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SKILLS FOR SMART SPECIALISATION IN MONTENEGRO

Aligning skills, technologies and productivity in the ‘Construction’ priority domain

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Authors: Pirita Vuorinen (ETF), Biljana Šćepanović (local expert)

Peer reviewer: Cristina Mereuta (ETF)

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EXECUTIVE SUMMARY

Montenegro's *Construction* domain benefits from strong engineering traditions, established material production, and alignment with EU regulatory frameworks. However, productivity and competitiveness are constrained by slow technology uptake, skills shortages, and limited responsiveness of education and training systems.

Smart specialisation, as an EU innovation policy approach designed to boost economic competitiveness, requires a clear strategic focus. Achieving its objectives depends on prioritising a limited number of high-impact technology clusters, addressing structural skills bottlenecks, and mobilising the skills ecosystem around clearly defined priority action areas.

Top 3 high-impact technology clusters

Digital design and modelling technologies
Computer-aided design, Building Information Modelling (BIM), Digital Twin applications, and digital documentation workflows that support integrated project delivery, coordination, and lifecycle management.

Monitoring, sensing and inspection technologies
Sensors, non-destructive testing (NDT), drones, computer vision systems, and digital safety and quality monitoring tools used for inspection, asset management, and real-time site oversight.

Energy-efficient and smart building systems
Building Management and Automation Systems (BMS/BAS), digital energy management solutions, smart controls, and technologies supporting energy-efficient construction and renovation.

Core skills bottlenecks

Severe shortages of technicians and skilled trades
Construction technicians, installers, equipment operators, maintenance staff, and inspection technicians are in short supply. These profiles are essential for operating digital tools, sensing equipment, smart building systems, and modern construction processes.

Insufficient practical and job-ready skills
VET and higher education programmes remain largely theoretical. Limited access to modern equipment, digital tools, and structured work-based learning reduces graduates' readiness for technology-enabled construction environments.

Weak digital competences at operational level
Many technicians and site workers lack practical skills in digital workflows, data entry, model maintenance, and use of monitoring devices. This constrains the routine use of BIM, sensors, and digital inspection tools.

Limited skills for energy-efficient and smart systems
Competences related to installation, commissioning, operation, and maintenance of BMS/BAS and energy-efficient building technologies remain fragmented and insufficiently scaled.

Underdeveloped adult learning and upskilling pathways
Upskilling relies heavily on informal, company-based training. The limited availability of short modular courses, micro-credentials, and certified requalification pathways slows workforce adaptation.

Institutional and administrative capacity gaps
Skills shortages within public administration affect procurement, permitting, and regulatory enforcement, weakening demand signals for digitalisation and sustainability-driven occupations.

Three priority action areas

Priority action area 1: Strengthen digital design and modelling skills across the construction sector

Focus on embedding CAD, BIM, and Digital Twin workflows across all qualification levels, with particular emphasis on practical technician competences in digital drafting, documentation, and model maintenance.

Roles across the skills ecosystem:

- **VET providers**: Modernise curricula to include hands-on digital design training; expand structured work-based learning.
- **Higher education**: Strengthen applied digital construction modules and interdisciplinary programmes; deepen cooperation with industry.
- **Adult learning & BSOs**: Deliver certified short courses, digital bootcamps, and shared access to software and digital construction labs for SMEs.

Priority action area 2: Advance skills for monitoring, sensing and inspection technologies

Build technician-level capacity to operate sensors, drones, NDT tools, and digital inspection systems, improving safety, quality control, and lifecycle management.

Roles across the skills ecosystem:

- **VET providers:** Integrate practical inspection and monitoring modules; establish school-based inspection labs.
- **Higher education:** Introduce advanced and interdisciplinary courses in structural monitoring and digital inspection.
- **Adult learning & BSOs:** Scale short, practice-oriented training, certification routes, and shared access to inspection equipment.

Priority action area 3: Strengthen skills for energy-efficient and smart building systems

Develop practical competences for installing, operating, and maintaining smart building and energy-management systems, supporting renovation and energy performance objectives.

Roles across the skills ecosystem:

- **VET providers:** Embed smart building and energy-efficiency training with hands-on practice.
- **Higher education:** Expand interdisciplinary programmes linking construction, energy, automation, and ICT.
- **Adult learning & BSOs:** Provide modular upskilling, certification for installers and maintenance staff, and advisory support for SMEs.

