

DIGI-ME

D1.1: Report on targeted Skills Framework Project No. 101123009

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Executive Summary

This deliverable outlines the proposed methodology for consistently updating the Targeted Skills Framework, emphasizing its role as a dynamic and adaptive tool in addressing the rapidly changing landscape of digital competencies and skills. Recognizing the evolving demands of technological advancements and labor market needs, the DIGI-ME project has developed a robust and evolving methodology to ensure the framework remains relevant and impactful over time.

This methodology aims to enable higher education institutions (HEIs) and lifelong learning initiatives to adapt their offerings effectively to emerging demands. By incorporating insights from local ecosystem partners and maintaining flexibility for diverse HEI contexts, the framework aspires to contribute to the transformative processes of purposeful business, digital, and sustainability transformations. These efforts ensure the framework's theoretical rigor and practical applicability while aligning with the EU's Digital Europe Programme (DIGITAL). This alignment emphasizes creating a digitally competent workforce, fostering secure and resilient digital infrastructures, and empowering citizens and businesses.

This deliverable underlines the importance of collaboration, adaptability, and continuous improvement, ensuring the framework evolves to meet the challenges of a rapidly digitalizing world. It marks a critical step toward advancing educational innovation and addressing the grand challenges of our time.

1. Introduction

1.1 Purpose of the document

The purpose of this document is to present the methodology developed under Work Package (WP1) of the DIGI-ME project, aimed at guiding the project partners toward the creation of an evolving Targeted Skills Framework. While the Grant Agreement specifies objectives to map profiles, identify skill requirements, and develop Intended Learning Outcomes (ILOs), this deliverable focuses on proposing a systematic approach to guide the development of the framework, rather than presenting the outcomes of this methodology in the form of a definitive skills framework.

The proposed methodology, to be implemented by July 2025, serves as a foundational tool and a forward-looking, systematic approach for addressing the evolving skill needs driven by transformative digital technologies. It outlines a step-by-step process designed to enable the DIGI-ME project to:

- Identify transformative digital technologies and corresponding competence and skill requirements, validated with local stakeholders for contextual relevance.
- Promote collaboration among the project partners, especially HEIs, through workshops and institutional validation, ensuring alignment with workforce needs and continuous monitoring.
- Develop innovative teaching methods and resources to effectively integrate digital competencies into educational offerings.

1.2 Content of the document

This report is structured to provide a comprehensive overview of the work undertaken as part of the DIGI-ME project, outlining the steps towards a novel and iterative methodology to the targeted skills framework development work. In addition, building upon initial findings from the needs assessment (T1.1), preliminary findings of the identified digital competencies and skills are provided in summary form.

The report is divided into the following sections: **Introduction, Refined methodology towards an evolving Targeted Skills Framework, and Developing the Targeted Skills Framework (version 1.0).**

1.3 Use of the document

This document serves as an integral component of the broader DIGI-ME project deliverables and is intended to support internal operations. It provides preliminary results and foundational elements for further development throughout the project's timeline. Given the dynamic and evolving nature of the Targeted Skills Framework, this document should not be perceived as a final or self-contained output. **Rather, it marks the starting point for an iterative process aimed at aligning digital competencies with evolving societal, industry and employer needs.**

To ensure clarity and consistency in the use of this document, it is essential to establish a shared understanding of key terms central to the framework's development. Providing clear definitions ensures alignment among stakeholders and supports the document's effective application across different institutional and professional contexts.

Competency is defined as a combination of “complex know-how based on the effective mobilization and combination of a variety of internal and external resources within a family of situations” (L'évaluation des compétences, 2015). This conceptualization emphasizes the active and applied nature of knowledge within real-world professional settings.

Digital Competency involves the “*confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It is defined as a combination of knowledge, skills, and attitudes*” (Council Recommendation on Key Competences for Lifelong Learning, 2018). This definition underlines the multifaceted nature of digital competency, extending beyond technical proficiency to include ethical and responsible engagement with digital tools (Ferrari, 2013).

Digital Skills refer to a range of abilities to use digital devices, communication applications, and networks to access, manage, and process information. These skills enable individuals to “*create and share digital content, communicate and collaborate, and solve problems for effective and creative self-fulfilment in life, learning, work, and social activities at large*” (Vosloo, 2018).

2. Refined methodology towards an evolving Targeted Skills Framework

This section outlines a forward-looking methodology for developing and continuously updating the DIGI-ME Targeted Skills Framework, ensuring it remains relevant and adaptable in the face of rapid technological and market changes. As digital transformation accelerates, the methodology must evolve to address emerging competences, refine existing skills, and maintain alignment with labour market demands.

This section starts with briefly highlighting the existing practices in curriculum development among participating higher education institutions (HEIs), then introduces the steps toward a more dynamic and innovative methodology and concludes with a discussion on the novel contributions of the proposed approach.

2.1. HEIs' Existing Practices and Methodologies

Participating HEIs employ several established as well as future-oriented methods to align curriculum development with the evolving needs of businesses, students, and the labor market. These practices ensure that programs equip graduates with the competencies and skills necessary for professional success.

First, **study program advisory boards**, which consist of industry representatives, are used in curriculum development. These boards meet annually to provide expert input on curricula to specific graduate profiles, ensuring alignment with the industry competencies required in fields such as strategy and international business.

Second, **targeted workshops and focus groups** are conducted with local ecosystem stakeholders to focus explicitly on the family of jobs and competence needs of businesses. This approach complements the broader discussions held at study program level, and facilitates a focus on specific knowledge/skill domains.

Third, **alumni engagement** is leveraged to gather insights from recent graduates working in managerial or professional roles. Their feedback helps identify entry-level skill gaps and informs curriculum improvements.

Fourth, **curriculum benchmarking** against peer and aspirant institutions allows HEIs to stay abreast of emerging trends and innovations in business education.

To validate the insights gained from these methods, HEIs embed competencies and skills into intended learning outcomes (ILOs), conduct graduate and alumni surveys to assess skill application and monitor employment trends in managerial and professional roles.

While these methods provide a strong foundation, challenges remain in integrating digital skills into business studies curricula. Addressing these challenges requires *a more agile and innovative approach to curriculum development to adapt to the dynamic nature of digital transformation*.

In general, curriculum development in business studies has traditionally progressed at a relatively gradual pace, often characterized by incremental evolutionary steps rather than significant overhauls. This measured approach has been suitable given the relatively stable nature of the subject matter, where frequent revolutionary changes in subject content are not typically necessary. However, challenges in curriculum design arise when business programs begin to integrate technology-related competencies. Such programs become inherently more dynamic, requiring curriculum development methodologies that can adapt to the rapid pace of technological advancements. This is where innovation in curriculum development methodologies becomes critical to ensuring that *business curricula keep pace with the demands of digital transformation*. Specifically, innovations are needed in how we identify and align with relevant job families and competencies, emphasizing agility and responsiveness when focusing on digital skills.

Furthermore, the integration of digital skills into business studies curricula requires *expert insights* (e.g. current needs assessments, technological forecasts) that can be beyond the capabilities of typical business studies teaching faculty and program directors. This places greater emphasis on the need for business studies curricula to developed *in close collaboration with experts in digital transformation* – whether this is technical teaching faculty or technology experts from industry, which lays the groundwork for the project Ecosystem for Transformative Innovation (DETI) and WP2.

Another challenge lies in the *tendency for program curricula and intended learning outcomes to treat student cohorts as homogeneous groups*. Traditionally, programs have been designed with common competencies and intended learning outcomes, assuming that all students start from the same baseline (e.g. prior learning, learning preferences, study motivation). However, recent advancements in personalization show that curricula design and delivery can be adapted to support better the idiosyncratic needs of individual learners (Bernacki et al., 2021; Bhutoria, 2022). By incorporating self-assessment mechanisms, curricula can shift from being generic instruments designed for all students to frameworks that accommodate personalized learning journeys. This approach allows for feedback loops at the individual level, rather than solely at the program level, fostering a more tailored educational experience, which provides the ground for the role and potential of personalization (T1.2).

Lastly, the focus of future higher education is being purported to shift from primarily emphasizing knowledge acquisition to *cultivating skills that enhance employability* (colloquially referred to as the ‘skills revolution’). This will be increasingly important in Europe in closing skills gaps, matching skills and jobs, facilitating upskilling and reskilling, and empowering adult learning. This means designing accessible offerings that can support skills acquisition for both degree students as well as lifelong learners. This lays the ground for how our methodologies, skills framework, and delivery of our offering also support the competence development of lifelong learners.

Building on these foundational challenges that need to be addressed beyond existing curriculum development methodologies, we propose initial steps towards an innovative methodology for developing the targeted skills framework. This methodology is designed to address the dynamic nature of digital competencies, the need to integrate the timely insights of experts in digital transformation, and the need to design more personalized and skills-focused educational pathways.

