontinuing a technology in response to evidence and changing conditions. Discontinuation should be understood as a legitimate outcome of evaluation rather than as evidence of implementation failure.

The same principle applies to international and cross-context learning. Transnational cooperation can facilitate the exchange of pedagogical designs, scenarios, evaluation methods, accessibility solutions, and implementation experience. However, cross-country cooperation should not become a process of technological imitation or competition for greater levels of technological sophistication. Different VET systems and institutions operate under distinct financial, organisational, curricular, linguistic, and infrastructural conditions.

The most useful comparative questions concern the educational problem addressed, the reason XR was selected, the learner activity created, the resources required, the barriers encountered, the evidence supporting continuation, and the extent to which particular elements can be adapted in another context. Cross-context learning should therefore support contextual transfer rather than technological replication.

4.6.5 A Strategic Model for Responsible XR Governance

The strategic implications developed in this chapter can be synthesised as a sequence of interconnected institutional decisions. The first step is the identification of a vocational learning problem. The second involves determining whether XR provides educational additionality relative to less complex alternatives. The third consists of assessing institutional readiness, including technical, pedagogical, financial, organisational, accessibility, ethical, and evaluative capacity. Where implementation is justified, XR should operate through pedagogical augmentation, strengthening an established learning mechanism rather than substituting technology for pedagogy. Implementation should then be monitored through evidence concerning learning outcomes, accessibility, cost, teacher workload, and organisational sustainability. Finally, the decision should be reconsidered periodically as technologies, curricula, professional requirements, and institutional conditions evolve.

The resulting logic may be represented as:

vocational learning problem → educational additionality → institutional readiness → responsible adoption → pedagogical augmentation → evaluation → adaptation

This sequence provides an alternative to technology-led innovation because it begins and ends with educational judgement. Technological selection occurs only after the learning problem and potential added value have been identified, while continuation depends on evidence rather than on sunk costs, novelty, or institutional prestige.

The broader conclusion is therefore that the future of XR in tourism VET should not be evaluated according to the extent to which immersive technologies become mainstream. The more significant criterion concerns the quality of institutional decision-making surrounding their use. XR can create meaningful opportunities for simulation, interpretation, collaboration, accessibility, and sustainability-oriented learning, but it can also generate cost, exclusion, technological dependency, complexity, additional workload, and pedagogical distraction. Responsible development requires both possibilities to remain visible.

The appropriate long-term objective is responsible technology governance. This refers to the capacity of VET institutions to determine whether a technology is educationally necessary, how it should be integrated, which learners may benefit or be disadvantaged, what evidence justifies continuation, and when the application should be adapted, replaced, or discontinued.

Technological sophistication should consequently not be treated as the ultimate indicator of educational innovation. A more meaningful indicator is the institution’s capacity to align technological possibilities with pedagogical purpose, learner diversity, occupational competence, ethical responsibility, sustainability considerations, and long-term organisational capability.

XR should therefore be understood not as the inevitable technological future of tourism VET, but as one possible component of a wider adaptive learning ecosystem. Its educational value depends on the quality of the decisions through which that ecosystem selects, designs, evaluates, sustains, and, where appropriate, rejects its use.

5 Implications for Tourism VET: Towards an Integrated Competence Framework

The preceding analyses demonstrate that the transformation of tourism is simultaneously environmental, technological, organisational, and social. Changes in sustainability requirements, digitalisation, visitor behaviour, business models, labour-market expectations, and emerging technologies do not generate isolated skills needs. Rather, they alter the configuration of professional competence required across tourism occupations. This has important implications for vocational education and training. The central challenge for VET is no longer simply to add new topics to existing programmes. Sustainability cannot be addressed adequately through a single environmental module, digital transformation through general ICT instruction, entrepreneurship through a stand-alone business course, or technological change through occasional exposure to XR. Contemporary tourism work increasingly requires learners to combine several forms of knowledge, judgement, and professional action within the same occupational task.

This chapter therefore shifts the analysis from individual skills gaps towards an integrated competence perspective. Its purpose is to examine how occupational, sustainability-related, digital, entrepreneurial, interpersonal, and transversal competences interact; how these combinations relate to changing forms of tourism work; and what these developments imply for curriculum design, pedagogy, assessment, teacher development, work-based learning, and cooperation with the labour market.

The analysis builds on three principal conclusions developed in the preceding chapters. First, contemporary tourism increasingly depends on hybrid competence profiles rather than narrowly specialised skill sets. Second, professional capability depends not only on what learners know, but also on their capacity to apply knowledge critically, adaptively, and responsibly within changing professional contexts. Third, competence development is shaped by a wider competence ecosystem in which learners, teachers, enterprises, VET institutions, destination organisations, public authorities, communities, and technology providers interact.

The implications for VET therefore operate simultaneously at individual and institutional levels. At the individual level, education needs to support professional judgement, adaptability, technological capability, communication, ethical reasoning, and responsible action. At the institutional level, VET providers require sufficient curriculum flexibility, teacher competence, workplace partnerships, evaluation capacity, and organisational support to respond continuously to sectoral transformation. The framework developed below therefore treats competence categories as interdependent components of professional capability rather than as separate curriculum domains.

5.1 From Competence Categories to Integrated Professional Capability

The analysis of sustainable tourism practices, stakeholder perceptions, labour-market expectations, and technology-enhanced VET reveals several recurring competence domains. These include occupational and technical competence, sustainability-related capability, digital competence, entrepreneurship, intercultural communication, collaboration, adaptability, critical thinking, accessibility awareness, and ethical judgement. Taken individually, these categories are familiar. Their analytical significance lies less in their presence than in the extent to which they increasingly intersect within real professional situations.

A tourism worker may need to use a digital system while responding to a dissatisfied customer. A destination professional may interpret visitor-flow data while considering environmental pressure and accessibility. A guide may combine cultural interpretation, digital storytelling, intercultural communication, and biodiversity awareness. An entrepreneur developing a sustainable tourism product may simultaneously need environmental knowledge, financial judgement, stakeholder cooperation, digital marketing capability, and understanding of local community interests. Professional competence therefore emerges through integration rather than accumulation.

5.1.1 Occupational Foundation and Cross-Cutting Competence Domains

Core occupational competence remains the foundation of professional capability. Digitalisation, sustainability, and technological innovation do not remove the need for substantive knowledge of tourism operations. Learners continue to require competence appropriate to their occupational field, including hospitality operations, customer service, guiding, heritage interpretation, tourism-product development, destination services, food and beverage operations, safety, event organisation, or travel services. These competences provide the professional context within which newer capabilities become meaningful.

Digital competence without occupational understanding may produce technically proficient learners who are unable to determine whether a technological solution addresses a genuine tourism problem. Sustainability knowledge without operational understanding may remain abstract, while entrepreneurial competence without sector-specific knowledge may generate ideas that are difficult to implement. Occupational competence should therefore not be positioned in opposition to green, digital, entrepreneurial, or transversal skills. It constitutes the domain foundation through which these competences acquire professional relevance.

Around this occupational foundation operate a series of cross-cutting competence domains. Sustainability competence is one of the most important. It cannot be reduced to awareness of environmentally desirable practices. Waste reduction, energy efficiency, water conservation, sustainable mobility, certification, biodiversity protection, and climate adaptation require specific knowledge, but contemporary tourism professionals increasingly need to do more than apply predefined environmental procedures. They must interpret information, recognise trade-offs, identify affected stakeholders, evaluate competing claims, distinguish substantive improvement from greenwashing, and select appropriate actions within specific organisational and destination contexts.

This broader capability may be described as sustainability judgement. It connects environmental competence with social, cultural, economic, and ethical considerations. It enables professionals to ask not only whether an intervention appears environmentally beneficial, but also who is affected, what evidence supports it, what trade-offs arise, and whether the proposed solution remains viable within the destination or organisation concerned. Sustainability should therefore function as a perspective informing occupational decision-making across tourism education rather than as an isolated specialist topic.

A comparable shift is required in relation to digital competence. General familiarity with digital technologies does not necessarily correspond to professional digital preparedness. Tourism increasingly requires the use of sector-specific systems, data interpretation, digital communication, AI-supported applications, platforms, immersive technologies, and digitally mediated service processes. Yet technological competence cannot be reduced to proficiency in a particular application because technological environments change too rapidly for platform-specific training to provide a sufficient basis for long-term adaptability.

The broader capability required is critical digital agency, understood as the ability to select, use, interpret, adapt, and evaluate technology within professional tourism contexts. It includes awareness of reliability, accessibility, privacy, ethics, environmental impact, and the limitations of automation. A digitally capable tourism professional should therefore be able to determine not only how a technology functions, but also why it is being used, what problem it is intended to solve, and whether it is proportionate and appropriate to that problem. This is particularly important in relation to AI and XR, where technological sophistication should not be treated as equivalent to professional value.

Entrepreneurial competence should similarly be understood more broadly than business creation. Tourism professionals increasingly need to identify opportunities, respond to disruption, redesign services, create new forms of value, and act under conditions of uncertainty. This capability is relevant both to entrepreneurs establishing new ventures and to employees introducing innovation within existing organisations. It incorporates creativity, initiative, collaboration, communication, problem solving, tolerance of uncertainty, and reflective learning.

These elements can be conceptualised through the notion of adaptive professional agency: the capacity to interpret a changing situation, mobilise appropriate knowledge and relationships, make decisions, accept responsibility for action, and modify behaviour in response to outcomes. Its educational significance is substantial because learners cannot develop adaptive agency solely by studying how organisations currently operate. They require opportunities to encounter uncertainty, make decisions, test ideas, receive feedback, reflect on consequences, and revise their actions.

Intercultural and relational competence constitutes another cross-cutting domain. Tourism remains fundamentally dependent on interaction between people. Digitalisation may alter the channels through which services are delivered, but it does not eliminate the importance of communication, empathy, cultural sensitivity, cooperation, trust, and conflict resolution. Intercultural competence should not be reduced to foreign-language proficiency or knowledge of

fixed cultural characteristics. Tourism professionals need to recognise differences in expectations and communication patterns while avoiding stereotyping and remaining responsive to individual situations. This requires adaptive communication.

The same relational capability extends to teamwork, leadership, customer interaction, conflict management, and cooperation with communities and external stakeholders. Such abilities should not be treated as merely secondary "soft skills". They directly influence occupational performance and are better conceptualised as transversal professional competences[144].

Accessibility should likewise become part of mainstream professional competence. Tourism professionals increasingly need to consider whether services, destinations, transport, information, heritage experiences, and digital interfaces are usable by people with different needs. Accessibility therefore intersects with service design, sustainability, digital competence, destination planning, and customer communication. The relevant capability extends beyond knowledge of accessibility regulations. It includes the ability to recognise exclusion, analyse barriers, and design appropriate alternatives. This may be described as accessibility-by-design competence. Its inclusion within the competence framework also reinforces a broader understanding of sustainability: a tourism system cannot be regarded as sustainable solely on the basis of environmental performance where participation remains systematically inaccessible.

5.1.2 Integrative Professional Capabilities

The increasing complexity of tourism work creates competence requirements that cannot be represented adequately through separate domains alone. Many professional problems require individuals to work across disciplinary, organisational, technological, and social boundaries. Tourism professionals may cooperate with environmental scientists, IT specialists, heritage experts, municipal authorities, accessibility organisations, marketing professionals, local communities, and technology developers. They do not need to become experts in all of these fields, but they require sufficient understanding to communicate requirements, interpret specialist input, coordinate work, and integrate different forms of knowledge.

This capacity may be conceptualised as boundary-spanning competence. It refers to the ability to operate effectively at the interfaces between professional domains and is particularly relevant to sustainable destination management, smart tourism, digital heritage, XR development, environmental monitoring, and community-based tourism.

Ethical and critical competence constitutes a further integrative capability. Many contemporary tourism decisions involve forms of judgement that cannot be reduced to technical efficiency or compliance with established procedures. Greenwashing, AI-generated content, digital surveillance, cultural representation, environmental trade-offs, accessibility, community interests, and the use of

[144] OECD, The Future of Education and Skills: Education 2030, OECD Education Policy Perspectives, no. 98, OECD Publishing, Paris 2018.

visitor data all involve normative choices. Tourism professionals increasingly need to identify ethical dimensions within apparently technical or commercial decisions[145].

Ethical competence therefore extends beyond adherence to professional codes. It involves asking whose interests are represented, who may be disadvantaged or excluded, what evidence supports a particular claim, what data are being collected, and whether the means used are proportionate to the intended objective. Ethical reasoning intersects directly with sustainability judgement, critical digital agency, accessibility, and professional responsibility.

The competence architecture emerging from the analysis can therefore be represented through three interconnected levels. The first is the occupational foundation, comprising the domain-specific knowledge and skills required to understand tourism work and perform relevant occupational tasks. The second consists of cross-cutting competence domains, including sustainability, digitalisation, entrepreneurship, communication, intercultural interaction, accessibility, and collaboration. The third consists of integrative professional capabilities, including sustainability judgement, critical digital agency, adaptive professional agency, boundary-spanning competence, and ethical professional judgement.

The resulting architecture may be expressed conceptually as:

occupational foundation - cross-cutting competence domains - integrative professional capability

This formulation should not be interpreted as a linear sequence of educational stages. The three levels need to interact throughout vocational learning. Occupational knowledge provides the professional context, cross-cutting domains broaden the range of considerations relevant to a task, and integrative capabilities enable learners to combine these elements in situations characterised by complexity, uncertainty, and competing demands[146].

5.1.3 Competence in Action and Implications for Learning Design

An integrated competence perspective changes the meaning of curriculum development. Adding content on sustainability, AI, XR, entrepreneurship, accessibility, or communication does not in itself demonstrate that learners can use these competences in professional contexts. Competence becomes visible when learners are required to mobilise several forms of knowledge and judgement in response to a realistic situation.

Assessment should therefore include authentic or realistically simulated tasks that require integration rather than isolated recall. A learner might, for example, be required to design a tourism product that is commercially viable, environmentally responsible, accessible, digitally communicated, and appropriate to local community conditions. Another task might require interpretation of visitor data followed by a decision concerning crowd management. A hospitality scenario may combine

[145] G. Bianchi, U. Pisiotis, M. Cabrera Giraldez, GreenComp: The European Sustainability Competence Framework, Publications Office of the European Union, Luxembourg 2022.

[146] R. Vuorikari, S. Kluzer, Y. Punie, DigComp 2.2: The Digital Competence Framework for Citizens – With New Examples of Knowledge, Skills and Attitudes, Publications Office of the European Union, Luxembourg 2022.

digital-system use, customer communication, problem solving, cultural sensitivity, and emotional regulation. Such tasks reveal whether learners can transform knowledge into professional action and make competence gaps more visible than isolated knowledge tests.

The competence profile identified here also has direct implications for pedagogy. Higher-order professional capability requires learning environments in which learners encounter complexity rather than only separated subject content. Project-based learning can combine sustainability, entrepreneurship, digital technology, and collaboration. Work-based learning can expose learners to authentic organisational constraints. Simulation can provide safe rehearsal of demanding or infrequent situations. Field-based learning can connect environmental and cultural knowledge with specific places. Role play can develop communication and interpersonal judgement, while interdisciplinary projects can strengthen boundary-spanning competence. Reflection is essential across these approaches because it enables learners to analyse decisions, understand consequences, and transfer learning to new situations[147].

These pedagogies should not be viewed as alternatives to professional knowledge. Their function is to create conditions in which knowledge becomes usable. Professional competence does not arise from experience alone, just as it does not arise from theoretical instruction alone. It develops through the interaction between conceptual understanding, professional action, feedback, reflection, and repeated application.

The principal implication of the analysed practices is therefore not that tourism VET requires an ever-expanding list of discrete skills. A purely additive response would eventually make curricula fragmented and unmanageable. The more important task is to identify which forms of knowledge remain foundational and which higher-order capabilities enable professionals to combine, update, and apply them under changing conditions.

This shifts the focus from competence accumulation towards professional capability. Professional capability may be understood as the ability to mobilise occupational knowledge, sustainability understanding, digital tools, entrepreneurial initiative, interpersonal competence, accessibility awareness, and ethical judgement in response to changing professional situations.

Such capability is necessarily dynamic. New technologies, environmental pressures, regulations, business models, and visitor expectations will continue to modify the content of tourism work. The purpose of VET cannot therefore be to anticipate every future tool, platform, or task. It should instead prepare professionals who can learn, judge, adapt, collaborate, and act responsibly as occupational conditions change. This constitutes the central competence implication emerging from the preceding analyses.

[147] M. Bacigalupo, P. Kampylis, Y. Punie, L. Van den Brande, EntreComp: The Entrepreneurship Competence Framework, Publications Office of the European Union, Luxembourg 2016.

5.2 From Green Skills to Sustainability Capability

The preceding analysis demonstrates that sustainability has become an established component of tourism discourse and, increasingly, of tourism vocational education and training. The principal educational challenge is no longer whether learners are aware of environmental problems, but whether they are capable of translating sustainability principles into professional decisions, operational practices, organisational change, and destination-level responses. This distinction is significant because the empirical material repeatedly indicates a gap between recognition and enactment. Learners may understand the importance of waste reduction, resource efficiency, biodiversity protection, or support for local communities while remaining insufficiently prepared to assess environmental performance, interpret sustainability indicators, manage certification requirements, redesign services, or respond to climate-related risks.

The educational challenge therefore extends beyond the development of individual green skills. It concerns the formation of sustainability capability, understood as the capacity to recognise the environmental, social, cultural, and economic consequences of tourism activity, mobilise relevant knowledge and tools, evaluate competing interests and evidence, and translate this understanding into context-sensitive professional action.

5.2.1 From Environmental Awareness to Sustainability Judgement

A recurring problem concerns the depth at which sustainability is addressed in tourism education. Basic environmental awareness is increasingly incorporated into curricula through topics such as recycling, energy efficiency, water conservation, waste reduction, responsible visitor behaviour, and environmentally preferable consumption. These topics provide an important foundation, but they do not in themselves constitute advanced professional competence. Tourism organisations increasingly require employees who can move beyond following environmentally responsible procedures towards understanding how sustainability is managed, monitored, evaluated, and improved.

This may involve interpreting resource-consumption data, participating in environmental audits, applying certification criteria, evaluating suppliers, identifying environmental risks, assessing the effectiveness of interventions, or contributing to operational improvement plans. The competence gap can therefore be described as a depth gap. Sustainability competence develops through progression from awareness towards operational, analytical, and systemic capability. At an introductory level, learners recognise sustainability problems and understand basic principles. At an operational level, they can implement relevant procedures. At an analytical level, they can interpret information and evaluate environmental performance. At a more advanced level, they can understand the interrelationships among environmental, economic, social, and cultural dimensions and make professional decisions where objectives may conflict.

Tourism VET should therefore support progression across these levels rather than treating environmental awareness as the endpoint of competence development. Operational capability remains essential because sustainability becomes professionally meaningful only where it influences

routine practice. Relevant areas include resource efficiency, waste management, responsible procurement, sustainable mobility, biodiversity-sensitive operations, environmental communication, and the implementation of basic environmental-management procedures. The depth of competence required will, however, vary across occupational roles. Hospitality employees, destination managers, guides, tourism entrepreneurs, and heritage professionals do not require identical technical expertise. This supports the development of a common sustainability foundation combined with role-specific application. The objective is not to transform all tourism learners into environmental specialists, but to ensure that graduates understand the sustainability implications of their professional responsibilities and can recognise when specialist expertise is required.

The increasing importance of sustainability data further illustrates the transition from awareness to professional judgement. Energy and water consumption, emissions, visitor flows, waste, environmental pressure, certification indicators, and other forms of evidence are becoming progressively more relevant to organisational and destination management. Learners therefore need to understand not only what should be monitored, but also how information becomes meaningful for decision-making. This process can be conceptualised as measurement → interpretation → decision → implementation → evaluation. Such a sequence transforms environmental monitoring into professional practice and strengthens learners' capacity to distinguish measurable improvement from symbolic or unsupported sustainability claims.

The ability to question whether an environmental claim is supported by credible evidence constitutes an important element of critical sustainability literacy and reduces vulnerability to greenwashing. Sustainability competence should therefore include not only knowledge of desirable environmental practices, but also the ability to evaluate the quality of evidence, the credibility of claims, and the effectiveness of interventions.