Key message for decision makers

The construction sector is undergoing a massive renewal driven by the green transition, digitalisation, and circularity. Montenegro’s construction sector’s competitiveness will depend on tackling **technician-level skills shortages** as a first priority, increasing the **practical orientation** and **flexibility of education and training**, and **scaling adult learning** beyond isolated initiatives. Concentrated investment in digital design, monitoring and inspection, and smart building technologies can raise productivity and accelerate technology adoption. **Stronger alignment across VET, higher education, adult learning, and business support** is essential to strengthen the sector’s contribution to the green and digital transition.

1. INTRODUCTION

1.1 The construction sector in Europe's competitiveness and green transition

Economic weight and employment relevance of the construction sector. Construction is the second-largest industrial ecosystem in the EU and remains a major contributor to growth and job creation, despite being strongly affected by the financial and economic crisis. The sector provides around 18 million direct jobs, supports approximately 25 million workers, and accounts for about 9% of EU GDP, making it central to Europe's economic resilience and social cohesion.

Highly fragmented industry structure dominated by SMEs. The sector consists of around 5.3 million enterprises, over 99% of which are SMEs. Construction projects typically rely on complex subcontracting chains and specialised expertise, making coordination, quality assurance, and skills availability critical for delivering economic, social, environmental, and energy objectives.

Housing demand pressures and efficiency challenges. Construction plays a key role in addressing Europe's housing challenges, as demand for affordable housing continues to outpace supply due to urbanisation, population growth, rising material costs, labour shortages, and increasingly complex regulatory requirements. High land prices, zoning constraints, and lengthy permitting procedures further contribute to cost pressures and project delays, underscoring the need for more efficient construction methods and streamlined administrative processes (EU, 2025).

Renovation imperative and climate policy drivers. Building renovation has become a strategic priority. Europe's ageing and energy-intensive building stock accounts for 40% of EU energy consumption and 36% of related emissions, while renovation rates remain low at around 1% annually. The European Green Deal and the Renovation Wave Strategy aim to accelerate renovation, reduce energy poverty affecting 34 million Europeans, and support climate neutrality by 2050 through the renovation of 35 million buildings by 2030 (EC, 2020).

Resource intensity and circular economy pressures. Construction is one of the most resource-intensive sectors, accounting for around 50% of raw material consumption (EC, 2026) and using 1.6 billion tonnes annually in the EU (EP, 2023). Improving productivity, reducing waste, and increasing the use of secondary materials are therefore essential for lowering environmental impacts and strengthening supply-chain sustainability.

Persistent skills shortages and unequal firm capacity. Despite these advances, the sector faces persistent shortages of skilled labour, driven by an ageing workforce, declining attractiveness of construction careers, and rising technical complexity (EC, 2025). These shortages contribute to project delays, higher costs, and risks to quality. While large firms are generally better positioned to invest in training and cleaner technologies, SMEs and subcontractors face greater constraints, particularly in accessing training and low-emission equipment.

1.2 Montenegro's smart specialisation context and policy objectives

Montenegro is preparing its second Smart Specialisation Strategy for the period 2026–2031. Within this process, the European Training Foundation (ETF) has been requested to provide analytical support focused on identifying skills needs for the implementation of the strategy. This includes identifying skills needs for strengthening productivity, competitiveness, and technology adoption, while ensuring alignment with European policy priorities, including the Competitiveness Compass and the Union of Skills.

The scope of the analysis was defined around the objectives for smart specialisation defined through the Entrepreneurial Discovery Process (EDP) which was conducted in compliance with the smart specialisation methodological framework and the European Commission's EDP guidelines. In addition to the European Commission's EDP guidelines, the process was carried out in line with the *Methodology for Policy Development, Drafting and Monitoring of Strategic Planning Documents* prescribed by the Secretariat-General of the Government of Montenegro.

The Entrepreneurial Discovery Process (EDP) resulted in the definition of the following vision, strategic objectives and operational objectives in the priority domain *Construction*:

Figure 1. Vision and the strategic objectives of the priority domain Construction

Vision: By 2035/2040, the construction sector is to be transformed into a sustainable, resilient, and digitalised industry, contributing significantly to regional development and delivering high-quality, efficient projects, trough utilisation of digital tools, enhanced workforce skills and certification, improved administrative and regulatory frameworks, promotion of sustainable local production and recycling, and the adoption of green materials.