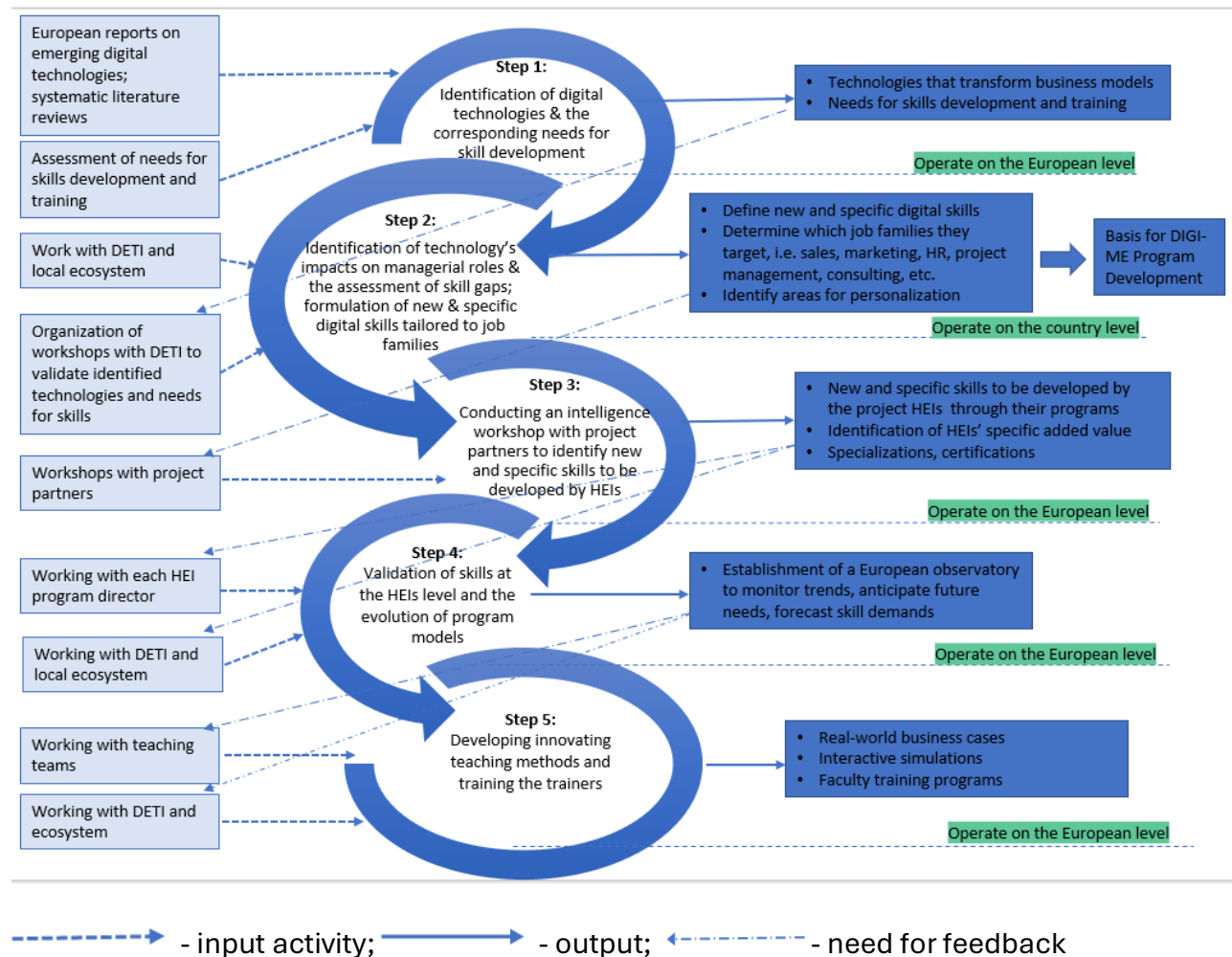
2.2. Suggested Steps Towards an Innovative Methodology

The proposed methodology seeks to address the above-mentioned challenges of integrating rapidly evolving digital competencies into business programs. It introduces a structured, dynamic, and multi-step process to ensure continuous alignment with technological advancements and the ever-changing demands of the labor market. The methodology focuses on adaptability, collaboration, and foresight among the partners to maintain the dynamic and iterative approach to further advancement of the targeted skills framework.

To ensure its relevance and robustness, the suggested methodology was developed collaboratively among the HEIs involved in the project. Each partner was asked to complete a detailed survey designed to gather insights into key methodologies, approaches, and collaborative strategies for developing and refining the framework. The survey questions focused on how to align the framework with the rapidly evolving digital landscape while addressing the specific needs of stakeholders, including students, educators, and industry representatives.

The survey responses were then discussed collaboratively among the group members, allowing all partners to contribute their perspectives, refine the proposed framework, and ensure a shared understanding of its goals and implementation. For reference, the survey questions that guided this process are provided in the appendix (see Appendix 1).

The key steps of the proposed methodology are presented in Figure 1 as well as further elaborated below:



DETI - Ecosystem for Transformative Innovation

Figure 1. Targeted Skills Framework Methodology Development

Step 1: Identification of Transformative Digital Technologies

Building on the project's Year 1 needs analysis of European labor market and technology trends, the proposed methodology adopts a balanced approach to identifying the digital technologies that are reshaping business models and workflows. This balanced methodology integrates both cutting-edge, speculative methods and more holistic, evidence-based approaches to ensure a comprehensive understanding of technological transformation and its implications for the labor market.

The first component of the methodology leverages dynamic and forward-looking tools such as forecasting and the Ecosystem for Transformative Innovation (DETI). These methods, while innovative and capable of identifying emerging trends, are inherently speculative and provide insights into potential future developments. They help highlight the technologies driving transformation—such as AI, blockchain, IoT, and advanced analytics—and their anticipated implications for managerial and operational roles.

Complementing these speculative methods, the second component involves a systematic and evidence-based approach, including a dynamic literature review. This literature review is designed to map the historical, technological, and economic contexts that underpin the evolution of these technologies. By grounding the analysis in historical trends and peer-reviewed evidence, this step ensures that the findings are robust, reliable, and reflective of broader patterns rather than isolated predictions.

Together, these two components enable a balanced and iterative process. The speculative methods identify emerging technologies and trends, while the systematic review validates and contextualizes these findings, ensuring a well-rounded perspective. This process also includes a detailed mapping of skill development needs, emphasizing the competencies required to effectively navigate and leverage these technologies in business settings.

Step 2: Validation with Local Stakeholders

This step engages local stakeholders, particularly members of the DETI – WP2 in this DIGI-ME project – in workshops to validate the findings from Step 1. These interactive sessions ensure that identified technologies and their associated skill needs are relevant and actionable within specific regional and sectoral contexts. Through these discussions, new responsibilities, emerging tasks, and critical skill gaps are identified,

forming the foundation for defining specific digital skills essential for modern business managers.

Step 3: Collective Intelligence Workshops

In this collaborative phase, project partners from participating HEIs work together to pool expertise and prioritize the digital skills to be integrated across institutions. These workshops are designed to foster a shared understanding of institutional strengths, define core competencies applicable across all HEIs, and localize additional competencies specific to regional job families and roles. By mapping these competencies to defined job families, the workshops ensure alignment between academic programs and workforce requirements.

Step 4: Institutional Validation and Observatories

Each participating HEI conducts a thorough validation of the proposed framework at the program level. This includes working closely with DETI partners to anticipate future needs and ensure the framework remains forward-looking. A key innovation in this step is the establishment of a European observatory. This observatory acts as a collaborative platform where HEIs and their ecosystems monitor trends, forecast skill demands, and share findings annually. The observatory ensures the framework is continuously updated to reflect the latest developments in technology and the labor market.

Step 5: Innovative Teaching Methods and Resource Development

Teaching teams are tasked with developing immersive and engaging pedagogical approaches tailored to diverse audiences. This includes creating real-world business cases, interactive simulations, and modular resources that align with the dynamic nature of digital competencies. Faculty training programs are also introduced, equipping educators with the tools and knowledge needed to effectively teach advanced digital technologies and methodologies. In practice, this entails collaboration between university lecturers, partners and local DETI to jointly develop curricula.

Regular feedback loops are integrated into the methodology to ensure its continuous improvement. These include student self-assessments, employability tracking, and alumni engagement, providing valuable insights into the effectiveness of the curriculum. Every 4-5 years, the entire framework undergoes a comprehensive review to ensure its ongoing relevance and impact.

2.3. Innovative Elements of the Suggested Methodology

The proposed methodology introduces several innovative and transformative elements:

Dynamic Curriculum Development. The methodology departs from traditional static approaches by incorporating agility and responsiveness. It emphasizes continuous updates and real-time alignment with emerging technologies, ensuring that business programs remain relevant in a rapidly evolving digital landscape. This dynamic approach ensures students are equipped with cutting-edge skills that align with current and future market demands. This is aligned with the expectations for syllabi and teaching materials development in WP3.

Personalized Learning Journeys. A core innovation is the integration of self-assessment tools, enabling students to evaluate their current skill levels as well as their psychophysiological state and receive tailored and personalized pathways to obtain these competencies. This personalization – Task 1.2. in this DIGI-ME project – promotes a learner-centric approach, enhancing employability and supporting lifelong learning pathways.

Collaborative Observatories. The establishment of observatories among three HEIs and their ecosystems as well as other project partners at the European level introduces a novel mechanism for cross-institutional collaboration. These observatories serve as hubs for monitoring digital skill trends, forecasting future demands, and disseminating insights across HEIs and their ecosystems. This collaborative effort ensures alignment between academic programs and the broader digital economy.

Integration of Practice and Pedagogy. Another innovative aspect of the methodology is the allocation of project funding specifically for training the trainers. In practice, this involves pairing university lecturers with local DETI partners to co-create curricula. This collaboration not only ensures that the curriculum reflects the latest industry developments but also brings trainers to a level of competence where they can effectively facilitate learning in advanced digital technologies. This approach represents a new way of integrating the world of practice into the classroom. Beyond simply aligning content with job family requirements, it actively involves DETI partners and educators in a joint effort to enhance teaching capabilities. By working together, DETI and university faculty ensure that educators are equipped to deliver high-quality, relevant instruction that bridges the gap between theoretical knowledge and practical application.