Climate change further expands the competence agenda beyond mitigation and resource efficiency. Tourism destinations are increasingly affected by heat, water scarcity, extreme weather, ecosystem transformation, changing seasonality, coastal risks, and shifts in visitor demand. Tourism professionals therefore require a degree of climate literacy sufficient to understand how climate-related change affects tourism systems and what forms of adaptation may be necessary. This does not require specialist climate-science expertise. It requires sufficient knowledge to interpret risks, recognise vulnerabilities, adapt products and operations, contribute to contingency planning, and understand how changing environmental conditions affect destinations and business models. Climate competence thus connects sustainability with risk management and adaptive professional agency.

Sustainability also increasingly intersects with standards, certification systems, reporting requirements, and environmental-management procedures. Professionals may encounter eco-labels, sustainability criteria, environmental-management systems, reporting mechanisms, or destination-level standards. The relevant capability is not the memorisation of individual certification schemes, but sustainability assurance literacy: an understanding of why standards exist, what types of evidence they require, how compliance is maintained, how certification influences operational

practice, and where the risks of superficial compliance arise. In educational terms, this capability can be developed through simulated audits, documentation exercises, environmental improvement plans, and critical comparison of certification requirements.

Taken together, these elements point towards a higher-order capability that may be described as sustainability judgement. Sustainability judgement enables professionals to interpret evidence, recognise trade-offs, assess competing interests, and justify context-sensitive action. It connects environmental competence with social, economic, cultural, and ethical considerations and allows professionals to move beyond predefined procedures towards reasoned professional decision-making.

5.2.2 Integrating Sustainability with Digitalisation, Circularity, and Destination Systems

Sustainability capability increasingly intersects with other areas of professional competence. One important example concerns circular-economy principles. Tourism organisations participate in wider systems involving suppliers, food production, transport, waste, construction, local enterprises, cultural production, and visitor consumption. Circular competence therefore extends beyond knowledge of recycling. Professionals need to understand material flows, procurement choices, reuse opportunities, waste prevention, local supply chains, and the potential redesign of products and services.

This perspective also connects environmental competence with entrepreneurship. A waste stream may create opportunities for product redesign, while local sourcing may simultaneously influence emissions, community value creation, destination identity, business resilience, and economic circulation within the local area. Circular-economy learning therefore provides a productive context in which learners can develop sustainability judgement together with entrepreneurial agency.

The relationship between green and digital transitions is equally significant. Digital tools can support environmental monitoring, visitor-flow management, mapping, mobility planning, resource optimisation, heritage protection, and sustainability communication. At the same time, digital technologies generate environmental costs through hardware production, energy consumption, data infrastructure, maintenance, and equipment replacement and may introduce new forms of dependency or exclusion.

The relevant professional capability is therefore not simply the use of digital tools in support of sustainability, but the ability to evaluate whether a digital intervention produces sufficient environmental or social value to justify its own costs and consequences. This may be described as green digital judgement. XR provides an illustrative example. Immersive technologies can support environmental simulation, visitor-flow analysis, or mediated access to sensitive locations, but these possibilities do not make XR inherently sustainable. Green-digital competence requires critical evaluation of both the benefits and the environmental implications of technological solutions.

Sustainability should also be understood at destination and community level rather than reduced to environmental efficiency within individual enterprises. Tourism sustainability concerns

residents, cultural heritage, accessibility, employment, local value creation, community participation, and the distribution of tourism benefits and costs. Professionals therefore need a territorial and relational perspective capable of recognising that an intervention may generate different effects at enterprise, destination, and community levels.

An initiative that increases visitor numbers may improve revenues while placing greater pressure on transport, housing, public space, ecosystems, or local infrastructure. Redistribution of visitors may reduce pressure in one location while shifting it elsewhere. Digitalisation may expand access for some groups while generating barriers for others. Such situations require multi-perspective judgement. Learners need opportunities to examine decisions from the perspectives of multiple stakeholders and to recognise that sustainable solutions are often negotiated, context-dependent, and characterised by competing objectives rather than technically self-evident.

This requirement reinforces the need to treat sustainability as a transversal dimension of professional competence. It intersects with digitalisation, entrepreneurship, accessibility, destination management, occupational practice, community engagement, and ethical decision-making. Teaching these areas separately may enable learners to acquire knowledge within each domain but does not necessarily develop the capacity to integrate them in professional situations.

This problem can be described as an integration gap. The gap occurs where sustainability remains separated from other areas of competence even though professional tourism practice requires their simultaneous mobilisation. A sustainable tourism product, for example, may require environmental analysis, economic viability, digital communication, accessibility, stakeholder cooperation, and local knowledge at the same time. Sustainability therefore needs to operate across the curriculum as an organising perspective rather than being confined to a single specialist module.

5.2.3 From Sustainability Knowledge to Professional Action

Recognition of sustainability needs does not necessarily translate into professional action. This can be conceptualised as an enactment gap. Learners may possess relevant conceptual knowledge but lack opportunities to apply it in decisions, projects, workplace settings, or authentic professional problems. The gap may also arise where teachers lack sufficient preparation, curricula remain fragmented, workplace placements provide limited responsibility, or sustainability roles within tourism organisations are poorly defined.

Addressing the enactment gap requires more than additional curriculum content. Learners need authentic or realistically simulated opportunities to apply sustainability principles through field projects, resource audits, destination case studies, certification simulations, workplace assignments, environmental-data analysis, community-based projects, and interdisciplinary challenges. The central pedagogical transition is from knowing about sustainability to acting on sustainability problems and reflecting on the consequences of action[148].

[148] A. Almici, L. Bosetti, R. Cassano, T. Fornasari, F. Gennari, “Circular Economy in the Tourism Industry: Mapping Drivers and Barriers through a Systematic Literature Review”, Piccola Impresa / Small Business, no. 3, 2025.

This transition also has important implications for assessment. Traditional examinations can evaluate terminology, conceptual understanding, and knowledge of environmental principles, but they provide limited evidence of whether learners can make responsible professional decisions in complex situations. Assessment should therefore increasingly include performance-based and problem-based tasks.

Learners might be asked to interpret environmental indicators, evaluate the credibility of a sustainability claim, compare alternative destination-management strategies, propose resource-efficiency measures, assess the implications of a certification requirement, or design a tourism product that balances environmental, economic, accessibility, and community considerations. Such tasks make visible whether learners can integrate knowledge rather than reproduce it as separate content.

Assessment should also address the reasoning underlying professional decisions. Learners should be able to explain which evidence informed their judgement, which stakeholders were considered, which trade-offs were identified, and why a particular intervention was selected. This approach makes sustainability judgement observable and prevents assessment from being reduced to identifying a single supposedly correct environmental answer.

Teacher competence represents an important enabling condition for this transformation. Educators require sufficient knowledge and confidence to move beyond introductory environmental topics and facilitate learning involving data interpretation, competing objectives, certification systems, community perspectives, regulation, and emerging climate risks. Professional development should therefore address both sustainability content and pedagogy. Teachers need access to contemporary tourism practices, environmental standards, case material, industry expertise, and methods for experiential, interdisciplinary, and problem-based learning[149].

This reinforces a principle running throughout the analysis: learner competence development depends on institutional competence development. Sustainability cannot become a transversal organising principle of tourism VET if teacher development remains occasional, fragmented, or disconnected from sectoral transformation.

The overall sustainability competence problem can consequently be conceptualised through three interrelated gaps. The depth gap occurs where sustainability remains at the level of general awareness rather than progressing towards operational, analytical, systemic, and judgement-based capability. The integration gap arises where sustainability is separated from digitalisation, entrepreneurship, accessibility, occupational practice, and destination management. The enactment gap emerges where conceptual knowledge is not translated into decisions, projects, workplace activities, or authentic professional action.

[149] P. Jones, M. G. Wynn, “The Circular Economy, Natural Capital and Resilience in Tourism and Hospitality”, International Journal of Contemporary Hospitality Management, vol. 31, no. 6, 2019, pp. 2544–2563.

These gaps require different educational responses. A depth gap requires progression towards more advanced professional capability. An integration gap requires curriculum redesign and stronger connections between competence domains. An enactment gap requires pedagogies and learning environments that provide opportunities for application, experimentation, feedback, and reflection. Treating all three merely as a shortage of "green skills" would obscure the different mechanisms that produce them[150].

The future-oriented competence agenda will continue to evolve and may include environmental data interpretation, circular economy, climate adaptation, sustainable mobility, biodiversity management, sustainability assurance, community engagement, green digitalisation, and responsible leadership. Continually adding new topics to curricula, however, is unlikely to provide a durable educational strategy. A more sustainable approach is to develop the professional capability that enables learners to interpret and incorporate emerging sustainability requirements as they change.

The progression from green skills towards sustainability capability may therefore be represented as:

environmental awareness → operational competence → analytical capability → systems understanding → sustainability judgement → responsible action

This sequence represents increasing depth of professional capability rather than a set of discrete curriculum stages. Environmental awareness provides conceptual orientation; operational competence enables implementation; analytical capability supports evidence-informed decision-making; systems understanding makes interdependencies visible; sustainability judgement enables the evaluation of trade-offs; and responsible action translates these elements into professional practice.

The central implication for tourism VET is therefore a shift from green skills understood as a catalogue of discrete abilities towards sustainability capability as an integrated form of professional action. The objective should not merely be to produce graduates who understand sustainability terminology or can follow prescribed environmental procedures, but to develop professionals capable of incorporating sustainability into decision-making even where situations are complex, evidence is incomplete, and competing objectives must be balanced. At this level, green competence becomes professional capability.

5.3 From VET Readiness to Adaptive Institutional Capacity

The capacity of vocational education and training to respond to the transformation of tourism depends not only on the competences incorporated into curricula, but also on the ability of institutions to recognise change, interpret its educational implications, and translate emerging requirements into sustainable learning provision. Environmental pressures, digitalisation, new

[150] A. Wiek, L. Withycombe, C. L. Redman, "Key Competencies in Sustainability: A Reference Framework for Academic Program Development", Sustainability Science, vol. 6, 2011, pp. 203–218.

business models, technological innovation, and changing visitor expectations evolve at different speeds and rarely correspond neatly to existing subject structures. The challenge for tourism VET is therefore not simply to become “ready” for a particular innovation. It is to develop the institutional capability to adapt repeatedly as professional practice changes.

Readiness should consequently be understood as a multidimensional and dynamic condition. Infrastructure remains important, but access to hardware, software, connectivity, or immersive technologies constitutes only one component. Educational innovation also depends on curriculum flexibility, teacher capability, organisational leadership, financial continuity, partnerships, evaluation mechanisms, work-based learning arrangements, and supportive policy conditions. Weakness in one dimension may substantially reduce the value of strength in another. An institution may possess advanced technological infrastructure while lacking educators capable of integrating it meaningfully into learning. Another may have innovative teachers and strong employer partnerships but insufficient resources to sustain new forms of provision. Readiness therefore emerges from the configuration of institutional capacities rather than from the possession of individual resources.

5.3.1 From Readiness to Adaptive Institutional Capability

This perspective changes how technological and pedagogical readiness should be interpreted. Digital infrastructure increasingly forms part of the basic operating environment of VET, particularly where learning involves professional software, data analysis, online collaboration, simulation, or immersive technologies. Yet technological availability alone does not constitute educational capability. Equipment must be reliable, accessible, maintainable, and supported by appropriate expertise. Institutions also need the capacity to replace obsolete systems and avoid dependence on short-lived project investments. The relevant distinction is therefore between technology acquisition and sustainable technological capability.

The same principle applies to pedagogical innovation. Project-based learning, experiential learning, interdisciplinary assignments, simulation, workplace projects, and digitally supported learning may already be present within tourism education, but their existence does not necessarily indicate systemic transformation. Such practices may remain dependent on individual teachers, temporary projects, or optional modules. Pedagogical readiness requires the capacity to connect innovative approaches with formal learning outcomes, assessment, curriculum progression, and occupational competence.

This creates an important distinction between innovation activity and innovation capacity. An institution may participate in numerous innovative projects while possessing limited ability to sustain their results once external funding, specialist support, or individual enthusiasm disappears. Conversely, another institution may introduce relatively few innovations but have robust processes for evaluating, integrating, maintaining, and, where necessary, discontinuing those that have demonstrated clear educational value. The latter may represent a more mature form of institutional capability.

Adaptive capacity therefore requires institutions to move beyond episodic innovation towards organisational learning. New practices become institutionally meaningful when they can be incorporated into shared procedures, professional-development arrangements, curriculum decisions, support structures, and evaluation mechanisms without losing the pedagogical conditions that made them valuable.

The central issue is not how rapidly an institution adopts new technologies or methodologies, but whether it possesses the capability to identify relevant developments, interpret their implications for professional competence, experiment with appropriate responses, and integrate those that demonstrate value. This shifts the focus from static readiness towards adaptive institutional capacity.

5.3.2 Teacher Professionalisation, Leadership, and Organisational Learning

Teacher development is central to this transition. Educators occupy a mediating position between labour-market change, curriculum content, technology, and learner experience. Their professional role increasingly requires more than subject knowledge. Tourism educators need opportunities to update their understanding of sustainability, digital systems, emerging business practices, data use, accessibility, and technological change while simultaneously developing pedagogical approaches capable of translating these developments into meaningful learning.

Teacher professionalisation should therefore be understood as a continuous process rather than a sequence of isolated training events. Short workshops may introduce new technologies or topics, but they rarely provide the depth required for sustained curriculum change. More durable approaches can include professional learning communities, industry placements, peer exchange, mentoring, collaborative curriculum design, applied projects, observation of practice, and access to current occupational environments.

Teachers do not need to become specialists in every emerging technology or sustainability domain. They do, however, require sufficient capability to determine which developments are relevant to their learners, when external expertise is required, and how new content or technologies should be incorporated pedagogically. This reinforces the concept of pedagogical-technical mediation developed earlier. Teachers are not simply users of innovation; they are professional interpreters who determine how technological and occupational developments relate to learning objectives, learner needs, assessment, and professional competence.

Institutional leadership plays an equally important role. Innovation that depends entirely on individual “champions” remains structurally fragile. Motivated teachers may initiate significant change, but practices can disappear when these individuals change roles, leave the institution, or lose access to project resources. Adaptive institutions therefore require mechanisms for converting individual expertise into collective capability through shared resources, collaborative planning, documented practices, distributed responsibilities, peer learning, and organisational routines.

Leadership also involves decisions about which innovations should not be expanded. A mature innovation culture is not characterised by permanent adoption of every new technology or

methodology. It includes the capacity to experiment, evaluate, revise, scale, reduce, and discontinue. An innovation should be retained because it improves learning or institutional performance, not because it carries symbolic value as evidence of modernisation.

Organisational learning consequently involves both adoption and rejection. Institutional capability is demonstrated not only by the ability to introduce change, but also by the capacity to determine when a particular practice no longer provides sufficient educational or organisational value.

5.3.3 Partnerships, Curriculum Flexibility, and Work-Based Learning

Partnerships constitute another important component of adaptive institutional capacity. Tourism VET cannot remain aligned with changing professional practice through internal resources alone. Enterprises, destination organisations, cultural institutions, environmental bodies, local communities, technology providers, universities, and intermediary organisations can contribute occupational knowledge, authentic problems, infrastructure, mentoring, specialist expertise, and opportunities for work-based learning.

The strongest partnerships, however, do more than provide temporary access to external resources. They create continuing feedback between education and professional practice. Partnerships can therefore be conceptualised as learning infrastructures. Employers can help identify emerging occupational requirements, while VET institutions translate these requirements into structured and transferable learning rather than reproducing current workplace practices uncritically. Communities can contribute local knowledge and perspectives, technology providers can introduce new tools while educators assess their relevance, and universities or research organisations can support evidence generation and evaluation.

Such cooperation strengthens the broader competence ecosystem when knowledge circulates between actors rather than remaining concentrated within individual organisations. Partnership quality should therefore be assessed not merely by the number of external relationships but by the extent to which they support mutual learning, curriculum renewal, knowledge transfer, and institutional capability.

Curriculum modernisation needs to be understood in the same dynamic way. The challenge is not simply to add sustainability, entrepreneurship, AI, XR, climate literacy, circular economy, or other emerging topics whenever they become prominent in policy or industry discourse. A purely additive model eventually produces curriculum overload and fragmentation. A more sustainable approach requires a flexible architecture in which durable occupational foundations coexist with transversal competence domains and opportunities to incorporate emerging professional problems.

Competence-based and problem-oriented approaches can support this flexibility. Instead of creating a separate subject for every new development, curricula can include tasks in which learners must combine environmental judgement, digital capability, entrepreneurship, communication, accessibility, and occupational knowledge. Such an approach supports curriculum renewal without

continuous proliferation of stand-alone modules and reflects the hybrid competence profiles increasingly required in tourism work.

Innovation opportunities therefore lie not only in new technologies, but also in redesigning relationships among curriculum, pedagogy, assessment, workplace learning, and institutional cooperation. XR represents one example. Its educational value depends on whether it addresses a meaningful learning problem and whether sufficient institutional capacity exists to support its use. The same logic applies to AI, digital platforms, environmental dashboards, smart-tourism applications, and other emerging tools. Innovation should begin with occupational and educational purpose rather than with technological availability.

Work-based learning is particularly important within this architecture. Workplace exposure does not automatically constitute meaningful workplace learning. Internships may remain limited to repetitive or low-responsibility tasks unless learning objectives, mentoring, feedback, and progressive responsibility are deliberately structured. Stronger cooperation between VET providers and enterprises can transform placements into genuine environments for competence development. Employers should therefore participate not only as hosts but as co-producers of learning, while VET institutions retain responsibility for educational quality, inclusion, assessment, and transferability.

5.3.4 Evaluation, Sustainability, Equity, and Policy Capacity

Adaptive institutional capacity also requires strong evaluative capability. Innovative practices frequently generate enthusiasm during pilot phases while producing limited evidence concerning their longer-term educational and organisational value. Institutions need to evaluate not only learner satisfaction or perceived usefulness, but also competence development, accessibility, transfer to professional practice, teacher workload, financial sustainability, and organisational feasibility[151].

This creates the need for evaluative capacity as a permanent component of institutional readiness. Evaluation should be proportionate to the decision being made. An exploratory project requires a different level of evidence from a curriculum-wide reform. Initial experimentation may appropriately rely on observation, learner feedback, teacher reflection, and performance-based tasks. Wider institutionalisation requires stronger evidence concerning educational outcomes, costs, accessibility, transferability, and sustainability.

Evaluation should therefore form part of innovation governance rather than being conducted only at the end of externally funded projects. Institutions need mechanisms for learning from both successful and unsuccessful experimentation and for incorporating this knowledge into subsequent decisions.

Financial sustainability represents another structural condition. Project-based funding can stimulate experimentation and provide access to equipment, international partnerships, or expertise that institutions might otherwise be unable to obtain. Repeated dependence on short funding cycles

[151] Council of the European Union, Council Recommendation of 24 November 2020 on Vocational Education and Training (VET) for Sustainable Competitiveness, Social Fairness and Resilience, 2020/C 417/01, Official Journal of the European Union, C 417, 2020, pp. 1–16.

can nevertheless produce a paradox: institutions become increasingly experienced in launching innovations while remaining unable to sustain them. This reinforces the distinction between project capacity and institutional capacity.

Funding strategies should therefore consider lifecycle costs and post-project continuity. Decisions need to account for maintenance, staffing, teacher development, software licences, accessibility, technical support, updating, and organisational responsibility. External funding creates the greatest long-term value when it develops enduring institutional capability rather than financing temporary visibility.

Questions of equity are inseparable from this process. Digital and organisational transformation may widen differences between VET providers if well-resourced institutions accumulate infrastructure, expertise, partnerships, and project experience while smaller, rural, or under-resourced providers struggle to participate. The resulting divide concerns not only access to technology but access to innovation capacity. Similar inequalities can develop within institutions where innovative learning opportunities remain limited to selected programmes or groups of learners.

System-level responses may therefore require shared infrastructure, regional support networks, teacher communities, common resources, joint procurement, mobile facilities, and other mechanisms through which smaller institutions can participate in innovation ecosystems without independently reproducing every resource. Equity should be assessed in terms of access to meaningful learning opportunities and implementation capability rather than access to devices alone[152].