Strategic objective: By 2031, Montenegro is to increase productivity in the construction sector by at least 25% trough the adoption of innovative solutions, digital tools and green technologies, supported by mandatory workforce training and certification, reformed education and employment policies, and an efficient regulatory and institutional framework.

Source: Bole D, al (2026), Final report on the Entrepreneurial Discovery Process (EDP) implemented in the preparation of the smart specialisation strategy 2026-2031.

During the Inception phase, the specific focus areas for the priority domain were clarified as outlined in Table 1.

Table 1. Constructions: Priority domain and sub-sectors for the analysis

Sub-sectors	NACE Codes (In-Scope)	Out-of-Scope
I level of priority Construction, maintenance, and safety of roads and highways Construction and maintenance of hydraulic infrastructure Construction design and engineering Construction, maintenance, renovation of buildings II level of priority Manufacture of construction materials and products Recycling and repurposing for construction purposes Buildings' energy efficiency	F41.1.0 - Development of building projects F41.2.0 - Construction of residential and non-residential buildings F42.1.1 - Construction of roads and motorways F42.2.1 - Construction of utility projects for fluids C23.32 - Manufacture of bricks, tiles and construction products, in baked clay C23.61 - Manufacture of concrete products for construction purposes C23.62 - Manufacture of plaster products for construction purposes C25.1 - Manufacture of structural metal products	Subways Railways Bridges and tunnels

Source: Erre Quadro

1.3 Analytical logic and methodology: from technologies to skills and occupations

The ETF's analytical contribution focuses on three interrelated dimensions that together provide a comprehensive understanding of the technological and skills transformation required in the Construction priority domain. The analytical framework is designed to link global technological developments with Montenegro's national context and to translate these insights into evidence and recommendations on emerging skills and occupational needs. All stages of the analysis were informed by extensive stakeholder consultations, ensuring close alignment with sector realities and national priorities.

The first analytical dimension concerns **innovation dynamics**. This dimension examines global technological developments shaping the construction sector through the analysis of more than 30 years of worldwide patent data. The use of global patent evidence is particularly important given Montenegro's position as a small, predominantly technology-adopting economy, where most innovations influencing domestic production and processing originate outside the country. The patent analysis enables the identification of major technological trends, growth trajectories and potential disruptors across the domain, and provides a forward-looking perspective on technologies likely to influence productivity and competitiveness in the short to medium term.

The second dimension focuses on **technology adoption readiness**. Global innovation trends do not automatically translate into national uptake. To address this gap, the analysis assesses Montenegro's readiness to adopt and deploy identified technologies by comparing global developments with national capabilities, institutional maturity, regulatory conditions and existing industry practices. This assessment applies a four-level readiness scale (low, increasing, high and stabilising) and draws on expert analysis, desk research and three rounds of stakeholder consultations. Readiness scores therefore reflect Montenegro's capacity to absorb, operate and scale external technologies, rather than domestic innovation output.

The third dimension examines **skills implications** arising from technological change. Building on the identification of priority technologies and readiness levels, the analysis applies ESCO-based semantic matching, supported by proprietary tools, to link technologies with relevant skills, competences, knowledge areas and occupational profiles. This approach makes it possible to identify skills likely to experience demand growth, highlight emerging or hybrid occupational profiles, and detect potential mismatches between technology adoption and workforce capacity. As with the readiness assessment, results were validated through expert input and stakeholder consultations to ensure their relevance for the Montenegrin labour market.

While these three dimensions structure the analytical work, the report presents its findings in two main analytical steps, reflecting how evidence is organised and used throughout the report. First, an analysis of global patent trends combined with technology-readiness scoring identifies priority technologies and assesses Montenegro's capacity to adopt and deploy them in the Construction domain (Chapter 2). Second, the skills and occupations associated with these technologies are identified (Chapter 3). Finally, the findings are translated into priority action areas and measures to operationalise smart specialisation through skills development and ecosystem mobilisation (Chapter 4). The recommendations were developed through a structured and iterative process that combines all analytical dimensions with extensive stakeholder consultations, ensuring close alignment with sector realities and a focus on producing actionable measures for integration into the national Smart Specialisation Strategy and its Action Plan.