European-Level Collaboration. The methodology leverages the collective strengths of three HEIs and their ecosystems, fostering a co-designed program that reflects the diverse contexts of each institution while maintaining a shared vision. This collaboration promotes best

practices, resource sharing, and a unified approach to addressing the challenges of digital transformation in business education.

By combining these innovative elements, the proposed methodology provides a forward-looking, adaptive framework that empowers business programs to meet the demands of the digital age.

3. Developing the Targeted Skills Framework (version 1.0)

The first iteration of the targeted skills framework (please see Figure 2 below) identifies eight generic clusters essential for equipping professionals with digital competencies aligned with market demands and emerging technologies.

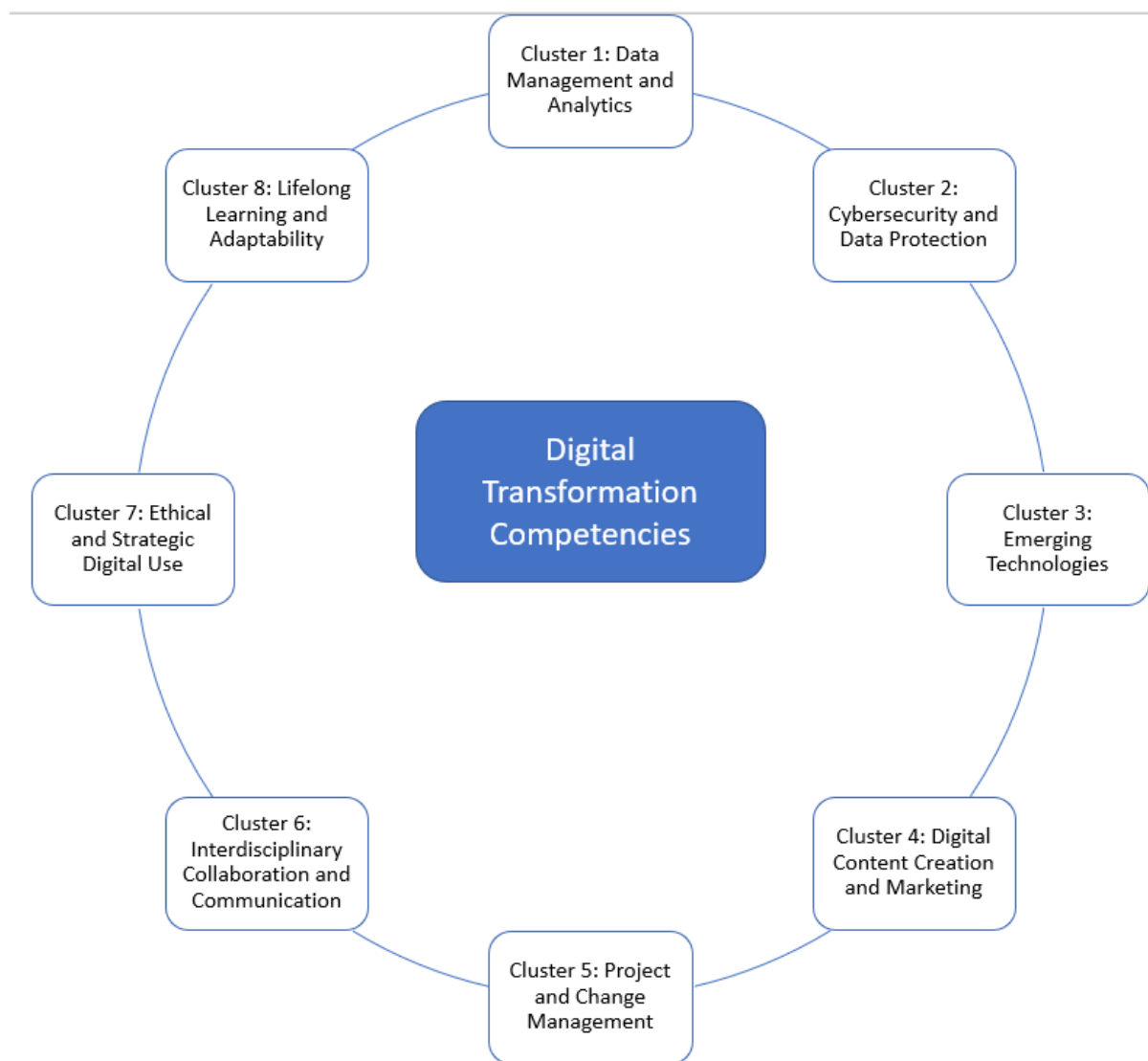


Figure 2. Targeted Skills Framework (version 1.0)

Digital Transformation Competencies emerge as a central node in competency frameworks, serving as an umbrella term for the critical skills professionals need to adapt, innovate, and lead in an increasingly digitized world.

Digital transformation is "a series of deep and coordinated culture, workforce, and technology shifts that enable new educational and operating models and transform an institution's operations, strategic directions, and value proposition" (Brooks & McCormack, 2020). Digital transformation represents the highest level of organizational and educational transformation, involving shifts in numerous areas (see Appendix 2). It is distinct from digitization (converting analog information to digital) and digitalization (applying digital processes). Unlike these, digital transformation is more complex and impactful, driving systemic change. To ensure clarity in our methodology, we provide clear definitions and distinctions among digitization, digitalization, and digital transformation, repeatedly clarifying questions to focus on transformation rather than narrower applications of technology (see Appendix 3).

The definition for each cluster, as well as reference to the data sources and analyzed frameworks, are provided in the table below.

Table 1. Clusters of Competencies with Definitions

Cluster	Definition	Sources
Data Management and Analytics	The ability to process, analyze, and interpret structured and unstructured data using tools such as Python, SQL, and data visualization platforms to support decision-making and innovation.	Labor Market Analyses, Stakeholder Interviews, Competency Mapping (e.g., European e-Competence Framework, DigComp), Literature Review (e.g., Kargas et al., 2022).
Cybersecurity and Data Protection	Understanding and navigating legal, regulatory, and policy frameworks related to digital transformation, such as data privacy, cybersecurity, intellectual property, and ethical standards in technology deployment.	European Competency Frameworks (e.g., DigComp, e-CF), Labor Market Analyses, Stakeholder Interviews, Literature Review (e.g., Blockchain Skills Forecast 2022).
Emerging Technologies	Expertise in leveraging advanced technologies, including artificial intelligence, machine learning, blockchain, IoT, and quantum computing, as well as foundational technical skills in programming, cloud computing, and cybersecurity.	Focus Group Discussions, Curriculum Benchmarking, Competency Mapping, Literature Review (e.g., Kinchin & Gravett, 2020).
Digital Content Creation and Marketing	The ability to generate and implement novel ideas and solutions, particularly in leveraging digital tools and technologies to create unique value propositions, products, or services in diverse contexts.	Design Thinking Workshop, Focus Group Discussions, Curriculum Benchmarking (e.g., EDUCAUSE Framework).

Project and Change Management	The ability to guide organizations through digital transformation by aligning technology solutions with business strategies, fostering innovation, and engaging diverse stakeholders to create value in competitive markets.	Stakeholder Interviews, Curriculum Benchmarking, Competency Mapping (e.g., EDUCAUSE Framework, OECD Learning Framework 2030).
Interdisciplinary Collaboration and Communication	The capacity to communicate complex ideas effectively, manage cross-functional teams, and leverage digital tools to foster collaboration across disciplines, industries, and cultural contexts.	Curriculum Benchmarking, Stakeholder Interviews, Labor Market Analyses (e.g., ESCO Framework).
Ethical and Strategic Digital Use	Integrating sustainability and ethical considerations into digital practices, such as ensuring responsible AI use, reducing environmental impact through sustainable computing, and fostering socially responsible innovation.	Focus Group Discussions, Literature Review, Competency Mapping (e.g., European Digital Competence Framework, DigComp).
Lifelong Learning and Adaptability	The readiness to embrace and adapt to rapid technological advancements and evolving market conditions, including continuous learning, reskilling, and cultivating a growth mindset.	Labor Market Analyses, Competency Mapping, Stakeholder Interviews, Literature Review (e.g., Kipper et al., 2021).

Within each cluster of the targeted skills framework, distinct categories were identified to ensure a structured and comprehensive understanding of the competencies required. This **cluster-based skill framework** is organized into three main categories: **Core Technical Skills**, which represent the foundational capabilities necessary for engaging with digital technologies; **Tools and Software Knowledge Skills**, which emphasize proficiency with specific tools and software integral to the field; and **Application of Skills**, which focus on the practical application of digital technologies to address real-world challenges.

The approach of categorizing competencies within clusters into Core Technical Skills, Tools and Software Knowledge Skills, and Application of Skills aligns with several established frameworks that emphasize structured skill development. For instance, the e-CF provides a clear categorization of ICT-related skills across technical, managerial, and application domains, facilitating targeted development. Similarly, the DigComp Framework identifies distinct dimensions of digital competence, including foundational knowledge, operational proficiency with tools, and the practical application of skills in solving problems and creating content.

These frameworks validate the structured categorization approach, ensuring that competencies are both comprehensive and adaptable to dynamic professional and technological landscapes. By adopting this model, the Targeted Skills Framework integrates established best practices to support holistic skill development and ensure alignment with global standards. Categorizing skills within each cluster is essential to clarify the learning pathways and to align education and training programs with both industry needs and the evolving digital landscape. Template to categorize clusters and their categories is provided in Table 2 below.