Policy frameworks can enable such development, but strategic declarations do not themselves produce institutional capability. Digitalisation, sustainability, and innovation may feature prominently in national and European strategies while implementation remains constrained by rigid curricula, insufficient financing, weak technical support, or limited teacher-development opportunities. The relevant distinction is therefore between policy ambition and implementation capacity.

Policy is most effective when it creates conditions through which institutions can translate strategic objectives into practice. This may include curriculum flexibility, professional-development infrastructure, sustainable financing mechanisms, support for cooperation with industry, accessibility guidance, evidence standards, and targeted support for under-resourced providers. The objective should not be to impose identical pathways of innovation, but to enable differentiated institutional responses within a shared direction of transformation[153].

The evidence therefore does not support a simple distinction between innovative frontrunners and lagging institutions. Readiness is multidimensional, contextual, and uneven even within

[152] Cedefop, Future-Ready VET Systems and Skills: Cedefop in 2024, Publications Office of the European Union, Luxembourg 2025.

[153] Council of the European Union, Council Recommendation of 24 November 2020 on Vocational Education and Training (VET) for Sustainable Competitiveness, Social Fairness and Resilience, 2020/C 417/01, Official Journal of the European Union, C 417, 2020, pp. 1–16.

individual national systems. One institution may be advanced in project-based pedagogy but constrained by digital infrastructure; another may possess sophisticated technology but weak partnership capacity; a third may have extensive employer cooperation but limited curriculum flexibility. These configurations require different development strategies rather than placement on a single innovation maturity scale.

5.3.5 Adaptive Institutional Capacity as Continuous, Evidence-Informed Adaptation

The concept emerging from this analysis can be defined as adaptive institutional capacity: the ability of VET organisations and systems to detect relevant change, interpret its implications for competence development, mobilise internal and external expertise, experiment with responses, evaluate their value, integrate successful practices, and discontinue approaches that no longer serve educational objectives.

This capacity operates through several interconnected mechanisms, including curriculum flexibility, teacher professionalisation, institutional leadership, infrastructure, partnerships, work-based learning, evaluation, financial sustainability, equity mechanisms, and supportive policy environments. No single dimension is sufficient in isolation. Their significance lies in the way they combine to create the institutional conditions for repeated adaptation.

The movement from readiness towards adaptive institutional capacity can therefore be conceptualised as:

recognition of change → interpretation of competence implications → experimentation → evaluation → institutional learning → integration or discontinuation → renewed adaptation

This sequence represents a more durable model of innovation than the conventional progression from pilot to mainstream adoption. It recognises that not every experiment should become permanent, that changing conditions may require practices to be revised or withdrawn, and that institutional learning depends as much on critical evaluation as on implementation.

The objective of tourism VET should therefore not be to become permanently “ready” for a particular set of technologies, sustainability requirements, or labour-market demands. Any such state would inevitably become obsolete. A more durable institutional capability lies in remaining responsive while preserving educational quality, professional relevance, inclusion, and organisational sustainability.

In this sense, innovation readiness is not an end state. It is an organisational capacity for continuous, evidence-informed adaptation.

5.4 From Entrepreneurial Learning to Adaptive Professional Agency

Entrepreneurial learning occupies a distinctive position within tourism vocational education and training because it connects occupational competence with the capacity to act under conditions of uncertainty, recognise opportunities, mobilise resources, and create value. In a sector characterised by changing visitor expectations, fragmented value chains, technological innovation, environmental

pressures, seasonality, and exposure to external disruption, entrepreneurship cannot be reduced to preparation for business start-up. Its broader educational significance lies in developing professionals who are able to initiate, shape, and adapt change within both new and existing organisations.

This broader understanding includes conventional entrepreneurship but also intrapreneurship, service innovation, community-based initiative, sustainable product development, and organisational problem solving. A tourism graduate may never establish an enterprise and still require entrepreneurial competence when redesigning a visitor experience, responding to an emerging market need, introducing a sustainability practice, coordinating a local partnership, or adapting an existing service to changing environmental or technological conditions. Entrepreneurial learning should therefore be understood as a component of professional capability rather than as preparation for a single career pathway.

5.4.1 Entrepreneurial Competence as Responsible Value Creation

The competence profile emerging from the preceding analysis combines opportunity recognition, creativity, initiative, business understanding, problem solving, uncertainty management, collaboration, and responsibility. These elements are interdependent. Opportunity recognition has limited value without the capacity to evaluate feasibility; creativity needs to be connected with implementation; business judgement should incorporate environmental and social consequences; and risk management requires both analytical capability and willingness to act despite incomplete information.

Entrepreneurship in sustainable tourism therefore operates at the intersection of economic, environmental, technological, territorial, and social considerations. This distinguishes sustainable entrepreneurial competence from a narrowly commercial interpretation of entrepreneurship. Value creation may include financial viability, but it also concerns environmental impact, community benefit, cultural continuity, accessibility, employment, visitor experience, and destination resilience.

A commercially attractive tourism product may create unacceptable environmental pressure. An environmentally ambitious concept may remain ineffective if it cannot attract sufficient demand or generate resources for continuation. A community-oriented initiative may fail where local actors are not meaningfully involved in its design. Entrepreneurial competence therefore requires the ability to recognise and balance several forms of value simultaneously.

For this reason, sustainable entrepreneurship should not be conceptualised simply as conventional entrepreneurship supplemented by an environmental component. Sustainability changes the entrepreneurial problem itself. Learners need to ask not only whether an idea can generate demand or revenue, but also what resources it requires, who benefits, who bears its costs, how it affects the destination or community, whether it creates exclusion, and whether its value can be maintained over time. Sustainability judgement therefore becomes an integral component of entrepreneurial decision-making.

The relationship also operates in the opposite direction. Sustainability knowledge becomes professionally meaningful when learners can translate environmental and social problems into viable

forms of action. Understanding circular economy, biodiversity, climate adaptation, sustainable mobility, accessibility, or local value creation has limited transformative effect where graduates cannot identify opportunities for redesign, mobilise partners, develop workable solutions, communicate value, and implement change. Entrepreneurial learning can therefore function as one of the mechanisms through which sustainability awareness becomes professional action.

This is particularly relevant to tourism, where SMEs, micro-enterprises, destination organisations, cultural institutions, local networks, and community actors operate alongside larger firms. In smaller organisations, professional roles are often less specialised and individuals may need to combine customer service, marketing, operational management, sustainability, partnership building, and innovation. Such contexts increase the importance of hybrid competence profiles and strengthen the value of initiative, judgement, and adaptability.

5.4.2 Entrepreneurial Learning Through Action, Experimentation, and Reflection

Entrepreneurial competence cannot be developed effectively through conceptual instruction alone. Learners may understand the formal components of a business plan while remaining uncertain about how to identify a meaningful problem, test assumptions, negotiate with stakeholders, respond to failure, or revise an idea after receiving feedback. The relevant educational gap therefore lies between entrepreneurship knowledge and entrepreneurial action.

Entrepreneurial learning requires environments in which learners make decisions whose consequences can be examined. Project-based learning is particularly appropriate because it enables students to address complex tourism problems for which no single predefined solution exists. Learners may be asked to design a low-impact visitor experience, redesign a local tourism service, develop an accessible cultural offer, propose a circular-economy solution for hospitality, or formulate a response to seasonality. Such tasks require simultaneous mobilisation of occupational, sustainability-related, digital, interpersonal, and business competences.

Experiential learning strengthens this process where learners engage with enterprises, destinations, cultural organisations, communities, or other external partners. Authentic professional problems expose students to constraints that theoretical exercises cannot fully reproduce, including limited budgets, conflicting stakeholder interests, incomplete information, regulatory requirements, changing customer expectations, environmental conditions, and implementation trade-offs. These constraints should not be treated as barriers to entrepreneurial learning; they constitute part of its professional authenticity.

Work-based learning can perform a similar function, provided that learners move beyond routine or purely auxiliary tasks. Entrepreneurial capability develops when students are able to identify problems, contribute ideas, participate in improvement processes, receive feedback, and assume progressively greater responsibility. The formal presence of a placement is therefore insufficient. The quality and structure of the learning environment determine whether workplace participation contributes to entrepreneurial agency.

Simulation and role play can provide further opportunities for decision-making where authentic experimentation would be costly, risky, or organisationally difficult. Learners can practise negotiation, customer interaction, resource allocation, crisis response, or business decisions and subsequently analyse the consequences of their choices. XR may support selected forms of such simulation where it offers genuine educational additionality, but it should remain one pedagogical option among several. A conventional simulation, role play, or well-designed project may be equally or more appropriate where immersion contributes little to the learning objective.

An important component of this learning process is the treatment of error and iteration. Entrepreneurial learning requires environments in which assumptions can be tested, weak ideas identified, prototypes revised, and unsuccessful approaches analysed without interpreting every unsuccessful attempt as incompetence. Failure should not be romanticised, but it can generate evidence that supports better judgement and more informed adaptation.

The learning cycle can therefore be conceptualised as:

problem recognition → opportunity formulation → experimentation → feedback → reflection → adaptation → action

This cycle is more educationally significant than the production of a polished business plan alone because it develops the capacity to revise judgement in response to evidence. Entrepreneurial learning thereby contributes directly to adaptive professional agency.

5.4.3 Digital, Territorial, and Collaborative Entrepreneurship

Digital competence increasingly intersects with entrepreneurial learning. Tourism enterprises depend on digital platforms, customer-management systems, data, online communication, AI-supported tools, and digitally mediated services. Learners therefore need to understand how digital technologies can support opportunity recognition, customer engagement, product development, distribution, and decision-making.

Entrepreneurial digital competence should not, however, be equated with the ability to operate a particular platform or application. It requires critical digital agency: the capacity to select technologies according to purpose, evaluate their limitations, interpret information, and consider their ethical, accessibility, environmental, and organisational implications. A new digital tourism service should therefore be evaluated not only in terms of technical novelty but also in relation to user need, inclusion, data requirements, business viability, sustainability, and proportionality of technological complexity.

Community-based entrepreneurship further broadens this competence. Tourism value is frequently created through places, cultural resources, environmental assets, local knowledge, food systems, crafts, and social relationships that cannot be treated merely as inputs into commercial products. Learners need to understand how entrepreneurial action interacts with communities and territories. Co-creation, stakeholder participation, negotiation, and distribution of benefits therefore form part of sustainable entrepreneurial competence.

The territorial dimension is important because tourism innovation can generate both benefits and pressures. An initiative designed to diversify visitor flows may stimulate economic activity while placing additional pressure on previously less visited areas. A cultural product may generate revenue while simplifying or commercialising local heritage. A digital service may increase access for some groups while excluding others. Entrepreneurial learning should therefore expose learners to unintended consequences as well as intended opportunities.

This context also increases the importance of boundary-spanning competence. Sustainable tourism innovation may require collaboration with environmental specialists, technology providers, municipalities, local enterprises, cultural institutions, accessibility organisations, or community groups. Learners do not require specialist mastery of every field, but they need sufficient capacity to communicate across professional boundaries, translate needs, coordinate perspectives, and integrate external expertise into decision-making.

Risk should likewise be understood more broadly than financial uncertainty. Sustainable tourism entrepreneurship may involve regulatory risk, climate risk, reputational risk, technological dependence, environmental impact, community opposition, or changing visitor preferences. Entrepreneurial competence therefore includes the ability to make proportionate decisions under uncertainty and to recognise when an opportunity should not be pursued or when an idea requires fundamental redesign.

Partnership ecosystems can strengthen this form of learning. Enterprises may provide authentic challenges and mentoring; communities can introduce place-based needs and perspectives; destination organisations can contribute system-level problems; universities and technology organisations can provide specialist knowledge; and public institutions can offer insight into regulation and development priorities. The value of these relationships lies in exposing learners to the multiple actors involved in tourism value creation.

Such partnerships also prevent entrepreneurial learning from becoming excessively individualistic. Many forms of tourism innovation depend on networks and collective action rather than on individual entrepreneurs acting independently. Sustainable mobility, destination management, cultural routes, community tourism, circular systems, and digital ecosystems require collaboration. Entrepreneurial capability therefore includes collaborative entrepreneurship: the capacity to create value through relationships, networks, and coordinated action.

5.4.4 Assessment, Teacher Capability, and Adaptive Professional Agency

Assessment should reflect the action-oriented character of entrepreneurial competence. Evaluating only the final business concept may conceal the reasoning, evidence, experimentation, and adaptations through which it was developed. Learners should therefore also be assessed on their ability to identify a meaningful problem, gather and interpret evidence, assess feasibility, consider stakeholder interests, recognise sustainability implications, respond to feedback, and justify modifications.

Process and judgement thus become legitimate objects of assessment alongside final outcomes. This is particularly important in open-ended entrepreneurial tasks, where several solutions may be defensible and where educational value lies partly in the quality of reasoning, iteration, and reflection[154].

Teacher competence constitutes a critical enabling condition. Entrepreneurial learning requires educators to facilitate open-ended tasks rather than merely transmit predefined content. Teachers need to manage project processes, provide formative feedback, support reflection, connect learners with external stakeholders, facilitate interdisciplinary cooperation, and assess solutions for which several legitimate answers may exist. This differs substantially from teaching entrepreneurship as a sequence of terminology, business-planning templates, or procedural exercises.

Teacher professional development should therefore include facilitation of experiential and project-based learning, mentoring, interdisciplinary collaboration, assessment of transversal competences, and cooperation with enterprises and communities. External entrepreneurs and industry representatives can contribute authentic knowledge and mentoring, but they should complement rather than replace pedagogical expertise.

Institutional conditions matter equally. Entrepreneurship is unlikely to develop as a meaningful transversal capability where it remains confined to one isolated subject while the remainder of the curriculum rewards passive reproduction of knowledge. Learners need repeated opportunities to exercise initiative across different tourism contexts. Entrepreneurial learning can be integrated into sustainability projects, digital tasks, heritage interpretation, destination planning, hospitality improvement, community-based assignments, and work-based learning[155].

This does not mean that every VET provider requires a dedicated entrepreneurship laboratory or incubator. Such structures may be valuable where resources and objectives justify them, but institutional entrepreneurship capacity is better assessed by the quality and regularity of opportunities learners receive to formulate, test, evaluate, and refine ideas.

This reinforces the distinction between entrepreneurship as a curriculum subject and entrepreneurial learning as a pedagogical orientation. The former can provide important knowledge of market analysis, finance, planning, and business models. The latter develops the learner's capacity to recognise problems, formulate opportunities, collaborate with others, act under uncertainty, and learn from consequences. Both are relevant, but the second is more closely aligned with the competence requirements identified throughout this study.

Entrepreneurial learning should consequently not be justified primarily by assumptions concerning future self-employment. Its professional relevance is considerably broader. Tourism organisations require employees who can respond to change, improve existing practices, coordinate

[154] H. M. Neck, P. G. Greene, "Entrepreneurship Education: Known Worlds and New Frontiers", Journal of Small Business Management, vol. 49, no. 1, 2011, pp. 55–70.

[155] M. Lackéus, "Entrepreneurship in Education: What, Why, When, How", OECD Local Economic and Employment Development (LEED) Papers, no. 2015/06, OECD Publishing, Paris 2015.

across organisational boundaries, contribute to innovation, and take responsibility for implementation. Graduates therefore need to become not only job-ready but change-capable.

At this point, entrepreneurial competence converges with the broader concept of adaptive professional agency. Adaptive professional agency can be understood as the capacity to recognise change, interpret its implications, mobilise relevant knowledge and relationships, initiate appropriate action, and modify that action in response to evidence and feedback. Entrepreneurial learning represents one of the principal pedagogical routes through which such agency can be developed[156].

The progression may therefore be represented as:

opportunity awareness → initiative → experimentation → value creation → reflective adaptation → responsible professional agency

This progression should not be interpreted as a linear model of business creation. Rather, it represents increasing capacity to influence professional situations instead of responding to them passively.

The central implication for tourism VET is therefore a shift from teaching entrepreneurship primarily as business creation towards developing adaptive and responsible professional agency. Graduates require business understanding, but they also need the capacity to combine it with sustainability judgement, critical digital agency, interpersonal competence, territorial awareness, and ethical responsibility.

Entrepreneurial learning thus becomes part of the broader professional-capability architecture developed in this chapter. Its purpose is not simply to produce more entrepreneurs, but to develop tourism professionals who can recognise possibilities, take responsibility for change, create value collaboratively, and adapt their actions to environmental, social, technological, organisational, and market conditions.

5.5 From Labour-Market Alignment to Adaptive Responsiveness

The effectiveness of tourism vocational education and training depends partly on its capacity to prepare learners for meaningful professional participation and to provide the sector with competences relevant to changing forms of work. However, the relationship between education and labour-market demand should not be understood as a simple matching exercise in which employers define a fixed set of skills and VET institutions reproduce them through curricula. Tourism is changing too rapidly, and occupational requirements are too heterogeneous, for alignment to be treated as a stable end state.

Tourism work is being reshaped simultaneously by sustainability requirements, digitalisation, climate-related pressures, demographic change, changing visitor behaviour, new business models, accessibility expectations, and recurrent external disruption. These transformations alter not only

[156] M. Bacigalupo, P. Kampylis, Y. Punie, L. Van den Brande, EntreComp: The Entrepreneurship Competence Framework, Publications Office of the European Union, Luxembourg 2016.

individual tasks but also the combinations of competences required to perform them. The central challenge is therefore not to achieve perfect correspondence between current curricula and current vacancies, but to develop a system capable of continuous labour-market responsiveness[157].

5.5.1 From Skills Matching to Competence Configuration

Traditional occupational competences remain fundamental. Employers continue to require graduates who understand customer service, hospitality operations, guiding, tourism-product development, safety, destination services, and other core functions. The emerging challenge is not that these competences are becoming obsolete, but that they increasingly need to be combined with capabilities that were previously treated as complementary, transversal, or specialist.

A hospitality employee may need to apply sustainability procedures while using digital customer-management systems. A guide may combine heritage interpretation with intercultural communication, environmental awareness, accessibility considerations, and digital storytelling. A destination professional may need to interpret data while accounting for mobility, local community interests, environmental pressure, and visitor inclusion. The emerging mismatch therefore concerns not only the presence or absence of individual skills, but the configuration of competence required for professional performance.

This is particularly visible in relation to the green transition. Employers may expect graduates to implement resource-efficiency measures, support environmental certification, communicate sustainability practices, or contribute to destination-level environmental initiatives. VET may nevertheless provide learners primarily with conceptual sustainability awareness rather than equivalent opportunities for operational application. The mismatch is therefore not necessarily an absence of sustainability content but a gap between recognition and professional enactment[158].

A comparable distinction applies to digital competence. Learners may be familiar with everyday communication tools and social media while having limited experience with sector-specific systems, digital distribution, customer-management technologies, data interpretation, or emerging forms of automation. The relevant labour-market challenge lies between general digital familiarity and professionally situated digital capability.

Entrepreneurial and transversal competences present a similar problem. Communication, initiative, adaptability, teamwork, problem solving, intercultural sensitivity, and resilience may be identified as important by employers, yet these capabilities are difficult to develop and assess through highly segmented subject-based instruction. Their professional relevance becomes visible when learners need to mobilise them simultaneously within complex occupational situations.

[157] OECD, Building Future-Ready Vocational Education and Training Systems, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris 2023.

[158] Cedefop, Next Generation Skills Intelligence for More Learning and Better Matching: Skills Anticipation Trends, Opportunities and Challenges in EU Member States, Publications Office of the European Union, Luxembourg 2024.

Labour-market alignment should therefore be assessed at the level of professional performance rather than curriculum terminology. The presence of sustainability, digitalisation, entrepreneurship, or communication in programme documentation does not demonstrate that graduates can integrate these competences effectively in work. The more significant question is whether learning environments require learners to combine them in occupationally meaningful action[159].

5.5.2 Work-Based Learning and Reciprocal Co-Construction with Employers

This shift places greater emphasis on the architecture of vocational learning, particularly work-based learning. Authentic professional environments provide opportunities to encounter real organisational constraints, workplace routines, technologies, relationships, and emerging practices. However, workplace exposure should not be equated automatically with competence development.