This approach ensures a coherent progression from global technological developments to national adoption capacity and, ultimately, to the skills, occupations, and implementation measures required to deliver Montenegro's smart specialisation objectives.

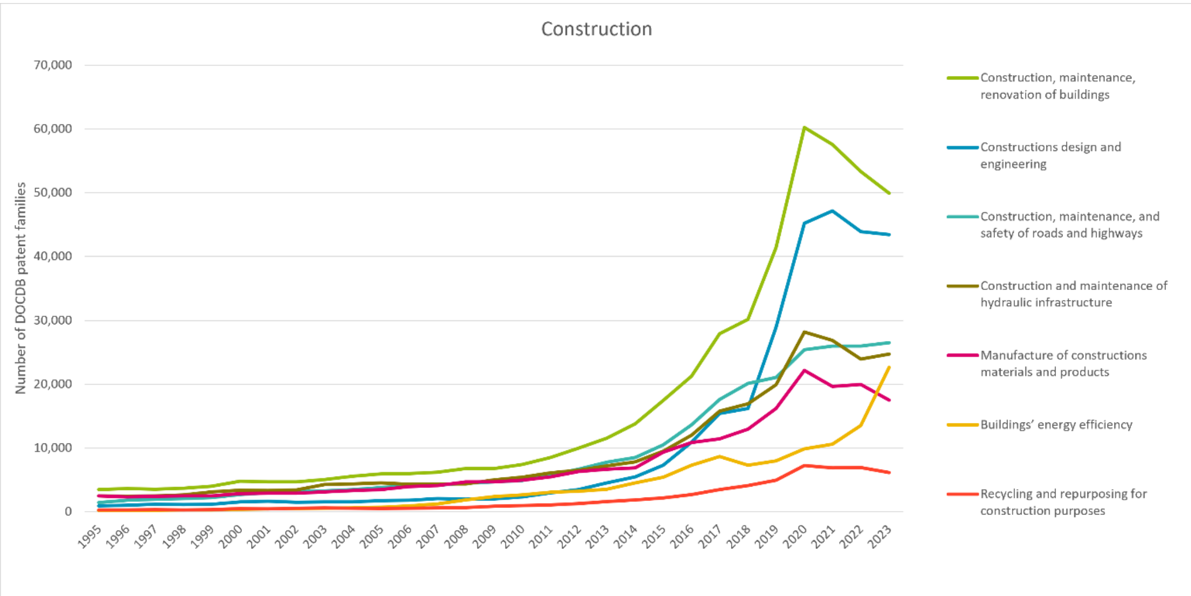
2. TECHNOLOGICAL DEVELOPMENT IN THE ‘CONSTRUCTION’ PRIORITY DOMAIN

To achieve the long-term vision and strategic objectives for smart specialisation outlined in Figure 1, Montenegro will need to adopt technologies that strengthen productivity, support the green and digital transition, and increase value added across the Construction value chain. This requires improving system efficiency, strengthening local production through better valorisation of raw materials, and building human, digital, and institutional capacities. Chapter 2 therefore reviews the global technological landscape and assesses Montenegro’s readiness to adopt relevant technologies, highlighting those most important for advancing the twin transition and the key barriers that still limit wider uptake.

2.1 Global patent trend analysis

For this analysis, more than **2 million patent documents** worldwide were examined for the period 1995–2025, focusing on the identified sub-sectors in the *Construction* domain (see Introduction in Chapter 1). In contrast, only **57 Montenegrin patents** were identified, with inventive activity focused on structural elements for the installation of wind farms, filtration systems for the treatment and disposal of households’ water, and techniques to produce semi-finished concrete products. This confirms that Montenegro is predominantly a **technology-adopting**, rather **than technology-developing**, economy in the construction domain.

Figure 2. Time series of patent families’ filings in the Construction sector



Source: Erre Quadro’s own elaboration

The construction sector worldwide experienced a marked peak in growth between 2020 and 2021, after which overall innovation rate seems to have slowed down. Within this broader trend, subsectors display differentiated trajectories: *Buildings’ energy efficiency* shows a steep and accelerating increase (as likely explained by the growing attention for sustainable technologies also in Constructions), whereas *Construction*, maintenance, and safety of *roads and highways* exhibit a more stable yet consistently positive pattern of growth.