Table 2. Targeted skills framework: Template to clusters and categories' categorization

Level 1 Name of the cluster	Cluster 1: Data Management and Analytics
Level 2 Description of the cluster	The ability to process, analyze, and interpret structured and unstructured data using tools such as e.g., Python, SQL, and data visualization platforms to support decision-making and innovation.
Level 3 Core technical skills	
Tools & Software skills	
Level 4 Application of skills	

The first version of the targeted skills framework was developed prior to the implementation of the innovative methodology presented in Chapter 2. Its development was guided by a comprehensive needs assessment to ensure alignment with both current and future demands (Kargas et al., 2022; Kinchin & Gravett, 2020; Kipper et al., 2021). The process included (i) needs assessment through the stakeholder analysis, labour market analysis, and curriculum benchmarking, as well as (ii) competency mapping. A detailed description of the data collection and analysis processes used to create the initial version of the targeted skills framework is provided in Appendix 4.

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Appendices

Appendix 1. Questions to Ask Partners to Determine Methodology for Targeted Skills Framework Development

As part of our ongoing commitment to developing innovative business programs, we are seeking your valuable input to refine our proposed targeted skills framework. This survey aims to gather insights into how we can collaboratively develop a framework that evolves alongside the rapidly changing digital landscape.

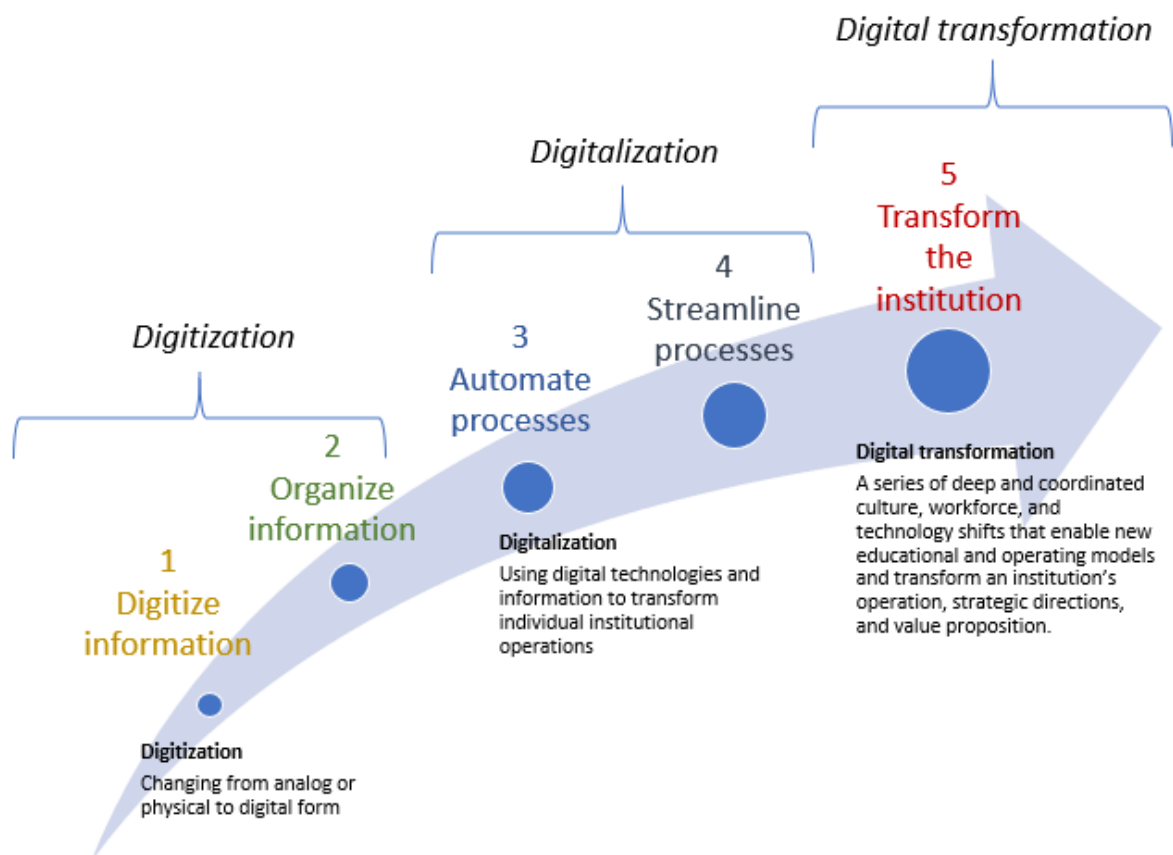
The questions below focus on the methodologies, approaches, and collaborative strategies that will drive the development and ongoing refinement of this framework. Your responses will help us identify the most effective ways to ensure that the framework remains relevant and responsive to the needs of our stakeholders.

General Methodology	
What methodologies are your institutions going to be using to ensure that this targeted skills framework evolves to meet the needs of your stakeholders?	
How will you identify the core digital skills needed by business students?	
How can you ensure that the framework aligns with the evolving needs of industry and employers?	
What data sources will you use to form the framework?	
How will you validate the framework to ensure its relevance and accuracy?	
Dynamic and Iterative Approach	
How will you establish effective feedback mechanisms to gather input from stakeholders and ensure the framework's ongoing relevance?	
What is the proposed timeline for reviewing and updating the framework?	
How will you leverage DETI's expertise to inform the framework's evolution and ensure its alignment with emerging trends?	
Partner Collaboration	
How can we share knowledge and best practices among partners to enhance the framework development?	

Appendix 2. Sources of Reference for Digital Transformation Competencies as the Central Node

Central Node	Description	Sources of Reference
Digital Transformation Competencies	Address the critical need for professionals to adapt, innovate, and lead in a rapidly digitizing world.	Stakeholder Analysis <i>Employers:</i> Identify skills gaps in strategic digital capabilities such as data-driven decision-making, digital leadership, and change management. <i>Academics:</i> Acknowledge the demand for curricula that prepare students to work with emerging technologies (e.g., AI, IoT, blockchain) and navigate ethical challenges in digital environments. Labour Market Analysis <i>Analysis of job market trends reveals a significant shift toward roles requiring digital transformation expertise:</i> Demand for data-driven decision-making, automation, and digital leadership. <i>EU, World Economic Forum and McKinsey reports:</i> Transformative competencies (adaptability, value creation), planning, data literacy, digital leadership, focus on fourth industrial revolution competencies (AI, IoT, blockchain), digital transformation managers, data strategists, and innovation consultants. Curriculum Benchmarking <i>MBA and MSc programs</i> increasingly offer courses on digital transformation, strategic innovation, and digital leadership. <i>The EDUCAUSE Digital Transformation Skills framework</i> identifies core competencies needed for digital transformation in educational setting. Frameworks and Standards <i>EQF:</i> Levels 5-8 focus on leadership, problem-solving, and strategic decision-making skills, aligning with the demands of digital transformation roles. <i>DigComp:</i> Problem solving, communication and collaboration, and digital content creation directly contribute to digital transformation competencies.

Appendix 3. Digital Transformation (adapted from EDUCAUSE, Digital Transformation Study 2020)



Appendix 4. Methodology to design Targeted Skills Framework (version 1.0)

This section outlines the methodology used to facilitate the design of the first version of the Targeted Skills Framework. The methodology (depicted in Figure 3 below) comprised several steps:

1. Define and analyze competencies and digital skills required for business students and lifelong learners through the stakeholder analysis, labour market analysis, and curriculum benchmarking;
2. The identified needs, competencies and skills are mapped based on the several current competence frameworks;
3. Identified basic components of competencies and skills are collected and structured into the first draft proposal for a conceptual framework;

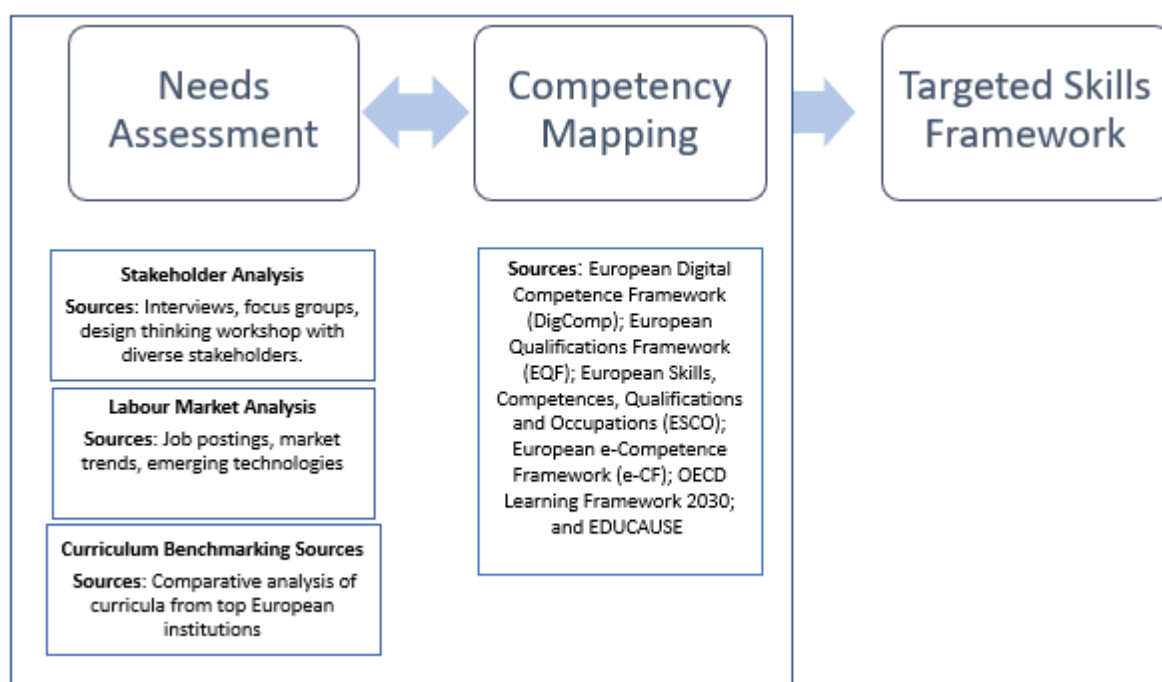


Figure 3. Phases of the Targeted Skills Framework (version 1) development

4.1. Data Collection

To develop the initial version of the Targeted Skills Framework aimed at enhancing the digital competencies and skills of master's degree business students and lifelong learners, the DIGI-

ME project adopted a structured multi-phased approach. This process was grounded in a comprehensive needs assessment to ensure alignment with current and future demands (Kargas et al., 2022; Kinchin & Gravett, 2020; Kipper et al., 2021). The process included (i) needs assessment through the stakeholder analysis, labour market analysis, and curriculum benchmarking, as well as (ii) competency mapping.