An internship may reproduce existing routines without enabling learners to encounter new practices, exercise judgement, receive meaningful feedback, or assume responsibility. The distinction is therefore fundamental:

workplace exposure ≠ work-based learning

Meaningful work-based learning connects professional experience with intentional competence development. Learning objectives need to be explicit, workplace mentors need to understand the competences learners are expected to develop, and students require opportunities to observe, practise, make decisions, receive feedback, and assume progressively greater responsibility. Experiences gained in the workplace should also return to the classroom, where they can be interpreted, compared, generalised, and connected with broader occupational concepts[160].

This has implications for the role of employers. Enterprises should not be treated merely as placement providers or external validators of curriculum content. They can function as co-producers of competence by identifying emerging occupational challenges, contributing authentic tasks, mentoring learners, providing feedback, and participating in curriculum renewal.

Closer employer involvement should nevertheless not result in curricular subordination to immediate business demand. Employers differ in technological maturity, sustainability practice, organisational quality, and capacity to anticipate change. Current labour demand may also reflect existing routines rather than desirable future professional practice. VET therefore needs to preserve educational autonomy.

Its role is not to reproduce employer demand mechanically, but to interpret labour-market signals critically, combine them with broader environmental, social, ethical, and educational objectives, and develop transferable professional capability. The relationship between VET and the

[159] Cedefop, ETF, OECD, Skill Needs Anticipation: Systems and Approaches: Analysis of Stakeholder Survey on Skill Needs Assessment and Anticipation, International Labour Organization 2017.

[160] OECD, Teachers and Leaders in Vocational Education and Training, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris 2021.

labour market is therefore better understood as reciprocal co-construction than as one-directional responsiveness.

This is particularly important in sustainable tourism. Labour-market relevance cannot be evaluated only through short-term employability or employer satisfaction. VET also has an anticipatory and developmental role. Graduates may enter organisations that have not yet fully integrated sustainability, accessibility, digital responsibility, or community-oriented approaches. Education should therefore prepare learners not only to function within existing work environments, but also to improve them.

This creates a productive tension between responsiveness and anticipation. VET needs to remain sufficiently responsive to current occupational realities to support credible labour-market entry, while also developing the capabilities required to respond to emerging conditions and participate in sectoral transformation. Excessive attention to current demand risks producing qualifications that rapidly become obsolete, while excessive attention to speculative future skills may weaken immediate occupational relevance.

A more durable model combines stable occupational foundations with adaptable higher-order capabilities. Core professional knowledge provides continuity, while sustainability judgement, critical digital agency, adaptive professional agency, boundary-spanning competence, and ethical judgement enable graduates to respond as occupational conditions evolve.

5.5.3 Adaptive Curriculum Capacity, Assessment, and Professional Translation

The changing nature of labour-market alignment also affects the role of skills forecasting. Anticipation and forecasting mechanisms can provide valuable information concerning technological developments, environmental requirements, demographic changes, occupational restructuring, and emerging services. However, forecasting cannot identify with certainty which technologies, platforms, business models, or job descriptions will dominate future tourism.

Its principal value lies in identifying directions of change and emerging competence pressures. VET therefore requires mechanisms capable of translating labour-market intelligence into educational decisions without redesigning curricula in response to every short-term trend. This capacity can be conceptualised as adaptive curriculum capacity.

Adaptive curriculum capacity refers to the ability to recognise significant change, evaluate its occupational relevance, integrate an appropriate educational response, assess whether that response improves competence development, and revise provision as conditions continue to evolve. It avoids two opposite risks: curricular inertia, in which programmes remain unchanged despite substantial transformation in professional practice, and curricular volatility, in which every

technological or market development produces another isolated module, qualification, or content requirement[161].

A more sustainable approach distinguishes between durable capabilities and changing applications. Learners may require long-term competence in data-informed decision-making even though specific software changes. They may need sustainability assurance literacy even as individual certification schemes evolve. They may require critical digital agency even though particular AI or XR systems are replaced. They may need entrepreneurial judgement even where specific market opportunities change. This distinction allows VET to remain responsive without becoming permanently reactive.

Assessment is a critical element of this alignment process. Where curricula emphasise applied professional competence but assessment remains dominated by recall-based examinations, learners receive conflicting signals regarding what constitutes successful performance. Capabilities such as sustainability implementation, customer problem solving, digital decision-making, collaboration, and entrepreneurial action are difficult to assess adequately through theoretical recall alone.

Greater use of authentic assessment can strengthen alignment between educational outcomes and professional performance. Learners may analyse tourism data, respond to a service problem, design an accessible and sustainable tourism product, assess an environmental intervention, present a business concept, or address a destination-management challenge. Such tasks can integrate several competence domains and reveal whether learners are able to mobilise knowledge under conditions resembling professional practice.

Authenticity does not require exact replication of workplace conditions. The more important criterion is whether assessment requires the kinds of judgement, integration, communication, and decision-making expected in professional situations.

Teacher capability is another central component of labour-market responsiveness. Educators cannot translate emerging occupational requirements into meaningful learning if their own understanding of professional practice becomes outdated. Teacher development therefore needs to include forms of industry currency alongside pedagogical development.

Industry currency can be supported through enterprise collaboration, workplace visits, professional networks, short industry placements, sectoral workshops, applied projects, joint curriculum development, and participation in research or innovation partnerships. Teachers do not need to reproduce current workplace procedures uncritically. Their role is one of professional interpretation and pedagogical translation.

This process may be represented as:

sectoral change → professional interpretation → pedagogical translation → learner competence

[161] Council of the European Union, "Council Recommendation of 24 November 2020 on Vocational Education and Training (VET) for Sustainable Competitiveness, Social Fairness and Resilience", Official Journal of the European Union, C 417, 2020, pp. 1–16.

Weakness at any stage can contribute to misalignment. Labour-market intelligence may be available but poorly interpreted; relevant changes may be recognised but not incorporated into pedagogy; or new curriculum content may be introduced without corresponding opportunities for application and assessment.

Institutional partnerships can strengthen this translation process, especially where they extend beyond conventional tourism employers. Tourism increasingly intersects with ICT, mobility, energy, cultural heritage, environmental management, health, food systems, accessibility, and local development. Emerging competence needs may therefore originate outside narrowly defined tourism organisations. Cross-sector cooperation helps VET interpret these intersections and strengthens boundary-spanning capability at both institutional and learner levels.

5.5.4 Adaptive Responsiveness as a Continuous Feedback Process

Labour-market alignment must also account for differences among employers, tourism subsectors, destinations, and occupational contexts. Large organisations may employ specialist sustainability or digital teams, while SMEs may require individual employees to combine multiple functions. Urban destinations may require different competence configurations from rural, protected, or peripheral areas. Heritage tourism, hospitality, events, nature tourism, destination management, and travel services also differ substantially in their occupational requirements.

Labour-market alignment therefore cannot be achieved through a single universal competence profile. A more appropriate model combines a common competence foundation with contextual specialisation. The common foundation may include occupational understanding, sustainability capability, digital competence, communication, collaboration, adaptability, ethical responsibility, and entrepreneurial agency, while specialisation reflects particular occupations, destinations, subsectors, technologies, and regional labour-market conditions.

This balance is essential for transferability. Highly specific training may produce immediate job fit but limited mobility or adaptability. Highly generic preparation may support flexibility while leaving graduates insufficiently prepared for actual occupational tasks. Effective VET needs both professional specificity and transferable capability.

Learners and recent graduates should also be incorporated into alignment mechanisms. They are not passive outputs moving from education into employment. Their experiences during placements, projects, initial employment, and transition into work can provide important evidence about curriculum relevance. Graduate feedback may reveal mismatches that employer consultation alone does not capture, including insufficient preparation for workplace culture, limited opportunities to apply knowledge, or discrepancies between formal job descriptions and actual work.

Labour-market alignment should therefore operate through recurrent feedback among VET institutions, learners, graduates, employers, sectoral organisations, teachers, communities, researchers, and policymakers. The objective is not permanent equilibrium but the institutional capacity to identify emerging mismatches and respond before they become entrenched.

The process may be represented as:

labour-market change → competence signals → stakeholder interpretation → curriculum response → learning and assessment → workplace application → feedback → curriculum adaptation

Its circular character is essential. Alignment is not an event that occurs when a curriculum is approved. It is a continuing institutional learning process.

The analysis also supports a distinction between three forms of misalignment. A content gap occurs where relevant knowledge or competence is absent from provision. A translation gap occurs where competence appears in curriculum documents but is not converted into meaningful learning, practice, or assessment. A responsiveness gap occurs where institutions lack mechanisms for recognising and integrating emerging requirements over time.

These gaps require different educational responses. Content gaps may require curriculum revision. Translation gaps require pedagogical and assessment change. Responsiveness gaps require stronger institutional capability, labour-market intelligence, partnerships, governance, and feedback mechanisms. Distinguishing among them prevents every observed mismatch from being interpreted as evidence that another curriculum module is required.

Some of the most significant future pressures concern combinations of competences rather than isolated domains. Employers may not simply require “green skills” or “digital skills”. They may require employees who can use digital data to improve resource efficiency, communicate sustainability credibly to visitors, redesign services, cooperate with external specialists, and make decisions under uncertainty. The future alignment challenge is therefore increasingly one of competence integration.

This has implications for the relationship between employability and adaptability. Employability is sometimes interpreted as immediate readiness for an existing position. In rapidly transforming sectors, however, sustainable employability also depends on the capacity to continue learning and adapting after entry into employment. Tourism VET should therefore prepare learners for both occupational entry and occupational evolution.

This includes the capacity to learn new technologies, respond to sustainability requirements, move between functions, participate in organisational innovation, and continue developing professional competence throughout working life. Labour-market alignment is therefore inseparable from lifelong learning. Initial VET cannot provide every competence that will be required across an entire career, but it can provide a strong occupational foundation together with the judgement, agency, and learning capability required for continued development.

The central implication is that labour-market alignment should be understood as adaptive responsiveness rather than static correspondence. A responsive tourism VET system is able to detect relevant change, interpret competing signals, distinguish temporary trends from structural transformation, translate emerging requirements into learning, evaluate whether those changes improve professional preparedness, and revise provision through continuing feedback.

This capability depends on employers, but not on employers alone. It requires interaction among learners, graduates, teachers, VET institutions, enterprises, sectoral bodies, communities,

researchers, and policymakers. The objective is not to produce graduates who correspond perfectly to current job descriptions, because such correspondence would necessarily be temporary. A more durable objective is to prepare professionals who enter tourism work with credible occupational competence while also possessing the sustainability judgement, critical digital agency, adaptive professional agency, boundary-spanning capability, and ethical awareness necessary to respond as tourism itself evolves.

In this sense, VET–labour-market alignment becomes not the final stage of curriculum development but a continuous learning process within the competence ecosystem.

6 Systemic Conditions for Sustainable Tourism VET Transformation

The preceding chapters have demonstrated that the transformation of tourism vocational education and training cannot be explained solely through individual competence gaps, curriculum content, or the adoption of particular technologies. The capacity of VET to respond effectively to sustainability, digitalisation, changing occupational structures, and new forms of tourism depends equally on the institutional and governance arrangements within which competence development takes place.

The analysis therefore shifts from the level of individual learners and VET providers towards the wider system. The empirical material reveals a recurring gap between recognised priorities and implementation capacity. Green, digital, entrepreneurial, intercultural, and transversal competences are widely identified as increasingly important to tourism work, yet their incorporation into curricula, assessment, teacher development, qualification structures, and work-based learning remains uneven.

This gap should not be interpreted simply as institutional resistance to innovation. It emerges from the interaction of multiple structural conditions, including fragmented responsibilities, differing national and regional governance models, unequal institutional resources, variable employer involvement, diverse certification arrangements, project-based funding, technological inequalities, and differences in the capacity of VET systems to translate sectoral transformation into educational practice.

The central systemic question is therefore not whether isolated examples of innovation exist, but whether VET systems possess the governance and implementation capacity required to identify valuable practices, adapt them to different contexts, support their continuation, and connect them with recognised competence frameworks.

This chapter examines the systemic conditions influencing tourism VET transformation, with particular attention to competence governance, certification and recognition, institutional and technological capability, and the mechanisms supporting continuous upskilling and adaptation.

The underlying argument is that sustainable transformation requires coordination without uniformity. European tourism VET operates across different institutional traditions, labour markets, destination structures, qualification systems, and regional conditions. Such diversity is neither inherently problematic nor something that should be eliminated through complete standardisation. The more important challenge is to establish sufficient common reference points, translation mechanisms, and institutional connections to ensure that competence remains intelligible, transferable, assessable, and adaptable across different contexts.

Systemic maturity therefore depends not on making VET systems identical, but on enabling them to learn from one another and respond coherently to shared transformations while preserving legitimate contextual differentiation.

6.1 From Policy Fragmentation to Coordinated Competence Governance

Tourism VET operates within a complex governance environment in which responsibility is distributed across education authorities, tourism bodies, labour-market institutions, regional administrations, employers, certification organisations, VET providers, and, in some cases, European-level frameworks. Such plurality can support contextual responsiveness because tourism regions do not face identical occupational challenges. Heritage destinations, coastal areas, rural tourism regions, urban hospitality markets, protected landscapes, and technologically advanced tourism ecosystems may legitimately require different competence configurations.

Fragmentation becomes problematic when diversity is not accompanied by effective mechanisms of coordination and translation. The relevant challenge is therefore not fragmentation as such, but uncoordinated fragmentation. Where competence requirements, qualification structures, certification systems, curriculum development, and labour-market signals evolve independently, it becomes difficult for learners, teachers, employers, and institutions to understand how different forms of competence relate to one another. This may reduce transferability, weaken transparency, and slow institutional adaptation.

The problem is particularly visible in competence domains associated with the green and digital transitions. Long-established occupational competences are generally easier to identify within existing qualification structures, whereas newer capabilities—such as sustainability assurance, environmental data interpretation, critical digital agency, green digital judgement, XR-related competence, or accessibility-by-design—may be represented differently across systems or may not yet be explicitly recognised.

This creates a competence translation problem. A capability may be recognised as important in professional practice but described differently in sectoral strategies, qualification standards, curricula, certification schemes, assessment frameworks, and employer expectations. The resulting difficulty does not necessarily mean that the competence is absent. Rather, it may lack a sufficiently shared language through which different actors can identify, interpret, assess, and recognise it.

The appropriate response should therefore not automatically be the creation of another qualification, framework, or standard. A more fundamental requirement is the development of governance mechanisms capable of translating between occupational change, competence frameworks, curriculum design, assessment, and professional recognition.

Sustainability certification illustrates this problem particularly clearly. Environmental labels, management standards, and sustainability certification schemes can translate broad sustainability principles into more specific organisational requirements concerning resource use, monitoring, documentation, management procedures, communication, and continuous improvement. For VET, their significance extends beyond familiarity with individual labels.

Certification frameworks can function as boundary objects between education and professional practice. They can make abstract sustainability principles more operational and provide authentic material for simulations, audits, workplace projects, case analysis, and assessment. However,

integrating certification into VET should not result in narrow preparation for one particular scheme. Certification systems evolve and organisations may use different frameworks.

The more transferable capability is therefore sustainability assurance literacy: the ability to understand how standards operate, what evidence they require, how performance is documented, how compliance is assessed, and how certification can be distinguished from substantive sustainability improvement. This protects VET from excessive dependence on external labels and supports professional transferability. Certification can contribute to competence development, but certification itself is not equivalent to competence. A learner who understands one checklist without understanding the sustainability principles and evaluative logic behind it may remain poorly prepared for a different scheme or a changing regulatory environment.

A comparable problem arises in relation to digital transformation. Digital and XR development may be shaped by different national priorities, funding programmes, institutional capabilities, and project cycles. From the perspective developed in this study, however, the objective should not be uniform adoption of XR or identical digital infrastructure across Europe. What requires coordination is the development of transferable digital capability.

Technology changes too rapidly for qualification systems to remain relevant if they specify particular tools in excessive detail. A more durable governance model focuses on functional and higher-order capabilities such as professional digital fluency, data interpretation, critical digital agency, ethical data use, accessibility, and the ability to evaluate technological appropriateness. This illustrates the distinction between standardising technology and coordinating competence. The first is likely to become obsolete rapidly; the second offers a more stable basis for mobility, curriculum development, professional adaptability, and lifelong learning.

Policy coordination is particularly important because responsibility for tourism competence crosses administrative boundaries. Tourism development, VET, employment, digitalisation, sustainability, environmental regulation, mobility, and regional development may be governed by different institutions. Such distribution is not inherently inefficient. Complex sectors require specialised knowledge and differentiated governance. Difficulties arise where the interfaces between policy domains are weak.

A tourism authority may identify emerging sustainability needs without an effective mechanism for translating them into VET provision. Employers may communicate new digital requirements without structured involvement in qualification development. Education authorities may revise curricula without sufficient information about transformation at destination level. Sustainability standards may become more demanding while teacher development remains unchanged.

This constitutes a policy–curriculum translation gap. The problem is not simply that policy changes too slowly or that VET institutions are insufficiently responsive. Rather, relevant information may not move effectively between the actors responsible for recognising transformation and those responsible for converting it into curriculum, pedagogy, assessment, and teacher development.

The concept of adaptive curriculum capacity developed earlier therefore has a governance dimension. Institutions require internal capability to revise provision, but they also depend on external structures through which relevant signals can be generated, interpreted, prioritised, and communicated.

Labour-market participation represents one such mechanism. Employer involvement can strengthen curriculum relevance, but ad hoc consultation is unlikely to provide the continuity required for adaptive governance. More mature arrangements require recurring feedback among employers, VET providers, teachers, learners, graduates, sector organisations, public authorities, communities, and other relevant actors.

This should not be interpreted as transferring curriculum authority to employers. Labour-market responsiveness requires reciprocal co-construction. Employers contribute occupational knowledge and emerging competence signals; VET institutions contribute pedagogical expertise and a longer-term perspective on transferable capability; learners and graduates provide evidence on transitions between education and employment; public authorities provide strategic and regulatory context; and communities or civil-society actors may identify social, territorial, accessibility, or environmental consequences that short-term labour-market signals do not capture.

The governance challenge is therefore to create mechanisms through which these different forms of knowledge can interact.

Cross-border recognition adds another dimension. Tourism is characterised by substantial geographical mobility, seasonal employment, international value chains, and cross-border career pathways. Competences acquired within one national or institutional system therefore need to remain intelligible beyond their original context. However, comparability should not be confused with complete equivalence.

A qualification developed for one regional or national tourism context does not need to reproduce exactly the learning experiences of another system. What matters is whether the resulting competence outcomes can be interpreted reliably. This supports the concept of structured comparability: different systems can retain contextual diversity while using sufficiently compatible descriptors, learning outcomes, levels, and assessment principles to support transparency, recognition, and mobility.

The objective should therefore not be to create a single European tourism curriculum. It is to increase transparency concerning what learners are actually capable of doing. This is especially important for emerging competence domains. Broad labels such as “green skills”, “digital skills”, or “entrepreneurship” provide limited value for recognition unless they are translated into more precise professional capabilities.

Sustainability competence, for example, may include resource management, environmental data interpretation, certification literacy, stakeholder engagement, and sustainability judgement. Digital competence may range from basic tool use to sector-specific systems, data analytics, AI

literacy, and critical evaluation of technology. Recognition improves when competence is expressed through observable and transferable professional capabilities rather than generic labels.

Qualification and certification frameworks can contribute to this process, but governance should avoid unnecessary proliferation. Additional micro-credentials, badges, labels, or competence certificates may increase rather than reduce complexity where their relationship to broader qualification structures remains unclear. The strategic objective should therefore be coherence rather than certification accumulation.

The same principle applies to mobility. Fragmented qualification and certification arrangements may complicate comparison, but national variation should not automatically be treated as evidence that all systems require harmonisation. Mobility depends on transparency, trust, assessment quality, employer familiarity, language, regulatory arrangements, and occupational structures. Common frameworks may facilitate interpretation, but formal alignment alone cannot guarantee recognition in practice.

Trust ultimately depends on credible learning and assessment. Assessment therefore becomes a governance issue rather than merely a classroom issue. Where institutions describe similar competence outcomes but assess them according to substantially different performance expectations, formal comparability may be misleading. Conversely, different curricula may produce comparable professional capabilities where assessment focuses on clearly defined outcomes and credible performance.

This leads to a broader principle:

recognition should follow demonstrated capability rather than terminology alone.