Constructions design and engineering also demonstrate substantial expansion during the same period, with a sharp rise preceding the peak in 2021 and a gradual decline, thereafter, suggesting a potential saturation or stabilization of innovation efforts.

Construction and maintenance of hydraulic infrastructure, as well as *Manufacture of construction materials and products* follows a similar pattern, though with less volatility, indicating steady innovation driven by material science advancements and industrial scaling.

In contrast, the *Recycling and repurposing for construction purposes* remains comparatively small but shows a gradual upward trend, reflecting the increasing relevance of circular economy principles, albeit still emerging relative to other domains.

Finally, the category *Construction, maintenance, and renovation of buildings* show sustained long-term growth, confirming its central role in Constructions innovation and its sensitivity to global policy incentives, market demand, and technological modernization.

2.2 Technology readiness scoring and local relevance

The identified technologies in each sub-sector were ranked using a **Global Score** that combines patent volume, growth rate and the strategic relevance of the corresponding subsectors. High-scoring technologies represent widely researched innovations with rapid growth driven by significant R&D investment and are therefore most likely to achieve widespread adoption and shape future skills demand. Lower-scoring technologies (below 0.5) remain relevant either because they are established but require updated skills, or because they are early-stage innovations with longer-term potential.

To complement the patent analysis, Montenegro's **readiness** to adopt each technology was assessed using expert insights and stakeholder consultations, supported by desk research, EU policy reviews, and available proxy indicators. This resulted in a four-level *Readiness Score*: low (), increasing (°), high (°°), and stabilizing (°°°).

Together, these two assessments provide a structured lens for identifying the technologies most relevant for Montenegro and understanding their potential contribution to the country's vision and strategic objectives.

Table 2 presents the full list of identified technological concepts. A small number of non-technological entries, *Safety & Risk Management and Regulatory and legal expertise*, are included for completeness and marked with the tag "N.T." at the bottom of the ranking.

Table 2. Emerging technology and innovation clusters for Constructions sector

Technological and Innovation Concepts	Global Score	Readiness Score
Raw Materials	1.000	°°°
Sensorized Instruments	0.756	
Modular and Prefabricated Constructions	0.599	°
Robotics & Automation	0.588	
Anti-seismic technologies	0.556	°
Smart PPEs & Exoskeleton	0.525	
3D printing & Additive Manufacturing	0.523	
Non-destructive testing (NDT)	0.517	
Route planning	0.506	
Digital Twin	0.493	
Smart Building & Infrastructure	0.488	°

Technological and Innovation Concepts	Global Score	Readiness Score
Recycling materials and Circular economy	0.458	°
3D modeling software and Computer-Aided design	0.457	°°°
Computer Vision & Image processing	0.456	
Drones	0.453	°
Building Information Modelling (BIM)	0.443	°
Energy Efficient System & Energy Management	0.440	°
Automatic Guided Vehicles (AGV)	0.393	
Building Automation System (BAS) / Building Management System (BMS)	0.379	°
Sustainable & Smart Materials	0.306	
5G connectivity	0.293	
Bid Management & DSS	0.284	°
Safety & Risk Management	N.T.	°
Regulatory and legal expertise	N.T.	°

Source: Erre Quadro's own elaboration

Digital and sensing technologies dominate global construction innovation, while readiness in Montenegro is strongest in established engineering and design niches. Globally, construction is being reshaped by digital design tools, monitoring and sensing technologies, energy-efficient systems, and data-enabled workflows, including BIM, Digital Twin applications, sensors, non-destructive testing, and smart building controls. Montenegro shows comparatively higher readiness in areas where traditional engineering strengths and basic digital tools are already in use, such as CAD-based design, materials engineering, and selected inspection and surveying applications. These capabilities demonstrate that local capacity exists to absorb and operate advanced technologies, even though uptake remains uneven and concentrated among larger firms and isolated projects. To support subsequent skills analysis, the identified technologies were clustered and prioritised through stakeholder consultations, reflecting their local relevance for Montenegro's construction sector and implementation capacity.