In addition to economic consequences, societal, political and cultural consequences of massive and rapid technological shifts require a socio-technical focus, where the application of these technologies for commercial purposes should yield valued societal outcomes (Mansell, 2021; Nylund et al., 2022; Galetsi et al., 2023; Senna et al., 2023). This insight further informed the development of the framework, emphasizing the importance of integrating digital competencies with societal considerations.

This methodology was chosen to create a robust, evidence-based framework that is both comprehensive and adaptable. By engaging stakeholders, analysing labour market trends, benchmarking curricula, and leveraging established frameworks, the DIGI-ME project ensures that the Targeted Skills Framework reflects real-world needs while adhering to established educational standards and is a reliable and practical tool for advancing digital education in business studies.

4.1.1. Needs Assessment

The creation of the Targeted Skills Framework began with a comprehensive needs assessment – an essential step to ensure the framework's relevance and alignment with stakeholder requirements. A needs assessment is important for identifying the competencies required to address current and emerging challenges in the labour market, particularly in sectors undergoing rapid digital transformation. It allows for the alignment of educational offerings and objectives with industry demands and societal needs, promoting employability and ensuring that learners are equipped with skills that are both actionable and future-proof. In this context, the article *Scientific Mapping to Identify Competencies Required by Industry 4.0* by Kipper et al. (2021) provided a theoretical foundation for understanding the interdisciplinary skills necessary for navigating Industry 4.0 and broader digital transformation developments.

A multi-faceted approach was undertaken to collect and analyse data, incorporating diverse perspectives and ensuring methodological rigor. First, **stakeholder analysis** was conducted to gather insights from those directly involved in or affected by digital transformation. The stakeholder analysis process incorporated an informal approach, involving brief interviews with key ecosystem partners such as program managers, faculty members, and industry

professionals, enabling an open dialogue to explore competencies, gaps, and opportunities for embedding digital skills. The questions were intentionally broad, encouraging respondents to express their perspectives freely. The design of the questionnaire was informed by two primary sources: a comprehensive review of academic literature and an analysis of existing curricula related to managing digital business. Notably, online platforms were excluded at this stage of the analysis. A design thinking workshop brought together project members to co-create innovative solutions for embedding digital skills, ensuring the framework was grounded in real-world applicability and creativity. Furthermore, a focus group on “Future of Computing” was organised involving corporations, start-ups, institutions and academia to analyse challenges, needs, competencies and skills at the light of the latest developments in computational science, such as artificial intelligence, high performance computing etc.

Complementing stakeholder input, a **labour market analysis** was carried out to examine job postings, market trends, and the emergence of new technologies. This analysis identified in-demand digital competencies and skills, ensuring that the framework addressed both current and anticipated professional opportunities. The findings from this analysis were important for tailoring the framework to the dynamic needs of the labour market.

To further validate and refine the framework, **curriculum benchmarking** was undertaken through comparative analysis of programs offered by leading European business schools and innovative e-learning platforms. This process highlighted best practices, identified gaps, and ensured that the framework integrated academic rigor with the flexibility and accessibility of online education. In addition, this process gives a comprehensive view of how digital management courses on e.g., MOOC platforms align with the EU Digital Skills Framework and where they might need enhancement. To perform this analysis, each platform was manually explored to gather data, and critically evaluate the course offerings against the EU standards.

By employing this robust and systematic approach, the needs assessment process provided a comprehensive understanding of the competencies and skills required for digital transformation, enabling the development of a targeted, actionable, and forward-looking skills framework. The integration of diverse data sources and stakeholder perspectives ensured that the framework would not only meet current demands but also anticipate future challenges, establishing its utility and reliability for guiding the integration of digital skills into business education.

Detailed information about data sources is provided in Table 3 below.

Table 3. Data Sources for Needs Assessment

Stakeholders	Data Sources	Detailed Information
Stakeholder Analysis	Unstructured interviews	<i>University of Vaasa:</i> In total five interviews were conducted - two ecosystem leaders, two program managers and one union leader. <i>University of Pavia:</i> interviews organized during MIBE Career Day 2024.
	Focus group	Key stakeholders invited to discuss the main challenges and opportunities offered by the latest computational technologies such as artificial intelligence, generative AI, high performance computing, quantum computing. Stakeholders included big corporations in energy, industry and financial services, cutting edge start-ups, high technology SMEs, research institutions, public sector, healthcare providers, service providers (strategic consultancy, legal). <i>Obloo, Milan:</i> “Discover the Future of Computing” workshop with experts organized on May 10, 2024
	Design thinking workshop with project members	The objective of this workshop was to define the various needs among the customer journey of two main stakeholders’ groups of DIGI-ME, students and enterprises (both SMEs and corporations). The output of the exercise was a set of features (services, processes, pricing and additional competencies) required to fully address the needs of these two main stakeholders. The rest of the stakeholder needs analysis that included Vaasa and Pavia, was conducted with a clear focus on creating an educational program that is learner-centric, industry-aligned, demands of the digital economy. <i>Obloo, Bergamo</i> on July 3, 2024
Labour Market Analysis	Job postings	International labour organization reports 2020, Cedefop labour and skills shortage index 2024, Cybersecurity workforce study 2022, European Union agency for cybersecurity 2023, ICT specialists in employment 2024, Future of jobs report 2023, The European data labor market 2023
	Market trends	Big data for labour market intelligence 2019, A new future of work 2024, From thinking about the next

		normal to making it work 2020, What is digital transformation? 2024, The feasibility of using big data in anticipating and matching skills needs 2020, European data market study 2021-2023, Digital Economy and Society Index 2022, The next generation Internet of Things 2023, JRC Annual Report 2020, Blockchain for supply chains and international trade 2020
	Emerging technologies	European approach to artificial intelligence, Blockchain and Web3 Strategy, Europe's Internet of Things Policy, Cloud computing, Europe's potential in edge computing 2023, Annual blockchain skills forecasts 2022, Blockchain technology 2024, Global blockchain employment report 2021, VR/AR Industrial Coalition 2022, Extended Reality 2023, XR and its potential for Europe 2021
Curriculum Benchmarking	Curricula from top European institutions	HEC Paris, London Business School, IESE Business School, ESCP Business School, SDA Bocconi School of Management, ESADE Business School, ESMT Berlin, Rotterdam School of Management, IMD, INSEAD, HEC Lausanne, University of St Gallen, WHU – Otto Beisheim School of Management, Frankfurt School of Finance and Management, ESSEC Business School
	e-Learning platforms	Cybersecurity higher education database 2018 Future Learn, mooc.fi, Coursera

4.1.2. Competency Mapping

In this phase, a comprehensive needs analysis was conducted through **competency mapping** to identify skills requirements and existing gaps to ensure the design of an educational framework is aligned with European standards and policy goals. This process involved an extensive review of European Commission reports, established competency frameworks, and academic literature to provide a credible foundation for defining digital competencies. The alignment with European Union policy objectives and the latest research reinforces the framework's scalability, coherence, and relevance for the evolving digital economy.

The identification of skills needs and the corresponding design of educational offerings were grounded in key European competency frameworks, which serve as foundational tools for understanding, categorizing, and communicating digital skills. The frameworks adopted include the **Digital Competence Framework for Citizens (DigComp)**, the **European Skills, Competences, Qualifications and Occupations (ESCO)**, and the **European e-Competence Framework (e-CF, EN 16234-1)**. Each of these frameworks contributes distinct value to the competency mapping process:

- First, **DigComp** provided a common understanding of digital competence, emphasizing the confident, critical, and responsible use of digital technologies. This framework ensured that the identified competencies align with broader EU policy goals, such as fostering digital literacy and inclusion among citizens.
- Second, **ESCO** established a shared “language” for occupations and skills, supporting job mobility and the integration of labour markets across Europe. By linking skills, competences, and qualifications, ESCO facilitated clear communication between stakeholders in education, employment, and training. In practical terms, ESCO skills and occupations are widely utilized, for example, within the Europass Profile to fill My Skills and My Interests sections.
- Third, the **e-CF (EN 16234-1)** served as a reference framework specifically designed for the Information and Communication Technology (ICT) sector. It identified 41 competences applied in the ICT workplace, presented using a common language for competences, skills, knowledge, and proficiency levels. This framework was instrumental in bridging the gap between technical expertise and broader digital skills, ensuring consistency and comparability across European education and labour markets.
- Additionally, the **EQF** was referenced to contextualize skills within qualification levels. The EQF linked learning outcomes to proficiency standards, offering a structured basis for assessing and validating digital competencies across various education and training systems.