The risks associated with policy fragmentation should nevertheless be interpreted cautiously. Diversity may contribute to duplication, difficulties in recognition, or unequal implementation, but these consequences should not be assumed automatically. Some duplication may constitute productive experimentation. Regional systems can generate alternative approaches, and pilot initiatives may provide contextual knowledge that would be lost through premature standardisation.

The policy challenge is therefore to distinguish productive diversity from dysfunctional fragmentation. Productive diversity exists where systems can experiment, specialise, and adapt while remaining connected through mechanisms of competence translation, knowledge exchange, and recognition. Dysfunctional fragmentation exists where differences impede cooperation, mobility, interpretation, or learning without generating compensating contextual value.

This distinction changes the meaning of harmonisation. The objective should not be convergence towards a single institutional model, but coordinated competence governance. Such governance combines common reference points with contextual flexibility. It supports shared understanding of broad competence domains while allowing their practical expression to differ across occupations, destinations, and territorial conditions. It creates mechanisms for translating labour-market change into curriculum and assessment, links sustainability and digital standards with learning without reducing VET to compliance training, supports mobility through transparent

competence descriptions and credible assessment, and enables institutions to exchange evidence and models without requiring direct replication.

European-level frameworks can contribute by providing reference languages for qualifications, competence, and occupations. Their effectiveness, however, depends on how they are interpreted and operationalised by national, regional, sectoral, and institutional actors. Formal frameworks cannot substitute for teacher competence, curriculum adaptation, employer engagement, assessment quality, or institutional implementation capacity.

The governance model should therefore be multi-level and iterative. European mechanisms may provide transparency and common reference points; national systems can translate these into qualification and curriculum structures; regional and sectoral actors can interpret them in relation to local tourism economies; VET providers can convert them into learning environments and assessment; employers and other stakeholders can provide feedback on occupational relevance; and learners and graduates can provide evidence concerning how competences function during professional transitions.

This process can be represented as:

sectoral transformation → competence signals → shared reference frameworks → national and regional interpretation → curriculum and assessment → workplace application → feedback → framework adaptation

The model links competence governance directly with adaptive responsiveness. It also illustrates why governance arrangements require revision mechanisms. Green and digital transformation will continue to generate new requirements that cannot be anticipated fully in advance. A rigid harmonised framework may therefore become obsolete almost as quickly as a rigid curriculum.

Coordinated governance requires stable principles combined with adaptable content. Stable elements include transparency, portability, evidence, accessibility, stakeholder participation, and clear descriptions of learning outcomes. Adaptable elements include technologies, sector-specific applications, certification schemes, regulatory requirements, and emerging occupational practices.

The systemic objective is therefore neither complete decentralisation nor complete harmonisation. It is the creation of a governance environment in which diversity remains compatible with mutual intelligibility, mobility, and collective learning. For sustainable tourism VET, this means moving from fragmented competence signals towards coordinated competence governance.

Systemic maturity should consequently not be measured by uniformity. It should be measured by the capacity to coordinate difference.

6.2 From Institutional Barriers to Unequal Implementation Capacity

Policy coordination and shared reference frameworks constitute necessary but insufficient conditions for the transformation of tourism VET. Even where sustainability, digitalisation, entrepreneurship, accessibility, and innovation are recognised as strategic priorities, VET institutions differ substantially in their capacity to translate these priorities into sustained educational practice.

The central structural issue is therefore not simply the existence of barriers, but the unequal distribution of implementation capacity. This may be understood as the ability of VET institutions to convert policy priorities, curriculum intentions, competence requirements, and innovation opportunities into durable learning provision.

Implementation capacity depends on the interaction of infrastructure, teacher capability, organisational coordination, financial continuity, assessment arrangements, technical support, leadership, accessibility, partnerships, and evaluation. Weakness in any of these areas may prevent recognised priorities from becoming meaningful educational practice.

Equipment acquired through temporary funding may remain underused where maintenance or technical support is unavailable. Teachers may receive introductory training without the time, mentoring, curricular flexibility, or organisational support required to apply it. Innovative practices may depend on individual enthusiasts and disappear when those individuals leave. Pilot projects may demonstrate short-term value without creating the financial and institutional conditions required for continuation.

Several distinctions are therefore important. Infrastructure acquisition is not equivalent to infrastructural capability. A teacher skills gap is not the same as a teacher-development infrastructure gap. Individual innovation capacity should not be confused with institutionalised capability. Innovation becomes sustainable only when knowledge, responsibilities, and support mechanisms are distributed across the organisation rather than concentrated in temporary projects or individual actors.

Implementation capacity is also shaped by the compatibility between innovative learning models and existing institutional structures. Curricula may increasingly emphasise integrated professional performance while assessment continues to focus predominantly on theoretical recall. This can create an assessment–competence gap, in which project-based learning, simulation, sustainability judgement, digital decision-making, entrepreneurial problem solving, and other integrated capabilities are insufficiently recognised through formal assessment.

A related organisational fit gap may arise where emerging pedagogies conflict with existing institutional routines. Rigid timetables, procurement requirements, fragmented responsibilities, data-protection procedures, accreditation rules, or inflexible organisational structures may constrain implementation even where pedagogical and technological resources are available.

Financial structures generate another tension. External projects can stimulate experimentation, professional development, partnership building, and technology acquisition, but project capacity does not automatically become institutional capacity. The capacity to launch an innovation during a funded project differs fundamentally from the ability to maintain it once temporary financing, specialist personnel, or external support is withdrawn.

This distinction has direct implications for scalability. Scaling should not be conceptualised as the simple replication of a successful pilot. Expansion increases demands on infrastructure, teacher development, governance, accessibility, technical support, financing, and evaluation. Scalability is

therefore a property of the surrounding implementation system rather than of an innovation in isolation.

The appropriate question is not whether a practice can be copied, but which institutional capacities are required for its underlying pedagogical mechanism to function reliably in another context. Shared infrastructure, regional resource centres, professional-development networks, collaborative service models, public–private partnerships, and jointly developed resources may help smaller institutions access capabilities they could not sustain independently. However, these arrangements themselves require governance, stable funding, teacher preparation, quality assurance, and mechanisms for equitable access.

Unequal implementation capacity therefore constitutes a systemic equity problem. Institutions that already possess strong infrastructure, experienced staff, leadership, partnerships, and project-management expertise may be better positioned to attract further resources. This may create a cumulative innovation divide, in which existing capability increases access to further capability.

At the same time, inequality should not be reduced to access to advanced technology. The relevant distinction concerns access to meaningful competence-development opportunities. A resource-constrained institution may provide high-quality vocational learning through strong teaching, effective work-based learning, and well-developed local partnerships, whereas a technologically sophisticated provider may invest in expensive tools with limited educational value.

Systemic support should therefore focus on strengthening the capacities that allow institutions to select, adapt, evaluate, and sustain contextually appropriate solutions rather than on equalising technological sophistication as an end in itself.

The analysis suggests three distinct mechanisms of implementation failure. A resource gap occurs where infrastructure, financing, time, or expertise are insufficient. An integration gap arises where resources exist but are poorly connected with curriculum, assessment, teacher practice, governance, or organisational strategy. A sustainability gap occurs where valuable innovations cannot be maintained after temporary funding, project structures, or individual leadership disappear.

These three gaps require different responses. A resource gap may require investment or shared provision. An integration gap requires organisational, pedagogical, or governance change. A sustainability gap requires attention to recurring financing, lifecycle planning, distributed competence, and institutional ownership. Treating all three as a single generic innovation problem would obscure the mechanisms through which implementation fails.

The systemic objective is therefore not merely to remove barriers or diffuse specific technologies. It is to strengthen and distribute implementation capacity more equitably across the VET system so that institutions can convert shared competence priorities into sustained educational value.

The critical question is no longer which institutions display the most advanced innovations. It is which institutions possess the capacity to convert relevant innovation into durable learning, and how that capacity can be strengthened across the system.

6.3 Strategic Enablers for Transition and Upskilling

6.3.1 From Strategic Enablers to Systemic Transition Capacity

The preceding analysis demonstrates that neither policy coordination nor institutional innovation is sufficient on its own to transform tourism vocational education and training. Fragmented competence governance, unequal implementation capacity, project dependence, technological disparities, and uneven teacher development all indicate that the central systemic challenge lies in connecting strategic intention with sustained educational change. The relevant objective is therefore not merely to identify isolated "enablers", but to develop systemic transition capacity: the ability of VET systems to coordinate competence priorities, mobilise resources, support institutional implementation, evaluate outcomes, and continuously renew provision as tourism evolves.

Governance and Coordination

Systemic transition capacity depends first on coherent multi-level governance. European reference frameworks can support transparency, mobility, and shared competence languages, while national and regional systems translate broad priorities into qualifications, curricula, teacher-development structures, funding arrangements, and implementation mechanisms. Coordination should not, however, imply uniformity. As argued throughout this study, the objective is to make diversity compatible with mutual intelligibility, portability, and adaptation.

Sustainability certification can contribute to this process by providing authentic reference points for professional practice, but VET should develop transferable sustainability assurance literacy rather than prepare learners narrowly for individual labels or schemes. Digital competence frameworks should similarly prioritise durable capabilities such as professional digital fluency, data interpretation, critical digital agency, accessibility, ethical technology use, and technological judgement rather than seek to standardise particular platforms or tools.

Effective governance also requires systematic interaction among education, tourism, labour-market, environmental, digital, mobility, and regional-development actors. The crucial mechanism is therefore not hierarchical policy alignment but recurring translation between sectoral change and educational response. Stable feedback structures are required in which employers contribute occupational signals, VET providers contribute pedagogical expertise, learners and graduates provide evidence concerning transitions into work, and public, regional, and sectoral bodies help interpret longer-term technological, environmental, economic, and social change.

From this perspective, governance capacity depends on the quality of translation across institutional levels and policy domains. Strategic priorities only become educationally meaningful when they can be converted into curriculum design, assessment, teacher development, work-based learning, and institutional practice. Systemic coordination therefore requires not simply common objectives, but mechanisms that connect policy interpretation with implementation.

Capacity Development and Implementation Ecosystems

Systemic transition capacity also depends on whether institutions possess the human, financial, organisational, and relational resources required to convert strategic priorities into sustained learning provision. Sustainable financing should therefore be understood less as the creation of successive short-term innovation programmes and more as the development of conditions that allow valuable practices to survive beyond individual project cycles.

External funding can remain an important catalyst for experimentation and capacity building, but its long-term value depends on whether it creates durable teacher capability, reusable resources, institutional knowledge, partnership structures, technical support, and realistic lifecycle arrangements. The relevant criterion is not the number of funded projects completed, but the extent to which temporary resources strengthen permanent institutional capability.

Teacher professionalisation is particularly important because educators perform the translation between sectoral transformation and learner competence. Continuous professional development should consequently move beyond occasional workshops towards professional-learning infrastructures that combine peer networks, industry exposure, collaborative curriculum design, mentoring, interdisciplinary learning, applied projects, and opportunities to evaluate emerging technologies and sustainability practices critically. Teachers do not need to become specialists in every new field, but they require sufficient capability to determine which changes are educationally relevant, how they should be incorporated into learning, and when external expertise is required.

The same ecosystem logic applies to partnerships. Tourism VET increasingly intersects with ICT, mobility, energy, cultural heritage, environmental management, accessibility, local development, and community organisations. Cross-sector collaboration should therefore be treated as a structural component of competence development rather than as an optional supplement. Partnerships are most valuable when they generate reciprocal knowledge exchange, authentic learning opportunities, and internal capacity rather than permanent dependence on external expertise.

Work-based learning can become one of the principal interfaces within this ecosystem, provided that workplace participation is intentionally designed. Placements need explicit learning objectives, mentoring, progressive responsibility, opportunities for feedback, and structured reflection. Enterprises should contribute occupational knowledge and authentic problems, while VET institutions retain responsibility for educational quality, transferability, inclusion, and assessment.

Digital and immersive technologies may support this wider ecosystem by enabling simulation, remote access, shared learning resources, data-informed learning, or forms of professional practice that would otherwise be difficult to organise. They should not, however, be treated as systemic enablers merely because they are technologically advanced. Shared infrastructure, regional resource hubs, reusable content, and technical-support networks can improve access where they address demonstrated educational needs, but technological adoption should remain governed by educational additionality, accessibility, total cost of ownership, and institutional readiness.

The strategic issue is therefore not the diffusion of particular innovations, but the strengthening of the institutional conditions through which relevant innovations can be selected, adapted, implemented, sustained, and, where necessary, discontinued.

Equity, Evaluation, and System Learning

The final component of systemic transition capacity is the ability to learn from implementation. Equity, evaluation, feedback, and strategic leadership should therefore be understood as interconnected mechanisms through which transformation is governed rather than as separate policy objectives.

Innovation may deepen existing inequalities when better-resourced institutions accumulate funding, networks, specialist expertise, technological infrastructure, and project experience while smaller, rural, or geographically peripheral providers remain outside the ecosystems through which capacity develops. Systemic support should consequently focus on equitable access to competence-development capacity, not simply on the equal distribution of devices, technologies, or projects.

Universal-design principles, multilingual and alternative learning routes, shared infrastructure, regional support arrangements, targeted capacity building, teacher networks, and collaborative service models can help ensure that innovation expands rather than narrows participation. Equity should therefore be evaluated in relation to learners' and institutions' ability to participate meaningfully in competence development, not merely their formal access to technological resources.

Evaluation should simultaneously become part of routine governance. VET systems need to be capable of determining whether curriculum reform, new pedagogies, partnerships, sustainability initiatives, work-based learning models, or digital interventions actually improve competence development, accessibility, transfer to professional practice, organisational sustainability, and educational quality.

This requires continuous feedback among learners, teachers, graduates, employers, institutions, sectoral actors, and policymakers. It also requires willingness not only to scale practices that demonstrate sufficient value but to redesign, limit, or discontinue those that do not. Evaluation should therefore support institutional and systemic learning rather than function solely as post-project accountability.

Strategic leadership is central to this process. Its role is not primarily to promote the greatest possible volume of innovation, but to create the conditions for collective learning. This includes connecting policy objectives with institutional realities, allocating resources over time, protecting space for experimentation, distributing responsibility, supporting evidence generation, and ensuring that findings influence subsequent decisions.

The interaction among these mechanisms can be represented as:

shared direction → resource mobilisation → capacity development → implementation → evaluation → system learning → adaptation

This sequence should not be interpreted as a one-off implementation pathway. It represents a recurring cycle through which the VET system responds to changing sectoral conditions, learns from intervention, and renews its own capacity.

Systemic transformation does not therefore occur when every innovation becomes mainstream. It occurs when VET systems become capable of moving repeatedly through this cycle while maintaining educational quality, inclusion, professional relevance, and institutional sustainability.

The ultimate strategic enabler is consequently not a particular technology, funding programme, policy framework, qualification model, or partnership structure. It is a competence ecosystem capable of renewing itself.

In this sense, tourism VET becomes transformation-ready not when it adopts the greatest number of innovations, but when it can coordinate change, distribute implementation capacity, learn from evidence, protect inclusion, and continuously translate sectoral transformation into meaningful opportunities for professional learning, reskilling, and upskilling.

The analyses developed throughout this study demonstrate that the transformation of tourism vocational education and training cannot be reduced to a single competence gap, technological innovation, curriculum reform, or policy intervention. Tourism is being reshaped simultaneously by sustainability requirements, digitalisation, changing visitor expectations, demographic and labour-market shifts, climate-related pressures, new business models, and growing expectations concerning accessibility and social responsibility. These developments generate new competence requirements, but they also expose a more fundamental challenge: how vocational education recognises change, translates it into learning, supports institutions in implementation, and renews itself as professional conditions continue to evolve.

The central conclusion is that tourism VET requires more than periodic modernisation. It requires adaptive capacity across several interconnected levels. Learners need professional capabilities that allow them to combine occupational knowledge with sustainability judgement, critical digital agency, entrepreneurial initiative, interpersonal competence, and ethical responsibility. Teachers need the capacity to interpret sectoral transformation and translate it into pedagogically meaningful learning. Institutions require sufficient implementation capacity to sustain curriculum development, work-based learning, technological innovation, partnerships, and assessment reform. At system level, governance arrangements need to coordinate diverse competence signals while preserving legitimate national, regional, sectoral, and institutional variation.

The strategic challenge is therefore not simply to determine which innovation should be introduced next. It is to develop the capabilities through which tourism VET can recognise emerging change, evaluate its significance, mobilise appropriate resources, implement proportionate responses, assess their effects, and revise them as conditions evolve. This perspective positions VET within a wider competence ecosystem connecting learners, teachers, providers, employers, destination organisations, public authorities, communities, technology providers, research

institutions, and other sectoral actors. Transformation depends on the quality of relationships and feedback mechanisms between these actors as much as on the actions of any individual institution.

7 Strategic Outlook and Next Steps

7.1 Consolidated Findings: From Fragmented Innovation to Systemic Capacity

The findings reveal a tourism VET landscape characterised less by an absolute absence of innovation than by uneven capacity to convert innovation into durable educational value. Across the analysed material, sustainability-oriented learning, experiential and project-based pedagogy, digitalisation, entrepreneurship, employer cooperation, and technology-enhanced training are already present in different forms. The recurring limitation is that such practices frequently remain dependent on temporary projects, individual teachers, local partnerships, or institution-specific conditions. The principal systemic gap therefore lies between experimentation and institutionalisation. Innovation exists, but the capacity to sustain, evaluate, transfer, adapt, and, where necessary, discontinue it remains uneven.

This distinction changes the interpretation of policy and institutional fragmentation. National and regional differences do not in themselves constitute a weakness. Tourism systems operate within different economic, territorial, cultural, environmental, and institutional contexts, and VET needs sufficient flexibility to respond to such variation. Fragmentation becomes problematic when diversity is not accompanied by mechanisms for competence translation, recognition, mobility, and shared learning. The strategic objective should therefore not be complete harmonisation but coordinated competence governance: the combination of common reference points with contextual adaptation.

This implies a distinction between productive diversity and dysfunctional fragmentation. Productive diversity enables systems and institutions to experiment, specialise, and respond to local conditions while remaining sufficiently connected for competences, qualifications, and evidence to be interpreted across contexts. Dysfunctional fragmentation arises where differences prevent meaningful comparison, transfer, cooperation, or collective learning without generating compensating contextual value. Systemic maturity therefore depends not on eliminating diversity but on developing the capacity to coordinate it.

A comparable distinction emerges at institutional level. Access to infrastructure, funding, technology, or innovative projects does not itself demonstrate transformation capacity. Institutions differ substantially in their ability to convert such resources into sustained learning. This led to the concept of implementation capacity, understood as the ability to translate policy priorities and competence requirements into curriculum, pedagogy, assessment, teacher development, work-based learning, organisational routines, and continuing educational provision.

Three forms of implementation difficulty are particularly significant. A resource gap occurs where funding, infrastructure, time, technical support, or expertise are insufficient. An integration gap occurs where resources exist but remain disconnected from curriculum, assessment, teacher practice, or organisational strategy. A sustainability gap arises where promising practices cannot continue once project funding, specialist support, or individual leadership disappears. These problems require different responses and cannot be addressed through a uniform policy of

additional investment. Building sustainable implementation capacity requires attention not only to resource availability but also to institutional integration, distributed responsibility, lifecycle planning, and organisational learning.

Teacher capability constitutes one of the strongest connecting mechanisms between system-level transformation and learner-level outcomes. Teachers are not merely recipients of policy priorities or users of new technologies. They interpret sectoral transformation, determine its educational relevance, design learning environments, facilitate professional judgement, and assess whether learners can integrate knowledge in action. Teacher professionalisation therefore needs to extend beyond occasional training events towards continuous professional-learning infrastructures combining pedagogical development, industry currency, sustainability competence, digital capability, peer learning, mentoring, interdisciplinary cooperation, and participation in applied innovation. Reform becomes more sustainable where such expertise is distributed across institutions rather than concentrated in individual enthusiasts.

The same principle applies to technology. XR and other emerging digital tools can provide meaningful opportunities for simulation, interpretation, collaboration, accessibility, and professional rehearsal, but technological adoption should not be treated as an objective in itself. The analysis consistently supports the principle of educational additionality: technology is justified where it enables educational value that would otherwise be substantially more difficult, unsafe, inaccessible, costly, or less effective to achieve.