Strong readiness in traditional materials but limited innovation spillovers. Montenegro shows high readiness in raw materials, as well as in **3D modelling software and computer-aided design**, reflecting long-standing construction material production and the widespread use of basic digital design tools. However, global innovation in advanced materials is moving fast, and Montenegro's traditional strengths do not translate into systematic innovation due to limited R&D capacity and low industrial scaling.

Weak readiness for digital sensing and monitoring technologies. Technologies such as sensorised instruments, computer vision, and digital twin have strong global growth but show low operational use in Montenegro. this gap reflects limited investment in modern monitoring solutions and conservative industry practices that still rely on manual inspections.

Prefabricated and modular construction is not developed. Although having potential, tendencies of Montenegrin construction sector are not aligned with global prefabricated and modular construction trends. Low industrial capacity, fragmented project pipelines, and absence of system support constrain rapid uptake in this area, being attractive from different aspects of sustainability, primarily in the context of smart use of natural raw material resources (e.g. timber), aiming at energy efficiency and smart construction.

Robotics and automation remain almost absent in practice. Globally, robotics and automated processes are transforming construction efficiency and safety, yet Montenegro shows no evidence of operational adoption. High capital costs, lack of trained operators, and risk-averse SMEs are the main causes of slow adoption.

Anti-seismic technologies show selective progress but lack mainstream deployment. Montenegro shows increasing readiness due to EU-funded research pilots and adoption of Eurocodes. However, advanced solutions such as base isolation or smart damping remain limited because the market focuses on compliance rather than innovation.

Readiness for smart buildings and digital energy management is developing but uneven. Technologies such as Smart Buildings, Energy-efficient systems, BMS/BAS, and Recycling and Circular Economy show early-stage use in selected high-end projects. Market uptake remains slow due to high upfront costs and the absence of regulatory incentives encouraging smart retrofitting.

BIM is recognised but not embedded in national standards or procurement. Montenegro has low but increasing readiness for BIM, with sporadic use by larger firms and international projects. The absence of legal mandates, standardised training, and public-sector uptake delays wider diffusion.

Drone-based inspection is growing but still limited to isolated projects. Drone applications appear in specific surveying and inspection activities, showing increasing readiness aligned with global trends. However, regulatory uncertainty and the absence of certified training schemes prevent scale-up.

Circular economy and green construction show interest but limited industrial capability. The global shift toward recycled materials and low-impact processes contrasts with Montenegro's low readiness caused by limited recycling infrastructure and weak demand for secondary materials. Pilot projects show potential but remain disconnected from mainstream construction activity.

Managerial, safety and regulatory digital tools show modest maturity. Readiness for Bid Management, Safety & Risk Management, and Regulatory expertise is increasing, helped by EU-funded knowledge-transfer projects and alignment with EU standards. Yet adoption in everyday practice remains slow due to inconsistent processes and lack of digital workflows within SMEs.

Strong foundations but slow and limited uptake of advanced technologies. Montenegro's construction sector benefits from strong traditional engineering competences, alignment with EU regulations, and widespread use of basic digital design tools. However, advanced and integrated technological solutions are still only weakly adopted. The sector is well aligned with global tools, regulatory standards, and conventional materials, yet remains less prepared for a new generation of digital, automated, and sustainability-driven innovations. Overall readiness is uneven: classical engineering tools and EU-aligned procedures are well established, but the uptake of advanced practices continues to lag.

3. The impact of technological development on skills demand in the ‘Construction’ domain

To achieve the long-term vision and strategic objectives of smart specialisation to boost economic competitiveness, Montenegro will need a workforce capable of integrating the technologies shaping the future of its construction sector. This requires skills that enable higher efficiency, support greater resilience, and promote environmentally sustainable practices across the built environment. Chapter 3 examines these requirements in detail and links the strategic objectives for smart specialisation with the human capital needed to deliver them.

The technologies–skills–occupations mapping applied in this chapter makes it possible to identify emerging skills needs and the potential rise of new or hybrid professional profiles. This type of skills intelligence is essential for curriculum development, targeted training design, and stronger cooperation between education providers and employers. It also highlights where skill gaps are likely to appear and where labour demand may increase in the near future.