By leveraging these frameworks, the competency mapping process ensured that the Targeted Skills Framework was developed with rigor, consistency, and relevance to both academic and professional contexts. The outcomes of this competency mapping highlight the importance of grounding digital skills development in established European standards. However, this initial mapping also acknowledges inherent challenges, such as the dynamic nature of digital transformation and the need for continuous updates as technologies evolve. These limitations, particularly in balancing generic and specific skills, underscore the iterative nature of the framework.

Detailed information about data sources of competency mapping is provided in the Table 4 below.

Table 4. Data Sources for Competency Mapping

	Data Sources	Detailed Information
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Competency Mapping	EU reports	European Qualifications Framework (EQF); European Digital Competence Framework (DigComp)
	Existing competency frameworks	European Skills, Competences, Qualifications and Occupations (ESCO); European e-Competence Framework (e-CF); OECD Learning Framework 2030; and EDUCAUSE
	Literature review	Kargas, A., Giannakis, A., & Foukas, I. (2022). Recognizing Skills and Competencies Required Under Industry 4.0's Framework for Achieving Business Digital Transformation. In Management Strategies for Sustainability, New Knowledge Innovation, and Personalized Products and Services (pp. 1-34). IGI Global. Kinchin, I. M., & Gravett, K. (2020). Concept mapping in the age of Deleuze: Fresh perspectives and new challenges. Education sciences, 10(3), 82. Kipper, L. M., Iepsen, S., Dal Forno, A. J., Frozza, R., Furstenau, L., Agnes, J., & Cossul, D. (2021). Scientific mapping to identify competencies required by industry 4.0. Technology in Society, 64, 101454.

4.2. Methods of Analysis

To analyze the data generated from needs assessments, stakeholder analysis, labour market analysis and curriculum benchmarking, and to convert it into a Targeted Skills Framework, a **thematic analysis approach** was applied (Braun & Clarke, 2006; Naeem et al., 2023). This method allows to systematically identify, categorize, and visualize the competencies and their interconnections. Thematic analysis involves identifying, analyzing, and organizing patterns (themes) within qualitative data (Braun & Clarke, 2006). This method has ensured that each digital skill is grouped into relevant clusters based on its core functionality, application, and alignment with the defined themes.

4.2.1. Thematic analysis

Thematic analysis is a systematic approach to data analysis that includes 6 steps. The analysis follows a step-by-step process to understand the research data. Each step builds on the last, leading to a complete understanding of the data. Detailed steps of the analysis are summarized in Figure 4 below:

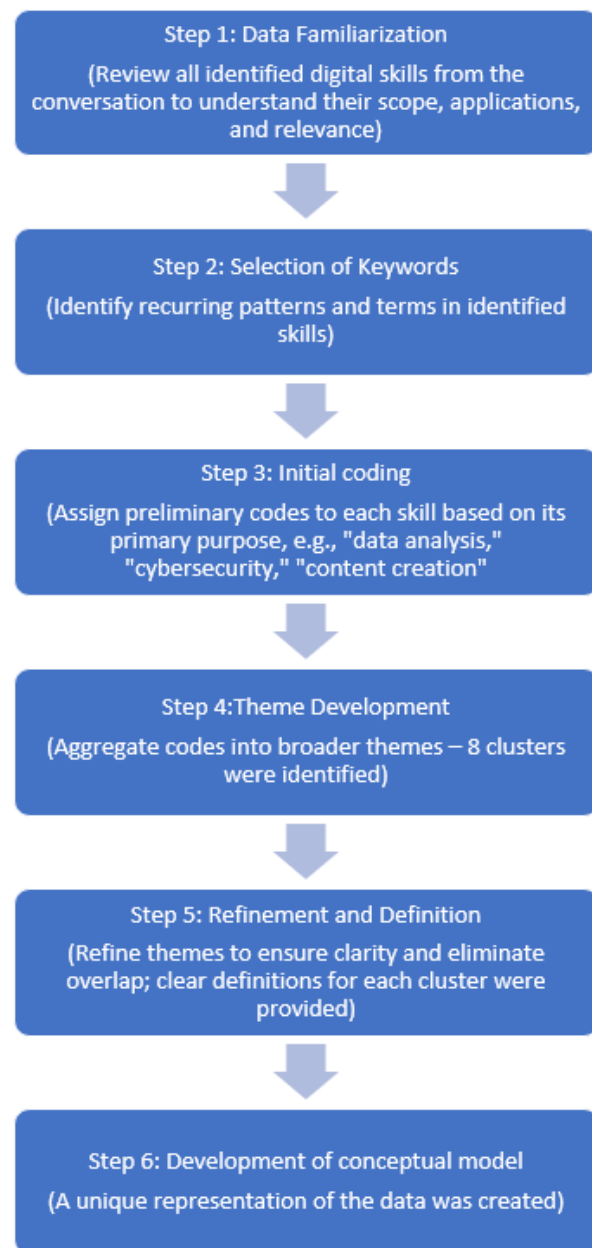


Figure 4. Thematic analysis approach

As a result of the thematic analysis, 8 clusters of digital competencies were identified. These clusters are discussed in more detail in the Findings section.

4.3. Findings from the needs assessment

This section presents the findings achieved to date, including the initial version of the Targeted Skills Framework, which will continue to be developed through collaboration between various stakeholders, especially via local ecosystem partners. The iterative methodology employed throughout the process is discussed, showcasing how the initial version of framework has been shaped through various *stakeholder analysis* and *labour market analysis*, which is then validated against *competency mapping* and *academic benchmarks*.

4.3.1. Stakeholder analysis

Stakeholder analysis reveals the critical roles and challenges faced by different actors in addressing technological, competency, and business model challenges in the digital landscape. This section examines the unique contributions and needs of universities and research institutions, startup companies, and big companies, highlighting their technological focus areas, required competencies, and business challenges (see Appendix 2 for detailed description of data sources for needs assessment).

Universities and research institutions are at the forefront of advancing knowledge in quantum computing, AI, and sustainable computing solutions. They face challenges such as securing funding, protecting intellectual property while collaborating with industry, and balancing the dual objectives of academic publication and applied innovation. Startups are driving innovation in areas like edge quantum computing and AI-powered diagnostics, requiring agility, domain-specific expertise, and strong business development skills to navigate regulatory landscapes and attract investment. Big companies, on the other hand, focus on integrating cutting-edge technologies like exascale computing and quantum-safe cryptography into their existing products and services, requiring robust project management and cybersecurity expertise while addressing sustainability and legacy system challenges.

The key findings are summarized in the table below underlining the interconnected nature of technological, competency, and business challenges across stakeholders. It also highlights the necessity for collaboration and targeted investments to address gaps and leverage emerging opportunities effectively.

Table 5. Summary of stakeholder analysis findings

Stakeholder	Technological Trends	Competencies Required	Challenges
Students	Chat GPT, Python, database management, AI	- Understanding IT operations to bridge the gap between IT and business - Data management (clearing, modelling, and managing data) - The basics of SQL - Effective interdisciplinary communication - Understanding AI - Leverage digital skills to create value propositions and solutions (application of digital competencies and skills) - Continuous learning mindset and adaptability	- Extensive course content and lack of prior knowledge - Increase practical, task-oriented exercises over theoretical lessons
Universities and Research Institutions	- Quantum computing algorithms - Advanced AI models - Sustainable computing solutions	- Interdisciplinary research skills - Quantum physics expertise - AI and machine learning proficiency	- Securing research funding - Balancing academic publication with IP protection - Industry collaboration
Start-up Companies	- Edge quantum computing - AI-powered medical diagnostics - Computational drug discovery	- Agile development practices - Domain-specific expertise (e.g., healthcare, materials science) - Business development skills	- Navigating regulatory environments - Scaling operations - Attracting investment
Big Companies	- Exascale computing - AI integration in existing products - Quantum-safe cryptography	- Large-scale project management - Legacy system integration - Cybersecurity expertise	- Adapting to rapid technological changes - Competing with agile start-ups - Managing energy consumption and sustainability

In addition, Table 6 below summarizes the legend of needs identified during a design thinking workshop with project members:

Table 6. Findings from Design Thinking Workshop

Legend of Needs	
Students	Corporates
Affordability	Mix business as usual and innovation
International experience, meet other cultures	Alignment with company's culture and values – try before you buy
Hands-on experience	Match mutual needs
Best career match	Talent retention
Be part of a network accelerating my career	Nurture critical thinking
Wellbeing, soft landing	Employer branding
Continuous learning	

4.3.2. Labour market analysis

The findings draw upon various reports, studies, and analyses conducted by reputable organizations and institutions across Europe, including the European Commission, EU agencies, industry associations, and research institutes (see Appendix 2). It is important to note that the demand for specific digital skills varies across regions and industries within Europe. Therefore, continuous monitoring of labor market trends is crucial to staying updated on evolving skill requirements.

The key findings from the labour market analysis illustrate that advanced technology jobs are driving job growth (The future of jobs report, 2025). The future of work will require that the workforce be able to upskill and reskill their capabilities, that is, acquire new competencies to help in their current roles and learn new capabilities to take on different or entirely new roles to adapt to the digital transformation (Fonseca & Picoto, 2020; Goulart et al., 2022; Kargas et al., 2022). The current demand for digital skills is in advanced IT as well as in non-tech roles. There is a substantial need for specialists in areas like cybersecurity, data analysis, and software development. The European labour market is experiencing shortages in these professions, indicating a pressing requirement for qualified individuals. The future demand for skills is in emerging technologies where significant growth is anticipated in AI, blockchain, extended reality (XR), internet of things (IoT), and blockchain requiring specialized skills.