This principle links technological innovation with institutional readiness and responsible technology governance. The relevant strategic question is not how rapidly XR, AI, or other digital tools can be mainstreamed, but whether institutions can determine when technology adds sufficient educational value, implement it accessibly and sustainably, evaluate its effects, and replace or discontinue it where a simpler or more effective alternative is available. Technological maturity is therefore better interpreted as decision maturity than as the intensity of technology use.

A parallel shift is necessary in relation to competence development. The evidence does not support an indefinitely expanding catalogue of green, digital, entrepreneurial, interpersonal, and transversal skills. Contemporary tourism work increasingly requires these domains to be combined within complex professional situations. The central challenge is therefore one of competence integration.

Occupational knowledge remains the professional foundation, but graduates increasingly require higher-order capabilities that allow them to mobilise different forms of knowledge in changing contexts. The analysis identified sustainability judgement, critical digital agency, adaptive professional agency, boundary-spanning competence, and ethical professional judgement as particularly important integrative capabilities. The role of VET is consequently not simply to add another competence whenever a new technological, environmental, or market trend appears, but to develop professionals capable of combining, updating, and applying relevant competences as circumstances change.

Sustainability illustrates this transition particularly clearly. The principal educational challenge is no longer basic environmental awareness. It is progression from awareness towards operational competence, analytical capability, systems understanding, professional judgement, and responsible action. The distinction developed in this study between the depth gap, integration gap, and enactment gap helps explain why adding sustainability content to curricula is insufficient. Learners need opportunities to work with environmental data, certification systems, circular-economy problems, climate adaptation, stakeholder perspectives, community interests, and professional trade-offs. Sustainability therefore becomes an integral dimension of occupational judgement rather than a supplementary subject.

Entrepreneurial competence follows a comparable logic. Its relevance extends beyond business creation. Tourism professionals increasingly need to recognise opportunities, mobilise resources and relationships, respond to uncertainty, collaborate across organisational boundaries, and initiate responsible change within existing organisations as well as new ventures. Entrepreneurial learning therefore contributes to adaptive professional agency. Its educational value lies in project work, experimentation, reflection, iteration, workplace challenges, and authentic problem solving rather than in business planning alone. Entrepreneurship becomes a mechanism for developing professionals who are capable not merely of responding to change but of influencing it responsibly.

The relationship between VET and the labour market must likewise be interpreted dynamically. Static alignment is neither realistic nor desirable in a sector where technologies, sustainability requirements, visitor behaviour, business models, and occupational configurations continue to evolve. The more durable objective is adaptive responsiveness. VET systems require mechanisms for identifying competence signals, interpreting their significance, translating them into curriculum and assessment, observing how graduates perform in professional contexts, and feeding that evidence back into subsequent adaptation.

Employers are important participants in this process, but they should not become the sole determinants of curriculum. VET retains a broader responsibility to develop transferable competence, professional autonomy, sustainability awareness, ethical judgement, and the capacity to contribute to the improvement of existing practice. This creates a necessary balance between responsiveness and anticipation. Vocational education must remain sufficiently connected with current professional realities to support credible occupational entry while also developing the capabilities required for occupational evolution. Excessive responsiveness may bind curricula to short-lived technologies or existing employer practices, whereas excessive anticipation may detach programmes from actual occupational requirements.

A resilient approach therefore combines stable occupational foundations with higher-order capabilities for continued adaptation. This principle also applies to equity. Unequal access to innovation is not simply a question of unequal access to devices or project funding. Institutions differ in teacher expertise, leadership, partnerships, infrastructure, organisational flexibility, technical support, and experience in securing and managing innovation resources. These advantages can accumulate, producing a cumulative innovation divide in which already well-connected institutions

gain further opportunities while less-resourced providers remain outside the ecosystems through which capability develops.

The strategic objective should therefore be equitable access to competence-development capacity, rather than identical provision of technologies or projects. Shared infrastructure, regional support networks, professional-learning communities, joint technical services, partnerships, and collaborative resource models can contribute to this objective where they are accompanied by effective governance, sustainable financing, and attention to actual educational needs.

Taken together, these findings indicate that the future of tourism VET depends less on the diffusion of individual innovations than on the development of systemic transition capacity. Such capacity connects coordinated competence governance, institutional implementation capability, teacher professionalisation, adaptive curriculum capacity, reciprocal labour-market relationships, responsible technology governance, sustainable financing, inclusion, and evaluation.

Its logic can be represented as:

sectoral transformation → competence interpretation → resource mobilisation → curriculum and pedagogical response → implementation → evaluation → system learning → adaptation

This cycle should not culminate automatically in the permanent institutionalisation of every innovation. Some responses should be expanded, others redesigned or limited, and some discontinued. A mature VET system is not one that changes continuously for its own sake, but one that can distinguish temporary novelty from meaningful structural transformation and respond proportionately to both.

The strategic challenge is therefore to move from fragmented innovation towards

a learning VET system: a system capable not only of teaching adaptability but of practising adaptation itself. Such a system does not attempt to predict every future technology, occupation, or competence requirement. Instead, it develops the institutional, professional, and governance capabilities necessary to recognise change, interpret its implications, design proportionate responses, evaluate their consequences, and learn from the results. This constitutes the foundation of resilient tourism VET.

7.2 From Skills Mapping to Integrated Competence Development Pathways

The findings of this study indicate that skills mapping, curriculum development, pedagogical innovation, and technology adoption should not operate as separate strands of VET modernisation. Skills mapping provides evidence about changing competence requirements, but its value depends on whether identified needs can be translated into meaningful learning experiences and assessment. The mapping undertaken through stakeholder surveys, interviews, practice analysis, and labour-market evidence points not simply to shortages of individual green, digital, entrepreneurial, or transversal skills, but to increasing demand for integrated professional capability. Learners need to combine occupational knowledge with sustainability judgement, critical digital agency, adaptive professional agency, communication, collaboration, and ethical reasoning in situations that resemble

the complexity of tourism work. The appropriate response is therefore not to connect every identified skills gap directly with a new module or technological solution, but to interpret competence signals as learning problems. A gap in sustainability competence may require workplace-based environmental analysis, project work, data interpretation, or certification exercises; a gap in intercultural communication may require role play and authentic interaction; an entrepreneurial gap may require iterative projects and stakeholder collaboration. Skills mapping becomes educationally valuable only when it is followed by a process of pedagogical translation that asks what learners need to be able to do, which learning environment can develop that capability, and how achievement can be demonstrated.

XR can form part of this pathway, but its role should remain conditional. Immersive technologies may provide educational additionality where competence development depends on repeated rehearsal, safe simulation, controlled variation, spatial representation, mediated access to distant or fragile environments, or exposure to professional situations that are difficult to reproduce through conventional methods. They may therefore support selected sustainability scenarios, customer-service simulations, heritage interpretation, collaborative problem solving, or intercultural rehearsal. However, skills mapping does not itself justify XR adoption, and a competence gap should not be treated as evidence that an immersive solution is required.

The relevant decision sequence is competence need → learning objective → pedagogical mechanism → technological appropriateness → institutional readiness. Only where XR adds meaningful value relative to simpler alternatives should it become part of the learning design. This approach also prevents project-driven experimentation from determining curriculum priorities. Instead of acquiring a technology and searching for educational applications afterwards, institutions begin with occupational and competence requirements and select the most appropriate learning method. Teachers are pivotal in this translation process because they need to interpret competence evidence, recognise where learners require additional practice, select appropriate pedagogical strategies, and determine whether technology can strengthen them. Professional development should therefore connect labour-market interpretation, curriculum design, assessment, sustainability, digital competence, and pedagogical-technical mediation rather than focus primarily on device operation. Assessment must follow the same logic: if learners are expected to demonstrate integrated competence, evaluation should capture professional judgement and performance rather than merely recall of content. XR-based performance may provide one source of evidence, but it should be judged against the same principles of validity, accessibility, fairness, and occupational relevance as any other form of assessment.

The strategic value of integration therefore lies not in creating a direct feedback loop between skills mapping and XR adoption, but in establishing a wider competence-development cycle.

This cycle can be expressed as sectoral change → competence signals → interpretation of learning needs → pedagogical design → appropriate technology selection → implementation → assessment → workplace feedback → renewed competence mapping. Such a model links labour-market responsiveness with adaptive curriculum capacity and responsible technology governance. It

also provides a more equitable approach to innovation. Institutions with limited resources do not need to reproduce the technological infrastructure of better-funded providers if equivalent competence outcomes can be achieved through alternative methods, while shared digital or immersive infrastructure may be justified where it expands access to learning opportunities that would otherwise remain unavailable. In this model, the objective is not technological parity but equitable access to competence development. The same logic strengthens scalability: what should be transferred across institutions is primarily the underlying learning mechanism and evidence of its effectiveness, not necessarily the same device, platform, or simulation. Skills mapping thus becomes part of an adaptive feedback system rather than a periodic inventory of shortages, while XR becomes one optional component of a broader pedagogical repertoire. The real innovation lies in the capacity of VET systems to connect evidence about changing work with curriculum, pedagogy, assessment, institutional readiness, and continuous evaluation. Such integration enables VET to move beyond reactive skills matching towards an adaptive model in which competence development is continuously revised as tourism, technology, sustainability requirements, and professional practice evolve.

7.3 Strategic Priorities for Adaptive Tourism VET

The findings of this study suggest that innovation in tourism vocational education and training should begin not with the addition of new subjects, technologies, or isolated competence areas, but with the development of an integrated competence architecture capable of responding to continuing sectoral transformation. Sustainability, digitalisation, entrepreneurship, accessibility, intercultural communication, and resilience should therefore be embedded across occupational learning rather than treated as supplementary curriculum components.

The first strategic priority is to strengthen learners' capacity to integrate these domains through higher-order professional capabilities, including sustainability judgement, critical digital agency, adaptive professional agency, boundary-spanning competence, and ethical professional judgement. This requires curricula that connect durable occupational foundations with authentic professional problems, work-based learning, project-based pedagogy, simulation, interdisciplinary tasks, and structured reflection.

Emerging technologies such as XR can contribute to this architecture where they provide demonstrable educational additionality, but technological adoption should follow rather than determine pedagogical design. The relevant decision sequence is therefore:

competence need → learning objective → pedagogical mechanism → appropriate technology → assessment → feedback

This sequence reinforces the principle that technology should be selected only after the competence requirement and pedagogical purpose have been established. The same logic applies to assessment. If VET is expected to develop integrated professional capability, assessment cannot rely predominantly on knowledge reproduction. It should increasingly generate evidence of professional judgement, integration, decision-making, and action. Portfolios, workplace assignments, simulations,

problem-based tasks, collaborative projects, and other forms of authentic assessment can complement conventional examinations where they provide valid evidence of the competence being assessed.

The strategic objective is consequently not to make curricula permanently larger, more fragmented, or more technologically sophisticated. It is to make them more adaptive and integrative, enabling emerging requirements to be incorporated without undermining occupational coherence. Curriculum development should distinguish between stable professional foundations and changing applications, allowing learners to acquire capabilities that remain transferable even as technologies, standards, and sectoral practices evolve.

A second strategic priority concerns the institutional capacity required to translate curriculum reform into sustainable practice. Transformation depends heavily on teachers, but teacher professionalisation should not be reduced to periodic training in newly emerging topics or tools. Educators require continuing opportunities to update occupational knowledge, develop sustainability and digital competence, engage with workplaces, collaborate with peers, experiment with pedagogy, and evaluate emerging approaches critically.

Institutions should therefore develop professional-learning infrastructures rather than rely on isolated innovation champions. Such infrastructures may include professional-learning communities, mentoring, peer observation, collaborative curriculum development, industry placements, applied projects, interdisciplinary cooperation, and structured opportunities to evaluate innovations. The strategic objective is to distribute expertise across the organisation so that curriculum renewal and pedagogical innovation become institutional capabilities rather than individual achievements.

The same principle applies to financing, technology, and partnerships. External projects can provide valuable opportunities for experimentation, equipment acquisition, partnership development, and professional learning, but their long-term contribution should be evaluated according to what remains after project funding ends. Durable value is created where projects generate teacher capability, reusable resources, institutional knowledge, functioning partnerships, technical support arrangements, and realistic mechanisms for maintenance and continuation.

Shared laboratories, regional resource centres, technical-support networks, collaborative digital platforms, and cross-institutional partnerships may reduce inequalities where individual VET providers cannot sustain specialist infrastructure independently. However, institutional modernisation should not be assessed according to the quantity or sophistication of technology acquired. The more significant criterion is whether an institution possesses sufficient implementation capacity to select, adapt, integrate, evaluate, maintain, and, where necessary, discontinue solutions according to their educational value.

This implies differentiated responses to institutional constraints. Resource gaps require investment or access to shared capacity. Integration gaps require stronger connections between curriculum, assessment, teacher practice, governance, and organisational processes. Sustainability gaps require attention to lifecycle financing, distributed expertise, institutional ownership, and post-

project continuity. A uniform expectation that every VET provider should adopt the same technologies or pedagogical models would therefore be inconsistent with the evidence developed in this study.

At system level, the strategic priority is to establish governance arrangements that combine coordination, contextual flexibility, and continuous learning. European, national, regional, and institutional actors require sufficiently shared competence languages to support transparency, recognition, mobility, and labour-market communication, but this should not lead to uniform curricula or premature standardisation of rapidly changing technologies and occupational practices.

Employers should participate systematically in competence development, but VET should retain responsibility for interpreting current occupational requirements and translating them into transferable learning. Labour-market responsiveness should therefore remain reciprocal rather than subordinating curriculum development to immediate employer demand. Learners, graduates, teachers, communities, destination organisations, sectoral bodies, researchers, and other stakeholders should also contribute to feedback processes because tourism transformation involves environmental, technological, social, territorial, cultural, and ethical dimensions that cannot be represented adequately by employer demand alone.

Equity should function as a criterion of systemic quality. Learners and institutions should have equitable access to meaningful competence-development opportunities even where geography, institutional size, technological resources, or financial capacity differ. This requires attention not only to access to equipment, but also to teacher expertise, support structures, work-based learning, partnerships, professional-development opportunities, accessibility, and institutional implementation capacity.

Evaluation should likewise become part of routine governance. Systems need to determine whether curriculum reforms, new pedagogies, partnerships, sustainability initiatives, work-based learning arrangements, and digital interventions actually improve competence development, accessibility, workplace transfer, educational quality, and organisational sustainability. Evaluation should provide a basis not only for expansion but also for modification, limitation, or discontinuation where an intervention fails to generate sufficient value.

Strategic leadership is therefore best understood as the capacity to create conditions for collective learning rather than as the promotion of permanent innovation. It involves connecting policy priorities with institutional realities, allocating resources over time, protecting space for experimentation, distributing responsibility, supporting evaluation, and ensuring that evidence influences subsequent decisions.

The strategic model emerging from the study can therefore be expressed as:

sectoral change → competence interpretation → curriculum and pedagogical response → capacity development → implementation → evaluation → feedback → adaptation

This model should be interpreted as a recurring cycle rather than a linear reform pathway. The purpose of VET innovation is not to reach a fixed model of “future-ready” education. Any such model

would itself become obsolete as tourism, technology, sustainability requirements, and labour-market conditions continue to change. The more durable objective is to develop a system capable of repeatedly recognising change, interpreting its implications, mobilising appropriate resources, implementing proportionate responses, and learning from the consequences.

In this sense, the principal strategic recommendation is to develop tourism VET as a learning system: one that equips learners to adapt professionally while itself retaining the capacity to interpret change, learn from implementation, distribute opportunities equitably, and renew its practices as tourism evolves.

The defining characteristic of adaptive tourism VET is therefore not the number of innovations it adopts, but the quality of the processes through which it decides what to change, why to change it, how to implement change, how to evaluate its effects, and when to revise or discontinue it.

8 Conclusions

This monograph examined how the green and digital transformation of tourism is reshaping competence requirements and what these changes imply for vocational education and training. The analysis demonstrates that the transformation taking place across tourism cannot be understood as a sequence of separate technological, environmental, organisational, or labour-market developments. Sustainability requirements, digitalisation, changing visitor expectations, demographic and labour-market shifts, climate-related pressures, evolving business models, accessibility expectations, and growing demands for social responsibility increasingly interact within the same professional contexts. Their educational implications therefore cannot be addressed effectively through isolated additions to existing tourism curricula[162].

This interpretation is consistent with the wider transformation of the European tourism ecosystem. The European Commission treats the future of tourism as a combined green, digital, and resilience transition rather than as a set of independent sectoral adjustments. Its 27 action areas include sustainability, digitalisation, skills, accessibility, stakeholder cooperation, and resilience, reinforcing the need to understand tourism transformation as a systemic and interconnected process.

The central competence challenge identified throughout this study is consequently one of integration rather than accumulation. Sustainability, digitalisation, entrepreneurship, accessibility, intercultural interaction, adaptability, and transversal competence should not be treated merely as additional skills placed alongside established occupational knowledge. Their significance lies increasingly in the way they are combined within professional action. Tourism professionals are expected not only to perform established occupational tasks but also to interpret environmental consequences, use digital technologies critically, communicate across cultural and organisational boundaries, work with diverse stakeholders, respond to uncertainty, and contribute to responsible forms of innovation.

This conclusion is reinforced by the structure of several European competence frameworks. GreenComp does not present sustainability as one isolated skill but as four interrelated areas encompassing sustainability values, complexity, future-oriented thinking, and action. Similarly, EntreComp treats entrepreneurship as a combination of interconnected capacities organised around ideas and opportunities, resources, and action rather than as knowledge of business creation alone. DigComp likewise conceptualises digital competence through knowledge, skills, and attitudes that enable confident, critical, and safe engagement with digital technologies. Together, these

[162] European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Transition Pathway for Tourism, Publications Office of the European Union, Luxembourg 2024.

frameworks support an understanding of competence as relational and integrative rather than as a collection of independent technical abilities[163].

The findings therefore challenge an additive approach to curriculum development in which every emerging sectoral requirement generates another topic, module, qualification element, or competence label. Such an approach risks producing increasingly crowded curricula without necessarily improving learners' ability to act in complex professional situations. The strategic issue is not whether sustainability, AI, circular economy, accessibility, XR, entrepreneurship, data literacy, or another emerging topic can be added to the curriculum. It is whether learners can mobilise relevant knowledge and competence when confronting a professional problem in which several of these dimensions are simultaneously present[164].

The study consequently supports an architecture of professional capability in which occupational knowledge provides the domain foundation, cross-cutting competence domains extend and reshape professional practice, and higher-order capabilities allow learners to mobilise different forms of knowledge and judgement under changing conditions. Within this architecture, sustainability judgement, critical digital agency, adaptive professional agency, boundary-spanning competence, and ethical professional judgement emerge as particularly significant integrative capabilities.

These concepts are not intended to replace established occupational or transversal competences. Rather, they describe the capacity required to combine those competences in situations characterised by uncertainty, competing objectives, incomplete evidence, technological change, and multiple stakeholder interests. The future-oriented question for tourism VET is therefore not simply which additional skills learners should possess, but whether they can recognise which competences are relevant, integrate them appropriately, make reasoned decisions, and revise those decisions when conditions or evidence change.

Sustainability provides one of the clearest illustrations of this shift. The findings suggest that the principal educational challenge is no longer an absolute absence of environmental awareness. Learners may recognise the importance of resource efficiency, responsible tourism, biodiversity protection, sustainable mobility, waste reduction, or community participation while remaining less prepared to translate these principles into professional decisions. They may have limited opportunities to interpret environmental indicators, evaluate competing interventions, work with certification requirements, assess climate-related risks, analyse stakeholder interests, or distinguish substantive improvement from symbolic sustainability claims.

The structure of GreenComp strengthens this interpretation. Its four areas move beyond environmental knowledge towards the capacity to engage with values, complexity, future

[163] Council of the European Union, "Council Recommendation of 24 November 2020 on Vocational Education and Training (VET) for Sustainable Competitiveness, Social Fairness and Resilience", Official Journal of the European Union, C 417, 2020, pp. 1–16.