The analysis uses semantic algorithms that match technologies with ESCO skills and occupations, reflecting international developments in how digital, green, and advanced construction technologies reshape workforce needs. In Montenegro, these findings were reviewed in three dedicated stakeholder meetings, where participants assessed their relevance for the national context. Their insights confirmed that the top skills and occupation profiles identified through the analysis align closely with Montenegro’s emerging needs and provide a solid basis for planning future workforce development.

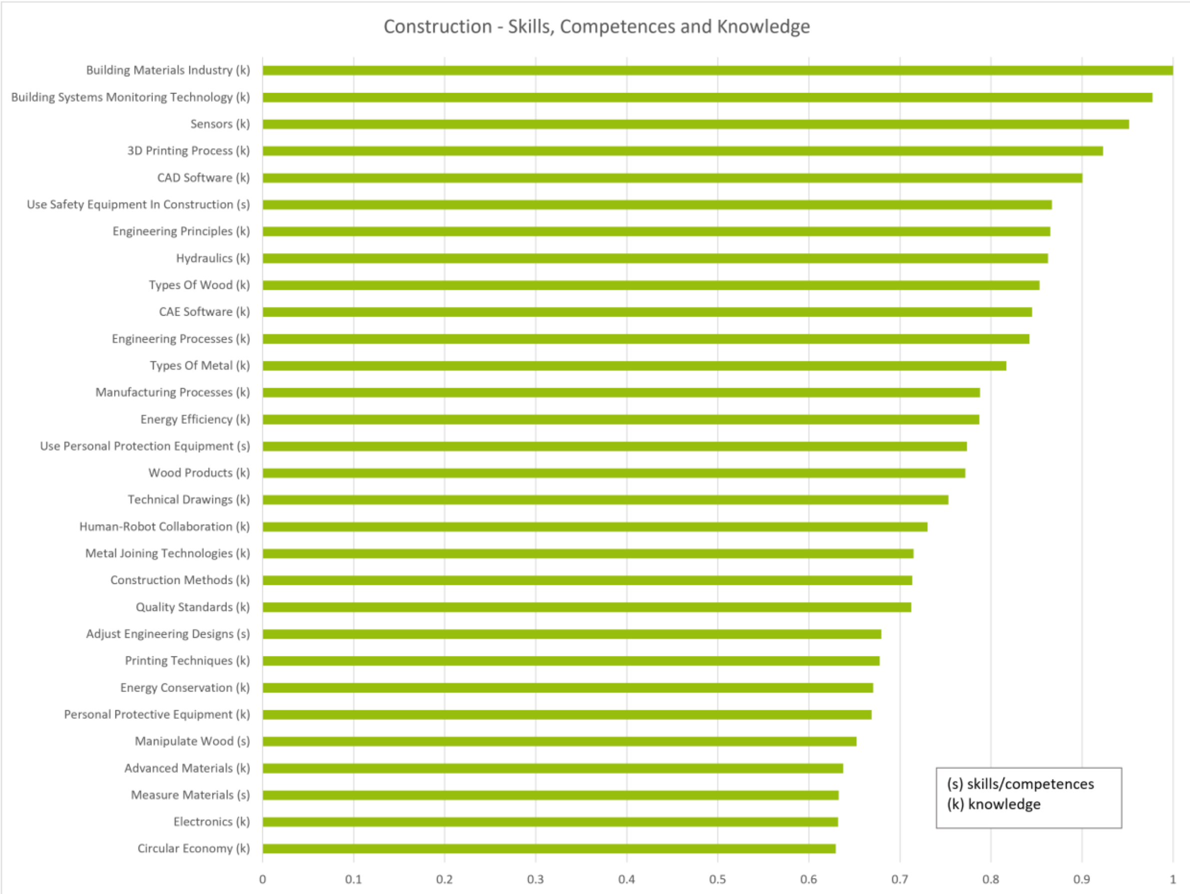
3.1 Skills demand emerging from technological change

Technological change is reshaping construction worldwide and creating new patterns of skills demand across digital design, automated processes, advanced materials, and smart-monitoring systems. For Montenegro, understanding these shifts is essential to ensure that the workforce can support the technologies that will drive the sector’s modernisation and reinforce competitiveness.

This chapter examines how global technological trends translate into specific skill needs and identifies where new capabilities must be developed to operationalise the country’s smart specialisation priorities. It also shows how emerging technologies influence both existing professions and new hybrid roles, highlighting the need for continuous upskilling, reskilling, and closer cooperation between education providers and employers.