Below are the results from the labor market analysis, highlighting in-demand digital skills in Europe both currently and for the future:

Table 7. Summary of labour market analysis findings

Stakeholder analysis	Identified areas of need	Identified current in-demand digital skills	Identified future in-demand digital skills
Labour market analysis	Advanced IT skills	Cyber security, data analysis, data science, data monetization, big data analytics, business intelligence, database and network, data engineering, software development	AI and ML expertise, advanced data analytics, cyber security, technical support, user interface and experience design, computational thinking skills
	Digital skills in non-technical roles	Cloud computing skills, sustainability	Integration of digital skills in all professional domains: e.g., project management, strategy, procurement, risk management, supply chain, green transition, problem visualization, communication, critical thinking, problem-solving, leadership, teamwork
	Emerging technologies	Limited current demand in AI, blockchain, XR, IoT	AI, blockchain, XR, IoT, edge computing, cloud computing, augmented and virtual reality, robotic process automation

It is important to note that the labor market analysis suggests employers may be overly focused on technologies and tools. A key recommendation is to avoid neglecting soft skills, such as empathy and communication, and instead seek well-rounded learners. The analysis reveals that while soft skills evolve gradually over the years, hard skills undergo drastic transformations as technology advances. Hard skills primarily involve an individual's ability to solve specific problems, whereas soft skills shape the approach to problem-solving. Soft skills are particularly relevant to *collaboration, problem-solving, decision-making, and adaptability*.

The analysis of the labour market also highlights a pressing need to bridge the gap between the demand for digital skills and their availability in the workforce. This challenge extends beyond technical proficiency, emphasizing the importance of integrating digital skills with strategic thinking to align digital transformation initiatives with organizational goals and market dynamics. Additionally, the human and social dimensions of digital transformation are

critical, requiring attention to change management, employee engagement, and the evolution of organizational culture.

To address these gaps, interdisciplinary approaches are essential. These involve understanding how digital skills influence human resource dynamics and managerial practices, promoting collaboration between technical and non-technical roles. By embedding digital competencies across professional domains and aligning them with strategic objectives, organizations can better navigate the complexities of digital transformation while cultivating a workforce equipped to thrive in a rapidly evolving digital economy.

4.3.3. Curriculum benchmarking

An analysis of leading 15 European business schools (Financial Times European Business School Rankings, QS World University Rankings) specializing in digital skills and management highlights their strategic focus on preparing students for the challenges of a digitally transformed economy (Appendix 2). Programs emphasize critical areas such as digital innovation, data analytics, digital transformation strategies, and technology management. Common trends include strong partnerships with industry leaders, integration of hands-on projects, and a focus on interdisciplinary learning that bridges business and technology. Many schools also prioritize entrepreneurial skills and digital business model development, ensuring graduates are well-equipped to drive innovation in various sectors.

The benchmarking reveals that top programs incorporate practical components such as digital labs, industry projects, and collaborations with tech firms, reflecting a commitment to applied learning. Additionally, schools are increasingly addressing emerging digital technologies and promoting innovation-driven entrepreneurial mindsets.

Table 8. Summary of digital skills offered by leading European business schools

University	Program	Digital Skills Focus
HEC Paris	MSc in Data Science for Business	Data analysis, machine learning, digital transformation
London Business School	MBA with Digital Business Electives	Digital innovation, data analytics, technology strategy
IESE Business School	MBA with Digital Business Specialization	Digital strategy, innovation, technology management
ESCP Business School	MSc in digital project management & Consulting	Digital project management, IT strategy, consulting
SDA Bocconi School of Management	MSc in digital Innovation and New Business Design	Digital innovation, entrepreneurship, new business models

ESADE Business School	MSc in Digital Business	Digital transformation, e-commerce, digital marketing
ESMT Berlin	MSc in Innovation and Entrepreneurship	Digital transformation, entrepreneurial skills, tech innovation
Rotterdam School of Management	MSc in Business Information Management	Data analytics, digital business strategies, IT management
IMD	MBA with Digital Strategy Electives	Digital strategy, data analytics, innovation management
INSEAD	MBA with Digital Strategy Specialization	Digital innovation, business analytics, technology management
HEC Lausanne	MSc in Information Systems	Digital business, IT management, data analytics
University of St Gallen	MSc in Business Innovation	Innovation management, digital business models, technology entrepreneurship
WHU – Otto Beisheim School of Management	MSc in Entrepreneurship and Digital Transformation	Digital business transformation, entrepreneurial skills, innovation strategies
Frankfurt School of Finance and Management	MSc in Digital Business	Digital business models, IT strategy, data analytics
ESSEC Business School	Advanced Master in Strategy & Management of International Business	Digital transformation, global business strategies, innovation

This benchmarking exercise illustrates the diversity of digital competencies being addressed and the innovative methods employed to prepare students for leadership roles in the digital age.

In addition to the curriculum benchmarking from the top universities, the analysis of online learning platforms was conducted (Appendix 2). The analysis of online learning platforms underlines their potential to complement traditional university education by offering modular, flexible, and industry-relevant learning experiences. These platforms provide insights into current digital skills and competencies, addressing gaps and identifying opportunities for improvement in traditional education approaches. A thorough analysis of online learning platforms focused on courses related to digital management, including the following digital competence areas:

- Data Management and Analytics
- Digital Marketing and Communication
- Cybersecurity and Data Protection
- Software Development and Programming

- Technology and Innovation Management

Online platforms offer a broader and deeper range of courses compared to individual universities. Many introductory courses are free and incorporate practical skills, often requiring real-world application. This underscores the need for universities to enhance hands-on engagement through partnerships with local business ecosystems. Many courses, often developed in collaboration with universities or consulting firms, implicitly align with EU framework such as DigComp, ESCO, and e-CF. While online platforms excel in flexibility and modularity, universities have the advantage of providing immersive, hands-on learning experiences.

4.3.4. Competency Mapping

The competency mapping analysis integrates key frameworks such as the European Qualifications Framework (EQF), European Digital Competence Framework (DigComp), European Skills, Competences, Qualifications and Occupations (ESCO), European e-Competence Framework (e-CF), OECD Learning Framework 2030, and EDUCAUSE (see Appendix 2). These frameworks collectively define a structured approach to understanding and addressing digital skills requirements across different sectors and proficiency levels.

Competency mapping highlights the integration of digital skills across multiple frameworks, emphasizing both foundational and advanced competencies. Frameworks like EQF and DigComp ensure scalability and progression in digital expertise, while ESCO and e-CF provide alignment with job-specific and ICT workplace needs. OECD and EDUCAUSE expand the focus to transformative and instructional digital skills, respectively, ensuring preparedness for future challenges in education and the digital economy.

Table 9. Summary of relevant digital skills based on competency mapping

Framework	Core Digital Skills	Key Applications
EQF	- Basic digital literacy - Advanced digital expertise (e.g., data analytics, AI)	- Structured progression from foundational to advanced skills across all sectors
DigComp	- Information and data literacy - Communication and collaboration - Digital content creation - Safety - Problem solving	- Effective navigation and creation in digital environments
ESCO	- Role-specific digital skills - Cross-cutting skills (e.g., problem-solving, adaptability)	- Alignment with labor market needs and enhanced job mobility

e-CF	- ICT-specific competences (e.g., software development, cybersecurity)	- Workforce readiness for technology-driven roles
OECD Learning Framework	- Critical thinking - Creativity - Collaboration and resilience	- Addressing complex challenges in the digital economy
EDUCAUSE	- Digital fluency - Data-informed decision-making - Instructional technology	- Preparing educators and learners for technology-enhanced teaching and learning

Key Insights:

- **European Qualifications Framework (EQF):** Focuses on a lifelong learning perspective, categorizing skills and competencies into eight levels, emphasizing the progression from foundational to advanced expertise.
- **European Digital Competence Framework (DigComp):** Identifies five competence areas—Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving—crucial for navigating digital environments effectively.
- **European Skills, Competences, Qualifications and Occupations (ESCO):** Offers a taxonomy linking skills, competences, qualifications, and occupations, fostering job mobility and aligning skills with labor market needs.
- **European e-Competence Framework (e-CF):** Provides 41 ICT-related competences structured across five proficiency levels, addressing needs specific to the technology workplace.
- **OECD Learning Framework 2030:** Emphasizes transformative competencies such as critical thinking, creativity, collaboration, and resilience, aligning education with the evolving demands of a digital economy.
- **EDUCAUSE:** Focuses on higher education, highlighting digital fluency, instructional technology, and data-informed decision-making as essential skills for educators and learners.

4.4. Thematic Analysis of Digital Competencies and Skills

Identification

A thematic analysis was conducted to identify digital competencies and relevant skills for business students. To ensure methodological rigor and relevance to industry needs, the multi-faceted approach integrated data from diverse sources. The process included six key steps.

Step 1: Data Familiarization

The analysis began with an extensive review of data sources, including stakeholder interviews and discussions, labour market analyses, curriculum benchmarking and competency mapping. A detailed description of the data sources is provided in Appendix 2.

Step 2: Selection of Key Words

During this step, keywords were identified in the findings from all data sources. Table 10 below outlines each data source and identifies relevant key terms and phrases associated with digital competencies and skills. These keywords will help focus the analysis and coding in subsequent steps.