[164] J. Radianti, T. A. Majchrzak, J. Fromm, I. Wohlgenannt, "A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda", Computers & Education, vol. 147, 2020.

possibilities, and action. Importantly, the framework describes these areas as interrelated and equally significant rather than as a linear hierarchy. This supports the argument developed in this monograph that sustainability capability cannot be reduced either to awareness or to technical environmental procedures: professional action requires the integration of analytical, normative, anticipatory, and practical dimensions.

This is particularly important in tourism because environmental decisions rarely concern environmental variables alone. Climate vulnerability, for example, interacts with economic dependence on tourism, destination characteristics, adaptive capacity, and regional development conditions. Research on global tourism vulnerability demonstrates considerable geographical variation and highlights the particular exposure of destinations in which tourism contributes strongly to economic activity while adaptive capacity may be more constrained. Sustainability competence in tourism must therefore include the capacity to recognise contextual vulnerability rather than assuming that identical environmental responses are appropriate across destinations.

The study conceptualised the educational problem through three distinct but interrelated gaps. A depth gap occurs where sustainability remains primarily at the level of awareness rather than progressing towards operational, analytical, systemic, and judgement-based capability. An integration gap emerges where sustainability is separated from occupational practice, digitalisation, entrepreneurship, accessibility, destination management, or community relations despite their intersection in professional work. An enactment gap arises where learners possess conceptual knowledge but have insufficient opportunities to apply it through decisions, projects, workplace practice, data interpretation, or authentic professional problems.

These gaps require different educational responses. Greater awareness alone cannot address a depth gap. Additional isolated sustainability content cannot resolve an integration gap. Conceptual instruction alone cannot overcome an enactment gap. The required educational progression is therefore broader:

environmental awareness → operational competence → analytical capability → systems understanding → sustainability judgement → responsible action

This progression represents increasing professional depth rather than a rigid sequence of curriculum stages. Environmental awareness provides orientation; operational competence enables implementation; analytical capability supports evidence-informed evaluation; systems understanding reveals interdependence and unintended consequences; sustainability judgement enables professionals to evaluate competing objectives; and responsible action translates these capabilities into practice.

The emphasis on systems understanding deserves particular attention. Sustainability competence literature consistently identifies systems thinking, anticipatory thinking, strategic capability, normative judgement, and interpersonal competence as central to the ability to address sustainability problems. These perspectives support the argument that tourism professionals should

not merely recognise sustainable practices, but understand interactions between ecological, economic, social, organisational, and temporal dimensions.

Sustainable tourism VET should consequently prepare learners not simply to follow prescribed green practices but to reason through situations in which environmental, economic, social, cultural, and organisational objectives conflict. This is the point at which sustainability becomes professional judgement rather than environmental compliance.

Digital transformation requires a comparable shift. The study distinguishes general digital familiarity from professionally situated digital capability. Tourism professionals increasingly interact with sector-specific digital systems, distribution platforms, customer-management technologies, data, AI-supported applications, digital communication environments, smart-tourism infrastructures, and immersive technologies. Yet the rapid evolution of technological systems means that proficiency with a particular platform is unlikely to provide a durable basis for professional preparedness.

DigComp 2.2 reinforces the importance of this distinction by treating digital competence as more than technical operation. Its updated examples explicitly address the knowledge, skills, and attitudes needed to engage confidently, critically, and safely with digital technology, including emerging AI-driven systems, while accessibility is treated as an important principle of digital resource development[165].

The more transferable capability identified in this monograph is therefore critical digital agency: the ability to select, use, interpret, evaluate, and adapt technologies according to professional purpose while considering their reliability, accessibility, ethical implications, privacy consequences, environmental costs, and effects on human interaction. Critical digital agency goes beyond operational technology use. It requires professionals to ask not only how a technological tool functions, but why it should be used, which professional problem it addresses, whose needs it serves, who may be excluded, what new dependencies it creates, and whether its complexity is proportionate to its educational or professional value.

This interpretation is particularly important because educational technology research does not justify an assumption that more advanced technology necessarily produces better learning. UNESCO's 2023 Global Education Monitoring Report emphasises that robust and impartial evidence concerning the added educational value of digital technology remains limited. It also stresses that technology should be evaluated in relation to learning outcomes rather than digital inputs, while long-term costs, equity, teacher preparation, privacy, and environmental consequences need to be included in decision-making[166].

The analysis of Extended Reality undertaken in this monograph illustrates the issue particularly clearly. XR can provide meaningful opportunities for simulation, safe rehearsal, collaborative

[165] R. Vuorikari, S. Kluzer, Y. Punie, DigComp 2.2: The Digital Competence Framework for Citizens – With New Examples of Knowledge, Skills and Attitudes, Publications Office of the European Union, Luxembourg 2022.

[166] UNESCO, Global Education Monitoring Report 2023: Technology in Education – A Tool on Whose Terms?, UNESCO, Paris 2023.

learning, heritage interpretation, spatial visualisation, and access to environments that would otherwise be difficult, costly, unsafe, or impossible to reproduce. At the same time, the available research cautions against equating technological intensity with educational effectiveness. It should also be noted that much immersive-VR research had focused on usability rather than learning outcomes and that learning theories were often insufficiently integrated into application design.

Experimental evidence provides an even stronger warning. Immersive VR condition produced substantially greater presence while simultaneously producing poorer learning outcomes and higher cognitive load than a less immersive version of the same simulation. The significance of this result for the present study lies not in treating one experiment as universally representative, but in demonstrating empirically that presence, enjoyment, and immersion cannot be used as proxies for learning.

The appropriate evaluative criterion is therefore educational additionality. XR is most strongly justified where it enables a form or quality of learning that would otherwise be substantially more difficult, inaccessible, unsafe, costly, or less effective to achieve through plausible alternatives. This principle leads to a model of pedagogical augmentation, in which technology strengthens an identified learning mechanism rather than replacing pedagogical reasoning.

This conclusion also clarifies the importance of comparison. Evaluation should not ask whether learners enjoy XR or whether immersive environments appear innovative. It should ask whether a technology produces educational value in relation to a realistic alternative and whether that value justifies the additional cognitive, organisational, technical, financial, and accessibility costs associated with its use.

The study therefore does not support the assumption that VET institutions should be considered technologically mature because they use a greater number of emerging technologies. Institutional maturity is more appropriately understood as decision maturity: the capacity to determine whether a technology addresses a relevant learning problem, whether teachers and learners can use it meaningfully, whether accessibility and ethical requirements can be met, whether lifecycle costs are sustainable, and whether available evidence justifies the proposed level of integration.

The resulting logic of responsible technological adoption can be expressed as:

learning problem → educational additionality → institutional readiness → responsible adoption → pedagogical augmentation → evaluation → adaptation

Responsible adoption may legitimately result in several outcomes. An institution may introduce and integrate a technology, maintain it at pilot level, redesign the intervention, use it only for selected learner groups or competence objectives, choose a less complex alternative, postpone adoption, or reject it. Choosing not to introduce XR or another emerging technology can therefore constitute evidence of institutional maturity rather than technological backwardness where educational additionality is insufficient.

Digital innovation in VET is consequently better conceptualised as a problem of responsible technology governance than as technological diffusion. This interpretation closely corresponds to

UNESCO's recommendation that educational technology decisions should be grounded in appropriateness, evidence, equity, scalability, and sustainability rather than novelty. The report also shows how apparently equal technological provision can coexist with unequal educational benefit, reinforcing the need to assess the capacity to use technology meaningfully rather than access alone[167].

At institutional level, the findings demonstrate that recognising emerging competence requirements does not automatically produce educational change. VET providers vary considerably in their capacity to translate strategic priorities into curriculum, pedagogy, assessment, work-based learning, teacher development, and sustainable organisational practice. Infrastructure, teacher capability, curriculum flexibility, leadership, financial continuity, partnerships, technical support, accessibility, governance, and evaluation interact in determining whether an innovation can move beyond experimentation.

These conditions were brought together through the concept of implementation capacity. The study distinguishes several mechanisms through which implementation may fail. A resource gap arises where institutions lack sufficient funding, infrastructure, expertise, time, or technical support. An integration gap occurs where resources are available but remain weakly connected with curriculum, assessment, teacher practice, or organisational strategy. A sustainability gap appears where promising innovations depend on temporary funding, specialist project personnel, or individual leadership and cannot be maintained once those conditions disappear.

This distinction helps explain why participation in innovative projects should not be interpreted automatically as evidence of institutional readiness. Project capacity is not equivalent to institutional capacity. A successful pilot generates lasting educational value only where relevant knowledge, responsibilities, professional capabilities, resources, and support mechanisms become incorporated into organisational routines. The ability to initiate innovation and the ability to sustain it are analytically distinct.

Teacher professionalisation is central to this transformation. Teachers occupy a mediating position between sectoral change, curriculum structures, technologies, professional practice, and learner experience. Their role is therefore not restricted to transmitting established knowledge or acquiring technical familiarity with emerging tools. They interpret which sectoral developments are educationally significant, determine how these changes relate to learning objectives, design authentic learning environments, facilitate reflection, support diverse learners, and assess whether competence can be integrated in action.

Cedefop's comparative work on VET teachers and trainers supports this interpretation. It describes their role as increasingly complex and identifies the need for a holistic approach to professional development capable of addressing new technologies, changing labour-market demands, inclusion, and the green and digital transitions. The implication is that teacher capability

[167] UNESCO, Global Education Monitoring Report 2023: Technology in Education – A Tool on Whose Terms?, UNESCO, Paris 2023.

cannot be maintained through isolated updating events alone; it requires continuing structures for professional learning[168].

Sustainable reform therefore requires professional development to move beyond occasional workshops towards continuous professional-learning infrastructures. Such infrastructures may combine industry exposure, peer collaboration, mentoring, collaborative curriculum design, sustainability learning, digital competence development, interdisciplinary projects, research participation, and structured opportunities to experiment with and evaluate emerging practices. Institutional resilience increases where this expertise becomes distributed across professional communities rather than concentrated in isolated innovation champions.

This also changes the meaning of teacher technological competence. Teachers do not need expert-level mastery of every new platform. They need sufficient pedagogical-technical judgement to decide whether a technology is relevant to a learning objective, how it affects learner participation, what support it requires, how it should be evaluated, and when external technical expertise is necessary. In this sense, the teacher performs a translation function between technological possibility and educational value.

Work-based learning represents another critical element of this translation. The workplace can provide access to real equipment, authentic professional relationships, tacit occupational knowledge, technical practice, and transversal competences such as communication and teamwork. However, the literature confirms the distinction developed in this monograph between workplace exposure and work-based learning. OECD analysis stresses that the quality of work-based learning depends on design and supporting mechanisms, including sequencing, while also identifying equity risks that need to be managed[169].

This means that simply placing students in tourism enterprises cannot be treated as evidence of competence development. Work-based learning requires educational intentionality: defined learning outcomes, appropriate tasks, mentoring, feedback, increasing responsibility, opportunities for reflection, and connection between workplace experiences and broader occupational concepts. Employers should therefore participate as learning partners rather than merely placement providers.

These findings support the broader concept of adaptive institutional capacity. Tourism VET cannot become permanently ready for a fixed set of technologies, environmental requirements, business models, or labour-market expectations because these conditions will continue to change. The more important institutional capability is the ability to recognise relevant transformation, interpret its implications, mobilise expertise, experiment with responses, evaluate results, integrate valuable practices, and discontinue approaches that no longer create sufficient educational value.

[168] Cedefop, Teachers and Trainers in a Changing World: Building up Competences for Inclusive, Green and Digitalised Vocational Education and Training (VET): Synthesis Report, Cedefop Research Paper, no. 86, Publications Office of the European Union, Luxembourg 2022.

[169] P. Musset, “Improving Work-Based Learning in Schools”, OECD Social, Employment and Migration Working Papers, no. 233, OECD Publishing, Paris 2019.

This perspective changes the meaning of readiness. Readiness is not an end state achieved once sufficient resources have been acquired or reforms introduced. It is a dynamic capacity for repeated adaptation. Institutions demonstrating high adaptive capacity are not necessarily those implementing the largest number of innovations, but those capable of distinguishing valuable change from temporary novelty and responding proportionately.

A similar argument applies to labour-market alignment. Tourism VET cannot maintain permanent correspondence with current employer demand in a sector characterised by continuing technological, environmental, organisational, and social transformation. Static alignment is therefore neither realistic nor necessarily desirable. The more durable objective is adaptive responsiveness.

This conclusion corresponds closely with the OECD conception of future-ready VET. Responsive systems require reliable information concerning current and anticipated skill needs, engagement with social partners, and sufficient capacity to translate these signals into programmes and provision. Importantly, OECD analysis also cautions that employer input should be balanced with other evidence so that VET reflects longer-term and broader societal needs rather than only those of a limited set of employers[170].

The latter point is crucial for the concept of reciprocal co-construction developed in this monograph. Employers are important sources of occupational information, but existing demand cannot be treated as an unquestionable specification for curriculum. Current practices may themselves require transformation in relation to sustainability, accessibility, digital responsibility, or employment quality. VET consequently has a dual role: preparing learners to participate credibly in contemporary work while also equipping them to improve and adapt professional practice.

Adaptive responsiveness requires mechanisms through which competence signals can be identified, interpreted, translated into learning and assessment, observed in workplace application, and reconsidered through feedback. Cedefop's work on next-generation skills intelligence reinforces this distinction between information and response: collecting labour-market data is not sufficient; data need to be converted into trusted, actionable intelligence capable of informing education and skills decisions .

This insight strengthens one of the broader conclusions of the study: information does not become educational capacity automatically. Between labour-market change and learner competence lies a chain of interpretation involving governance structures, curriculum developers, institutional leaders, teachers, workplace partners, assessment mechanisms, and learners themselves. A failure at any stage may create misalignment even where accurate information concerning changing skills needs exists.

The study therefore conceptualises employers as co-producers of competence rather than sole definers of competence requirements. Enterprises can contribute occupational knowledge,

[170] OECD, Building Future-Ready Vocational Education and Training Systems, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris 2023.

workplace experience, emerging skill signals, authentic problems, mentoring, and feedback. VET providers contribute pedagogical expertise and a longer-term perspective on transferable professional capability. Learners and graduates contribute evidence concerning transitions between education and work. Public authorities, sectoral bodies, destination organisations, communities, and other actors contribute social, environmental, territorial, and regulatory perspectives that may not be visible in immediate labour-market demand.

This produces a necessary balance between responsiveness and anticipation. VET needs to remain sufficiently connected with present professional practice to support meaningful labour-market entry while also preparing learners to respond to structural transformation. Excessive responsiveness risks tying curricula to technologies, business models, and occupational practices that may become obsolete. Excessive anticipation risks producing programmes detached from present occupational realities. A resilient model therefore combines durable occupational foundations with higher-order capabilities that enable continued professional adaptation.

Entrepreneurial learning contributes directly to this adaptive capability. The findings do not support restricting entrepreneurship education to preparation for business creation or self-employment. EntreComp itself defines entrepreneurship through interrelated competence areas connecting ideas and opportunities, mobilisation of resources, and action, explicitly creating a bridge between education and work[171].

Practice-oriented entrepreneurship education literature reinforces this interpretation by conceptualising entrepreneurship as a form of learning that extends beyond knowing and discussing towards applying, practising, experimenting, and reflecting. Such approaches emphasise pedagogies based on simulation, design-oriented problem solving, practical entrepreneurial activity, and reflective practice. This perspective supports an understanding of entrepreneurial learning as an active and iterative process in which learners develop competence through decision-making, experimentation, feedback, and adjustment.

This is closely aligned with the concept of adaptive professional agency developed in this monograph. Tourism professionals increasingly require the ability to recognise opportunities, mobilise resources and relationships, act under conditions of uncertainty, experiment, learn from feedback, and initiate change within existing organisations as well as new ventures. Entrepreneurial learning is therefore valuable not only because some graduates may become entrepreneurs, but because initiative, experimentation, responsible action, and learning from consequences constitute increasingly important dimensions of professional capability.

The research literature also supports caution concerning simplistic measures of entrepreneurship-education outcomes. Systematic reviews indicate that research in this field has frequently relied on relatively short-term and subjective outcome measures, while providing

[171] Cedefop, Next Generation Skills Intelligence for More Learning and Better Matching: Skills Anticipation Trends, Opportunities and Challenges in EU Member States, Publications Office of the European Union, Luxembourg 2024.

insufficient detail about the specific pedagogical mechanisms being evaluated. This reinforces the methodological caution developed elsewhere in the monograph: entrepreneurial intentions, confidence, satisfaction, or perceived preparedness should not automatically be equated with demonstrated competence, sustained behavioural change, or subsequent professional action.

In sustainable tourism, entrepreneurial action likewise cannot be evaluated solely through commercial success. Sustainable entrepreneurship literature emphasises the relationship between what is to be sustained and what is to be developed, including environmental systems, communities, and both economic and non-economic forms of value. This supports a broader understanding of entrepreneurial value creation in which feasibility and economic viability must be considered alongside environmental, social, cultural, and territorial consequences. Entrepreneurial competence therefore involves not only recognising and exploiting opportunities, but also evaluating their wider effects and determining whether the value created is responsible, inclusive, and sustainable over time[172].

Entrepreneurial learning, sustainability judgement, critical digital agency, ethical reasoning, and boundary-spanning competence should therefore be treated as mutually reinforcing rather than separate competence domains. A digitally innovative tourism product that is economically viable but inaccessible, environmentally disproportionate, or harmful to community interests cannot be regarded as evidence of fully developed professional capability. Conversely, an environmentally ambitious idea that cannot be operationalised, financed, communicated, or sustained may have limited transformative capacity. Professional judgement lies precisely in navigating these tensions.

At system level, the findings extend these arguments beyond individual institutions. European tourism VET is characterised by substantial national, regional, institutional, and sectoral diversity. This diversity reflects legitimate differences in qualification structures, tourism economies, labour-market organisation, institutional traditions, destination characteristics, and resources. The findings provide no basis for treating diversity itself as a policy failure or assuming that greater standardisation necessarily produces better outcomes.

Problems arise where diversity becomes uncoordinated fragmentation and prevents competence recognition, mobility, knowledge exchange, or collective learning. The strategic alternative developed in the study is coordinated competence governance: an approach combining sufficiently shared reference points and mutual intelligibility with contextual flexibility. This interpretation is consistent with the broader European VET policy direction, which links high-quality VET with green and digital transitions, adaptability, resilience, continuing training, and the capacity to respond to economic change rather than prescribing a single model of provision.

The distinction between productive diversity and dysfunctional fragmentation is therefore important. Productive diversity enables systems and institutions to experiment, specialise, and adapt

[172] H. M. Neck, P. G. Greene, “Entrepreneurship Education: Known Worlds and New Frontiers”, Journal of Small Business Management, vol. 49, no. 1, 2011, pp. 55–70.

while remaining connected through mechanisms for translation, recognition, and knowledge exchange. Dysfunctional fragmentation arises where differences obstruct interpretation, transfer, mobility, or cooperation without generating compensating contextual value.

The objective should not be a single European tourism curriculum, identical national provision, or harmonisation of rapidly changing technologies. It should be to ensure that competence remains sufficiently visible, interpretable, assessable, transferable, and open to revision across different systems. European and national frameworks, qualification systems, sustainability standards, certification mechanisms, and labour-market intelligence can contribute to this objective where they support competence translation rather than simply add new layers of formalisation.

Recognition should consequently follow demonstrated capability rather than terminology alone. Generic labels such as “green skills”, “digital skills”, or “entrepreneurship” have limited value for mobility and recognition unless they are translated into observable professional capability. Likewise, apparent similarity between qualification descriptors provides limited assurance where assessment expectations differ substantially. Assessment quality therefore becomes a governance issue as well as a pedagogical one.

The findings thus strengthen the case for authentic and performance-oriented assessment. If the educational objective is integrated professional capability, assessments should require learners to mobilise knowledge and judgement in tasks that reproduce relevant features of professional activity. This does not require literal replication of the workplace. It requires sufficient authenticity for learners to demonstrate decision-making, problem solving, communication, integration, and justification of professional choices[173].

These arguments converge in the concept of systemic transition capacity, identified in the study as an overarching condition for longer-term tourism VET transformation. Systemic transition capacity connects coordinated competence governance, implementation capacity, teacher professionalisation, adaptive curriculum development, work-based learning, reciprocal labour-market relationships, sustainable financing, inclusion, responsible technology adoption, and evaluative capability.