Table 10. Data Sources and Relevant Keywords

Data Sources	Relevant Keywords
Stakeholder interviews and discussions	Digital transformation Hands-on learning Competency gaps Industry alignment Interdisciplinary collaboration AI and machine learning Data-driven decision-making Business ecosystems Local partnerships Practical applications
Focus Group Discussions	High-performance computing AI-driven innovation Quantum computing Interdisciplinary skills Computational problem-solving Edge computing Sustainable computing Industry-academia collaboration Advanced modeling techniques
Labour Market Analyses	Digital skills gap AI and automation Cybersecurity expertise Data analysis Big data analytics Emerging technologies Digital marketing Digital transformation readiness

	Workforce adaptability Continuous upskilling Industry 4.0 Job market trends
Curriculum Benchmarking	Modular learning Data management Agile project management Technology adoption Practical simulations Capstone projects Digital content creation Digital transformation
Competency Frameworks	Information and data literacy Digital communication Content creation Cybersecurity and safety Problem-solving Advanced digital skills Competence mapping Digital transformation Ethical digital use Interpersonal collaboration
Literature Review	Industry 4.0 Business digital transformation Personalized learning pathways Concept mapping Competency alignment Knowledge innovation Data visualization Digital transformation Strategic leadership Digital economy
Technological Trends	Blockchain technology Extended reality (XR) Internet of Things (IoT) Quantum-safe cryptography AI-powered diagnostics Smart manufacturing Digital twin Data integrity

Step 3. Initial coding

In this step, the identified keywords from Step 2 were analyzed and grouped into initial codes. By identifying recurring keywords and concepts, the coding process refined critical areas of focus such as practical applications, interdisciplinary collaboration, emerging technologies, ethical digital use, and advanced computing. Each code was grounded in the context and frequency of its appearance across sources. These codes were then used as the foundation for clustering competencies and skills into meaningful themes. Table 11 outlines the emergence of initial codes.

Table 11. Initial Codes

Data Sources	Relevant Keywords	Initial Codes
Stakeholder Interviews and Discussions	Hands-on learning Practical applications Continuous learning Reskilling opportunities Competency gaps Industry alignment Interdisciplinary dialogue AI and machine learning Data-driven decision-making Business ecosystems Local partnerships Business intelligence	→ Digital Transformation → Cross-Functional Teamwork → Stakeholder Engagement → Interdisciplinary Collaboration → Business Intelligence → AI and Machine Learning Integration → Continuous learning mindset
Focus Group Discussions	High-performance computing Machine learning AI-driven innovation Quantum computing Interdisciplinary skills Computational problem-solving Edge computing Sustainable computing Industry-academia collaboration Advanced modeling techniques Data cleaning Data modeling	→ Advanced Computing Skills → AI-Driven Problem Solving → Sustainable Digital Solutions → Collaboration for Innovation
Labour Market Analyses	Digital skills gap AI and automation Cybersecurity expertise	→ Emerging Technology Proficiency → Digital transformation

	Data analysis Big data analytics Data privacy Implementing secure systems Emerging technologies Digital marketing Digital transformation readiness Workforce adaptability Continuous upskilling Industry 4.0 Blockchain technology IoT application Adaptability to technological change	→ Continuous Learning and Adaptability → Digital Marketing and Communication → Data privacy → Cybersecurity Expertise → Risk Management → Data literacy
Curriculum Benchmarking	Modular learning Data management Agile project management Technology adoption Practical simulations Capstone projects Digital content creation Digital branding Creative storytelling Platform-specific marketing Change management frameworks Digital transformation	→ Big Data Proficiency → Effective Digital Communication → Digital Economy Insights → Addressing Regional Needs → Technology Proficiency in Practice → Project and Change Management → Digital Content Creation
Competency Frameworks	Information and data literacy Digital communication Content creation Cybersecurity and safety Problem-solving Advanced digital skills Competence mapping Digital transformation Ethical digital use Interpersonal collaboration Sustainable technology solutions	→ Foundational Digital Literacy → Advanced Problem-Solving Skills → Cybersecurity frameworks → Ethical and Responsible AI Use → Collaborative Digital Work → Interdisciplinary Dialogue → Cross-functional Teamwork → Data Visualization
Literature Review	Industry 4.0 Business digital transformation Personalized learning pathways Concept mapping Competency alignment Knowledge innovation Data visualization Digital transformation	→ Strategic Digital Leadership → Data-Driven Innovation → Personalized Competency Development → Industry 4.0 Readiness → Ethical AI practice

	Strategic leadership Digital economy Continuous learning mindset Sustainable technology solutions	
Technological Trends	Blockchain technology Extended reality (XR) Internet of Things (IoT) Quantum-safe cryptography AI-powered diagnostics Smart manufacturing Digital twin Data integrity	→ Specialized Tech Proficiency → Secure and Reliable Systems → Smart Systems and Integration

Step 4: Theme Development

In this stage, the initial codes were analyzed and grouped into broader themes, forming clusters of competencies that reflect the interconnected and interdisciplinary nature of digital skills required in business contexts. These themes were developed by examining patterns, relationships, and overlaps among the codes while maintaining alignment with the data sources. Themes developed are represented in the table below.

Table 12. Theme Development

Data Sources	Initial Codes	Theme development
Stakeholder interviews, labour market analyses, curriculum benchmarking	→ Data Proficiency → Data Literacy → Business Intelligence	Data Management and Analytics
Labour market analysis, competency frameworks	→ Data Privacy → Risk Assessment → Cybersecurity Frameworks	Cybersecurity and Data Protection
Focus group, curriculum benchmarking, technological trends	→ Advanced Computing Skills → Specialized Tech Proficiency → Technology Proficiency in Practice	Emerging Technologies

Curriculum Benchmarking, labour market analysis, competency frameworks	→ Digital Content Creation → Digital Marketing and Communication → Data Visualization → Project and Change Management	Digital Content Creation and Marketing
Across all data sources	→ Stakeholder Engagement → Collaboration for Innovation → Digital Transformation → Advanced Problem-Solving Skills → Strategic Digital Leadership	Project and Change Management
Stakeholder interviews, competency frameworks, focus group discussions	→ Interdisciplinary Collaboration → Cross-Functional Teamwork → Collaboration for Innovation	Interdisciplinary Collaboration and Communication
Competency frameworks, literature review	→ Ethical AI practice → Ethical and Responsible AI Use	Ethical and Strategic Digital Use
Stakeholder interviews, labour market analysis	→ Continuous Learning and Adaptability → Continuous learning mindset	Lifelong Learning and Adaptability

Step 5: Refinement and Definition

In this step, we refine and define the clusters identified in Step 4. Each cluster is defined with reference to the data sources and frameworks mentioned earlier. The definition for each cluster is provided in the table below.

Table 13. Clusters of Competencies with Definitions

Cluster	Definition	Sources
Data Management and Analytics	The ability to process, analyze, and interpret structured and unstructured data using tools such as Python, SQL, and data visualization platforms to support decision-making and innovation.	Labor Market Analyses, Stakeholder Interviews, Competency Mapping (e.g., European e-Competence Framework, DigComp), Literature Review (e.g., Kargas et al., 2022).
Cybersecurity and Data Protection	Understanding and navigating legal, regulatory, and policy frameworks related to digital transformation, such as data privacy, cybersecurity, intellectual property, and ethical standards in technology deployment.	European Competency Frameworks (e.g., DigComp, e-CF), Labor Market Analyses, Stakeholder Interviews, Literature Review (e.g., Blockchain Skills Forecast 2022).
Emerging Technologies	Expertise in leveraging advanced technologies, including artificial intelligence, machine learning, blockchain, IoT, and quantum computing, as well as foundational technical skills in programming, cloud computing, and cybersecurity.	Focus Group Discussions, Curriculum Benchmarking, Competency Mapping, Literature Review (e.g., Kinchin & Gravett, 2020).
Digital Content Creation and Marketing	The ability to generate and implement novel ideas and solutions, particularly in leveraging digital tools and technologies to create unique value propositions, products, or services in diverse contexts.	Design Thinking Workshop, Focus Group Discussions, Curriculum Benchmarking (e.g., EDUCAUSE Framework).
Project and Change Management	The ability to guide organizations through digital transformation by aligning technology solutions with business strategies, fostering innovation, and engaging diverse stakeholders to create value in competitive markets.	Stakeholder Interviews, Curriculum Benchmarking, Competency Mapping (e.g., EDUCAUSE Framework, OECD Learning Framework 2030).
Interdisciplinary Collaboration and Communication	The capacity to communicate complex ideas effectively, manage cross-functional teams, and leverage digital tools to foster collaboration across disciplines, industries, and cultural contexts.	Curriculum Benchmarking, Stakeholder Interviews, Labor Market Analyses (e.g., ESCO Framework).
Ethical and Strategic Digital Use	Integrating sustainability and ethical considerations into digital practices, such as ensuring responsible AI use,	Focus Group Discussions, Literature Review, Competency Mapping (e.g.,

	reducing environmental impact through sustainable computing, and fostering socially responsible innovation.	European Digital Competence Framework, DigComp).
Lifelong Learning and Adaptability	The readiness to embrace and adapt to rapid technological advancements and evolving market conditions, including continuous learning, reskilling, and cultivating a growth mindset.	Labor Market Analyses, Competency Mapping, Stakeholder Interviews, Literature Review (e.g., Kipper et al., 2021).

Step 6: Development of Targeted Skills Framework

The first iteration of the targeted skills framework (please see Figure 2 above), based on the findings presented above, identifies eight generic clusters essential for equipping professionals with digital competencies aligned with market demands and emerging technologies.