Its logic can be represented as:

sectoral transformation → competence interpretation → resource mobilisation → curriculum and pedagogical response → implementation → evaluation → system learning → adaptation

The circular character of this model is essential. Transformation is not completed when a new curriculum, policy, technology, qualification, or pedagogical approach is introduced. The consequences of implementation need to be observed, evaluated, interpreted, and incorporated into subsequent decisions. Some innovations may justify wider implementation; others may require

[173] T. Sitzmann, K. Ely, K. G. Brown, K. N. Bauer, “Self-Assessment of Knowledge: A Cognitive Learning or Affective Measure?”, Academy of Management Learning & Education, vol. 9, no. 2, 2010, pp. 169–191.

redesign; some may remain valuable only in specific contexts; and others may appropriately be discontinued.

The importance of evaluation follows from several strands of the literature analysed in this study. Technology research demonstrates that engagement and learning may diverge. Entrepreneurship-education research warns against over-reliance on short-term subjective outcomes. Skills-intelligence research demonstrates that information does not become action automatically. Work-based learning research shows that placement alone does not guarantee learning. Taken together, these findings support a broader methodological principle: the presence of an educational input should never be treated as evidence of the intended educational outcome[174].

This principle has important implications for governance. A learning system needs not only innovation capacity but evaluative capacity: the ability to define what success means, collect proportionate evidence, distinguish implementation from impact, identify differential effects across groups and institutions, and use results to inform subsequent decisions. Evaluation is therefore not simply a research activity performed after implementation. It is part of the infrastructure through which institutional and systemic adaptation occurs.

This leads to the broader concept of tourism VET as a learning system. A learning VET system does not merely teach learners to adapt while its own structures remain fixed. It develops institutional and governance mechanisms through which the system itself can recognise change, experiment, evaluate outcomes, share knowledge, revise assumptions, and renew provision. Its future-readiness lies not in predicting every emerging technology or occupational requirement, but in maintaining the capability to respond intelligently when those conditions change.

OECD's future-ready VET framework provides important external support for this conclusion by treating responsiveness to changing skill needs, flexibility, transitions into changing labour markets and further learning, and innovation in VET design and delivery as interconnected dimensions rather than independent policy goals[175].

The concept of a learning system nevertheless extends beyond responsiveness.

A system may respond rapidly and still reproduce ineffective assumptions. Learning requires feedback capable of altering subsequent choices. It therefore involves institutional memory, evidence interpretation, mechanisms for sharing practices across organisations, and the willingness to discontinue approaches that no longer produce sufficient value. Adaptation without evaluation risks becoming permanent experimentation; evaluation without adaptation risks becoming reporting without learning.

[174] R. J. Vandenberg, C. E. Lance, "A Review and Synthesis of the Measurement Invariance Literature: Suggestions, Practices, and Recommendations for Organizational Research", Organizational Research Methods, vol. 3, no. 1, 2000, pp. 4–70.

[175] OECD, Building Future-Ready Vocational Education and Training Systems, OECD Reviews of Vocational Education and Training, OECD Publishing, Paris 2023.

Equity is integral to this model. The findings suggest that unequal access to innovation cannot be reduced to unequal access to technology. Institutions differ in teacher expertise, leadership, infrastructure, partnerships, funding, organisational flexibility, project-management experience, technical support, and ability to participate in innovation networks. These advantages may reinforce one another, producing a cumulative innovation divide in which already well-connected institutions obtain further opportunities while less-resourced providers remain outside the ecosystems through which capability develops.

UNESCO's analysis of educational technology illustrates the same underlying problem: technology can extend access while simultaneously reproducing or widening inequality where meaningful connectivity, teacher preparedness, accessibility, and effective pedagogical integration are absent.

This also means that equality of inputs should not automatically be confused with equity of opportunity. Identical technologies may have very different educational value across institutions depending on teacher capability, learner needs, connectivity, organisational support, accessibility, or curriculum integration. Conversely, different institutional solutions may create comparable learning opportunities. Equity in adaptive VET therefore requires attention to function and educational outcome rather than formal similarity of provision.

The comparative dimension of the study also has implications for transferability. The findings do not support treating practices identified in particular national or institutional settings as universally replicable solutions. Differences in governance, resources, tourism profiles, curricula, labour markets, teacher capacity, and institutional organisation affect how interventions function. Transferability should therefore not be equated with replication.

The more appropriate object of transfer is often the underlying mechanism.

A sustainability initiative may be transferable because of the way it structures stakeholder participation rather than because the same activity can be copied elsewhere. A successful XR intervention may transfer through its sequence of simulation, feedback, reflection, and workplace connection rather than through identical hardware or software. A work-based learning model may transfer through mentoring, progressive responsibility, and structured reflection rather than through duplication of a particular organisational arrangement.

This mechanism-based understanding of transferability allows common learning while respecting contextual difference. It is consistent with the wider principle of coordination without uniformity and reinforces the need to identify not only whether an intervention appears successful, but how it works, for whom, under which conditions, and what capacities are required for its educational mechanism to operate elsewhere.

The contribution of this monograph lies in bringing these different levels of analysis together within a common framework. Sustainable tourism, digital transformation, technological innovation, entrepreneurship, labour-market change, competence development, and VET governance are frequently discussed as partially separate challenges. The findings presented here indicate that they

are better understood as interconnected dimensions of a broader competence-transformation process.

At the individual level, this process concerns integrated professional capability: the ability to mobilise occupational knowledge together with sustainability judgement, critical digital agency, adaptive professional agency, interpersonal and boundary-spanning competence, and ethical judgement.

At the institutional level, it concerns implementation and adaptive capacity: the ability of VET providers to translate competence priorities into curriculum, pedagogy, assessment, teacher development, work-based learning, partnerships, and sustainable organisational practice.

At the governance level, it concerns coordination, translation, recognition, feedback, and collective learning: the capacity to make diversity compatible with transparency, mobility, contextual adaptation, and continuing system renewal.

The concept of the competence ecosystem provides the analytical bridge between these levels. Competence is not produced by learners or educational institutions in isolation. It develops and is renewed through interaction among learners, teachers, VET providers, employers, destination organisations, communities, technology providers, research institutions, sectoral organisations, and policymakers. The quality of these relationships influences not only what learners encounter but how emerging occupational requirements are interpreted, how innovations are evaluated, how professional knowledge circulates, and whether successful practices become durable.

This ecosystem perspective provides an additional explanation for why isolated reforms frequently have limited transformative effects. A new competence framework may have little impact where teachers lack opportunities to operationalise it. Advanced technology may create limited value where assessment remains unchanged. Strong employer partnerships may not improve learning where workplace experiences are unstructured. High-quality labour-market intelligence may remain unused where curriculum revision mechanisms are rigid. Transformation therefore depends not simply on the quality of individual components but on the connections between them.

Several limitations of the study nevertheless need to be recognised. The comparative material does not provide a basis for ranking national VET systems or for assuming that individual projects, programmes, or institutions are representative of entire countries. National differences identified in the analysed material should therefore be interpreted as contextual patterns rather than evidence of overall system performance.

Stakeholder evidence also reflects reported perceptions and experiences. Self-reported familiarity, confidence, preparedness, or perceived importance should not be interpreted automatically as objective measurement of competence. Similarly, differences between stakeholder groups may involve related but non-equivalent constructs. Awareness among industry respondents, for example, should not be treated as directly equivalent to proficiency assessments among teachers or learners. The research design supports identification of recurring patterns, relationships,

implementation conditions, and areas of convergence or divergence, but causal conclusions require evidence beyond descriptive or cross-sectional comparisons.

Claims concerning XR require particular caution. Positive perceptions, learner engagement, confidence, satisfaction, or successful pilot experiences do not themselves demonstrate long-term learning, workplace transfer, improved employability, or institutional scalability. Evidence of simulation performance should not automatically be equated with real-world mastery. Similarly, pilot implementation does not establish sustainable institutional adoption. The wider XR literature strengthens the methodological basis for these distinctions by demonstrating both a tendency to evaluate usability more often than learning outcomes and empirical cases in which increased immersion and presence did not translate into greater learning.

Comparable caution is required when interpreting entrepreneurship education, sustainability awareness, employer satisfaction, or technology confidence. Across these domains, subjective indicators may provide meaningful evidence of experience, motivation, or perceived preparedness, but they answer different questions from behavioural performance, competence transfer, long-term retention, or institutional impact. The broader methodological implication is that measurement needs to remain aligned with the construct being claimed.

These limitations strengthen rather than weaken the argument for greater evaluative capacity within VET. If transformation depends on adaptation, systems need evidence capable of distinguishing promising innovation from temporary enthusiasm, competence development from awareness, institutionalisation from project activity, and professional transfer from successful classroom performance.

Future research should consequently move beyond broad questions concerning whether particular innovations “work” and examine for whom, under what conditions, through which mechanisms, compared with which plausible alternatives, and at what educational and institutional cost they create value.

Longitudinal research is particularly important for understanding whether sustainability, digital, entrepreneurial, and transversal competences transfer into professional practice and remain relevant over time. Studies should examine the persistence of institutional innovations after external project funding ends, the transfer of simulation-based learning to workplace behaviour, and the durability of teacher and organisational capability developed through innovation projects.

Further research is also needed on authentic assessment of integrated competence. If tourism VET increasingly aims to develop professional judgement and the capacity to combine competence domains, assessment models need to provide credible evidence of this integration. Future studies should therefore examine the validity, reliability, feasibility, and fairness of performance-based, workplace, project-based, and simulation-based assessment across different VET contexts.

Teacher professionalisation represents another important research area. More evidence is required concerning which combinations of professional learning, industry engagement, peer

collaboration, mentoring, interdisciplinary work, and applied experimentation are most effective in supporting the translation of sectoral transformation into pedagogy.

The governance of competence ecosystems likewise requires further investigation. Research could examine how labour-market signals, sustainability priorities, technological developments, learner experience, employer expectations, community perspectives, qualification systems, and policy frameworks interact in actual governance processes. Particular attention should be paid to the mechanisms through which knowledge moves—or fails to move—between sectoral change and curriculum practice.

Skills intelligence represents an especially important area for such research. The central question is no longer simply whether information about emerging demand exists, but how it is selected, interpreted, legitimised, translated into educational decisions, and subsequently evaluated. The distinction between data and actionable intelligence highlighted by Cedefop provides a useful basis for examining this process empirically.

Cross-context research would benefit from shared analytical dimensions that enable comparison without erasing institutional difference. Rather than asking which national model is superior, comparative studies could examine configurations of conditions: which combinations of governance, teacher capability, financing, partnerships, curriculum flexibility, infrastructure, assessment, and evaluation enable particular forms of competence development.

The relationship between digital and green transformation also warrants continued attention. Digital technologies may support resource monitoring, sustainable mobility, visitor management, accessibility, environmental learning, and professional decision-making, but they also create environmental, ethical, infrastructural, and social costs. UNESCO's analysis of the long-term financial, privacy, well-being, and environmental consequences of education technology reinforces the need to avoid assuming that digitalisation is intrinsically sustainable.

Future research should therefore examine the conditions under which digitalisation contributes to sustainability and those under which it creates additional resource demand, exclusion, dependency, or complexity. This provides an important empirical agenda for the concept of green digital judgement developed in the study.

The overarching conclusion of this monograph is consequently not that tourism VET requires a definitive new catalogue of future skills, a universal curriculum model, or a standardised pathway towards technological modernisation. The transformations affecting tourism are too dynamic, context-dependent, and interconnected for such solutions to remain adequate for long.

The more durable requirement is the development of adaptive competence ecosystems capable of continuously interpreting change and translating it into professional learning.

At learner level, this means developing professionals who can combine occupational expertise with sustainability judgement, critical digital agency, adaptive professional agency, interpersonal and boundary-spanning competence, and ethical responsibility.

At teacher level, it means developing professionals capable not only of maintaining occupational and pedagogical expertise but of acting as interpreters between sectoral transformation, curriculum, technology, and learner development.

At institutional level, it means developing VET providers capable of adapting curricula, supporting teachers, integrating meaningful workplace learning, evaluating innovation, sustaining valuable practices, and using technology selectively and responsibly.

At system level, it means creating governance arrangements capable of coordinating diversity, improving mutual intelligibility, distributing implementation capacity more equitably, maintaining feedback with professional practice, translating skills intelligence into educational action, and learning systematically from evidence.

The resulting conception of future-readiness differs fundamentally from an approach based on prediction. Tourism VET cannot know with precision which AI applications, digital platforms, sustainability standards, visitor behaviours, occupations, or business models will dominate professional practice in the longer term. Attempting to construct a permanently future-proof curriculum would therefore be contradictory: a curriculum defined in excessive detail around a predicted future may become obsolete precisely because that future changes.

Future-readiness should instead be understood as adaptive capacity under conditions of uncertainty. Its core lies in the ability to recognise relevant change without reacting indiscriminately to novelty; to distinguish structural transformation from temporary trends; to interpret implications for competence; to design proportionate educational responses; to mobilise institutional and external resources; to evaluate outcomes; and to revise decisions in light of evidence.

This interpretation also reframes resilience. Resilience should not mean preserving existing provision unchanged in the face of disruption. Nor should it mean responding to every disruption through continuous restructuring. A resilient VET system combines continuity with adaptability: it protects durable occupational foundations, educational quality, inclusion, and professional standards while remaining capable of changing those elements of provision that no longer correspond to professional and social needs.

The central strategic movement identified throughout the monograph can therefore be expressed across three interconnected levels:

integrated professional capability → adaptive institutional capacity → systemic transition capacity

These levels are connected through the competence ecosystem and sustained by feedback, evaluation, and collective learning.

The ultimate implication is that future-readiness in tourism VET should not be measured by how accurately education predicts the next technology, occupation, sustainability requirement, or market trend. Nor should it be measured by how many innovations an institution adopts, how many digital tools it owns, or how rapidly new terminology appears in curriculum documents.

It should be assessed according to whether learners, teachers, institutions, and systems possess the capability to recognise changing conditions, interpret their significance, integrate relevant knowledge, act proportionately, evaluate consequences, and adapt intelligently. The central challenge is therefore not to design vocational education for one particular future. It is to build VET capable of learning with the future.

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Acronyms & Abbreviations

Term	Description
AI	Artificial Intelligence
AR	Augmented Reality
DigComp	Digital Competence Framework for Citizens
DTX	Destination Travel Experience
EMAS	Eco-Management and Audit Scheme
ESCO	European Skills, Competences, Qualifications and Occupations
ESG	Environmental, Social and Governance
EU	European Union
GreenComp	European Sustainability Competence Framework
HBIM	Historic Building Information Modelling
ICNF	Instituto da Conservação da Natureza e das Florestas
ICT	Information and Communication Technologies
ISO	International Organization for Standardization
IVET	Initial Vocational Education and Training
LifeComp	European Framework for Personal, Social and Learning to Learn Key Competence
MR	Mixed Reality
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PNPG	Peneda-Gerês National Park
QR	Quick Response
SME	Small and Medium-sized Enterprise
UNESCO	United Nations Educational, Scientific and Cultural Organization
VET	Vocational Education and Training
VR	Virtual Reality
XR	Extended Reality

Appendix 1 - Project information

Acronym	**TourXpeRience**
Title	**TourXpeRience: Nurtutring Entrepreneurial Teaching and Learning for VET Excellence in Tourism Education**
Coordinator	CEIPES EST
Reference	101193962
Type	ERASMUS Lump Sum Grant
Programme	**ERASMUS+**
Topic	ERASMUS-EDU-2024-PEX-COVE
Start	01.02.2025
Duration	48 months
Website	www.tourxperience.eu
Consortium	**Centro Internazionale per la Promozione dell'Educazione e Sviluppo ETS** (CEIPES ETS), Italy, Coordinator
	Learnable Società Cooperativa (Learnable), Italy
	Istituto tecnico superiore per le Tecnologie Innovative per i Beni e le Attività Culturali – Turismo- Marche (ITS Marche), Italy
	Asociacion Empresarial de Investigacion Centro Tecnológico del Mueble Y la Madera de la Region de Murcia (CETEM), Spain
	Universidad Politecnica de Cartagena (UPCT), Spain
	Servicio Regional de empleyo (SEF), Spain
	Karlsruhe Institut Fuer Technologie (KIT), Germany
	Datey Eyrich GmbH (DATEY), Germany
	Regionalna razvojna agencija za Podravje - Maribor (RDAPM), Slovenia
	Visja Strokovna Šola Za Gostinstvo in Turizem Maribor (VSGT Maribor), Slovenia
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	Izba Przemyslowo-Handlowa Ziemi Radomskiej (IPHZR), Poland
	Institoyto Biomichanikis Kai Epicheirisiakis Epimorfosis Kai Katarsis Sev Syndesmos Epicheiris Eon Kaibiomichanion (IVEPE- SEV), Greece
	Institouto Syndesmou Elinikon touristikon Epixiriseon (INSETE), Greece
	Wittenborg University of Applied Sciences BV (WUAS), Netherlands
	Turismo de Portugal I P (EHTP), Portugal
	Szkola Glowna Gospodarstwa Wiejskiego (SGGW), Poland

E.A.C.E. European Academy of Certified Education gGmbH (E.A.C.E. European Academy Berlin gGmbH), Germany

INTERSPREAD GmbH (INSP), Austria

Project Background

The TourXperience project aims to modernise vocational education and training (VET) in the tourism sector through the application of Extended Reality (XR) technologies, including Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR). These technologies have demonstrated significant educational benefits, particularly in the wake of the pandemic, by enabling the integration of digital content with real-world environments, thereby enhancing the quality of learning experiences.

The tourism sector often lacks formal training requirements, leading to a need for structured and ongoing education. The rapid evolution of the industry necessitates continuous updates to training methods to keep pace with new technologies and trends. Additionally, there is a pressing need to adopt sustainable practices to balance environmental, economic, and social interests.

Through the incorporation of XR technologies, the project seeks to update VET curricula, provide essential training resources, and equip students with the skills, digital competencies, and environmental awareness required for leadership in sustainable tourism. By fostering collaboration among educational institutions, industry representatives, and policymakers, the project aims to enhance the competitiveness of the tourism sector while mitigating its environmental impact.

Project Objectives

1. Enhancing teaching and learning experiences within vocational education and training (VET) institutions using modern XR technologies.

2. Boosting innovation and engagement in education through immersive and interactive XR learning experiences.

3. Fostering collaboration among tourism VET and higher education institutions, third sector entities, industry stakeholders, and policy-makers.

4. Updating VET education to meet state-of-the-art industry demands, equipping learners with relevant skills for the labour market.

5. Reforming policy to support the integration of XR technology and sustainable entrepreneurship in tourism education.

6. Increasing tourism competitiveness through modern technologies in education, fostering a skilled and environmentally-aware workforce.

TourXpeRience

This monograph is based on Deliverable D2.1 „Comprehensive report synthesizing the findings from the mapping and research undertaken," developed as part of Work Package 2 „Mapping of VET opportunities and labour market demand within the touristic sector," within the project „Nurturing Entrepreneurial Teaching and Learning for VET Excellence in Tourism Education."

Project partners:

Co-funded by the European Union

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HOW CAN TOURISM EDUCATION PREPARE LEARNERS FOR A SECTOR TRANSFORMED BY SUSTAINABILITY AND DIGITALISATION?

This monograph examines how the green and digital transitions are reshaping competence requirements in the European tourism sector and how vocational education and training systems can respond to these changes.
Drawing on cross-country research conducted in Germany, Greece, Italy, Poland, Portugal and Spain, the publication integrates evidence on sustainable tourism trends, labour-market needs, skills gaps and the educational potential of Extended Reality technologies. It identifies the green, digital, entrepreneurial and transversal competences increasingly required across the sector, while examining institutional readiness, barriers to innovation and opportunities for curriculum development.
The monograph offers a comparative perspective and evidence-based recommendations for VET institutions, educators, tourism enterprises, policymakers and other stakeholders involved in preparing the tourism workforce for the twin transition.

Co-funded by the European Union

The monograph develops and extends research findings originally produced within the TourXpeRience project (Nurturing Entrepreneurial Teaching and Learning for VET Excellence in Tourism Education), co-funded by the European Union under the Erasmus+ Centres of Vocational Excellence initiative.

TourXpeRience

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