Figure 3 presents the top 30 ESCO skills and knowledge areas associated with technologies likely to shape the Construction domain in the years ahead. These skills point to the rising importance of digital and computational capabilities, advanced monitoring tools, and technical competences linked to modern materials, automated fabrication, and energy-efficient building systems. Together, they reflect the growing relevance of simulation, CAD-based modelling, safety-critical monitoring, and material-testing expertise. Collectively, these capabilities provide a basis for identifying priority areas for workforce development and ensuring that Montenegro’s human capital can keep pace with emerging technological trajectories.

Figure 3. Top 30 ESCO skills, competences and knowledge in Constructions sector



Source: Erre Quadro's own elaboration

Digital design and modelling (CAD, BIM, Digital Twin). The demand for digital design skills is substantial, and stakeholders confirmed that BIM and computer-based modelling remain core priorities. They emphasised the need for broader, routine use of these tools across projects. Slow uptake is tied to the absence of mandatory BIM requirements and a lack of standardised training programmes, which prevents these methods from becoming normal practice in the sector.

Monitoring and sensing for worksites and assets (sensors, NDT, CV, drones). Monitoring-related competences, such as the use of sensors, non-destructive testing, drones and computer-vision systems, are increasingly important for ensuring safety and real-time oversight. Stakeholders fully agreed. They highlighted that limited investment, coupled with no formal training pathways, restricts wider adoption and keeps many practices manual and labour-intensive.

Energy-efficient systems and smart buildings (BMS/BAS, energy management). Skills related to building-management systems, digital controls, and energy-efficiency retrofitting are gaining importance as buildings become more complex. Stakeholders strongly aligned with this and pointed out that slow uptake is mainly due to high upfront costs, limited incentives for renovation and uneven capacity across firms. Strengthening these skills would directly accelerate smart-building deployment.

Materials, manufacturing and testing (advanced materials, circularity). Competences in advanced materials, manufacturing processes, and circular-economy practices are central to improving productivity and sustainability. Stakeholders agreed but placed greater urgency on shortages in recycling-related roles and capacities for buildings' energy-efficiency work. These gaps stem from underdeveloped recycling infrastructure, weak demand for secondary materials and limited industrial scaling.

Automation and advanced construction methods (robotics, 3D printing, exoskeletons). Automation-focused skills, including robotics, additive manufacturing and human–robot collaboration, are becoming more relevant as global construction advances. Stakeholders acknowledged their importance but underlined a significant skills shortage. They attribute this to high investment requirements, limited exposure to pilot projects and the absence of operators who can manage these advanced systems safely and effectively.

Site safety, standards and compliance (PPE, risk management, quality). Safety remains a fundamental competence area, especially as technology is introduced into worksite processes. Stakeholders confirmed high demand for improved use of personal protective equipment, quality-standards enforcement and structured risk-management practices. Adoption of digital safety tools is still inconsistent because worksite routines vary and practical training is lacking.

Project delivery and decision support (bid management, DSS, technical drawings). Skills in digital decision-support tools, bid-management systems and technical documentation are important for planning and delivering modern projects. Stakeholders agreed but placed these skills lower than technical competences related to operations and manufacturing. They noted that SMEs often lack experience with digital workflows and face barriers when using DSS tools in procurement processes.

Workforce mix and technician pipeline. Stakeholders stressed that technician and craftsman-level shortages constitute one of the most critical systemic constraints. While analytical exercises focus on technical skill domains, stakeholders emphasised that without skilled technicians and craftsman (installers, operators, maintenance staff) new technologies cannot be deployed at scale. These shortages are rooted in declining interest in vocational pathways, ongoing emigration and limited opportunities for mid-career upskilling.

Public-administration and regulatory skills. Stakeholders highlighted structural gaps within public bodies responsible for procurement, permitting and regulatory enforcement. These gaps slow the implementation of BIM, digital permitting systems, energy-efficiency measures, and circular-economy programmes. As a result, the uptake of contemporary innovation trends across the construction sector remains uneven. Strengthening public-sector skills is therefore essential, as public authorities shape demand signals, compliance standards, and investment decisions throughout the construction ecosystem.

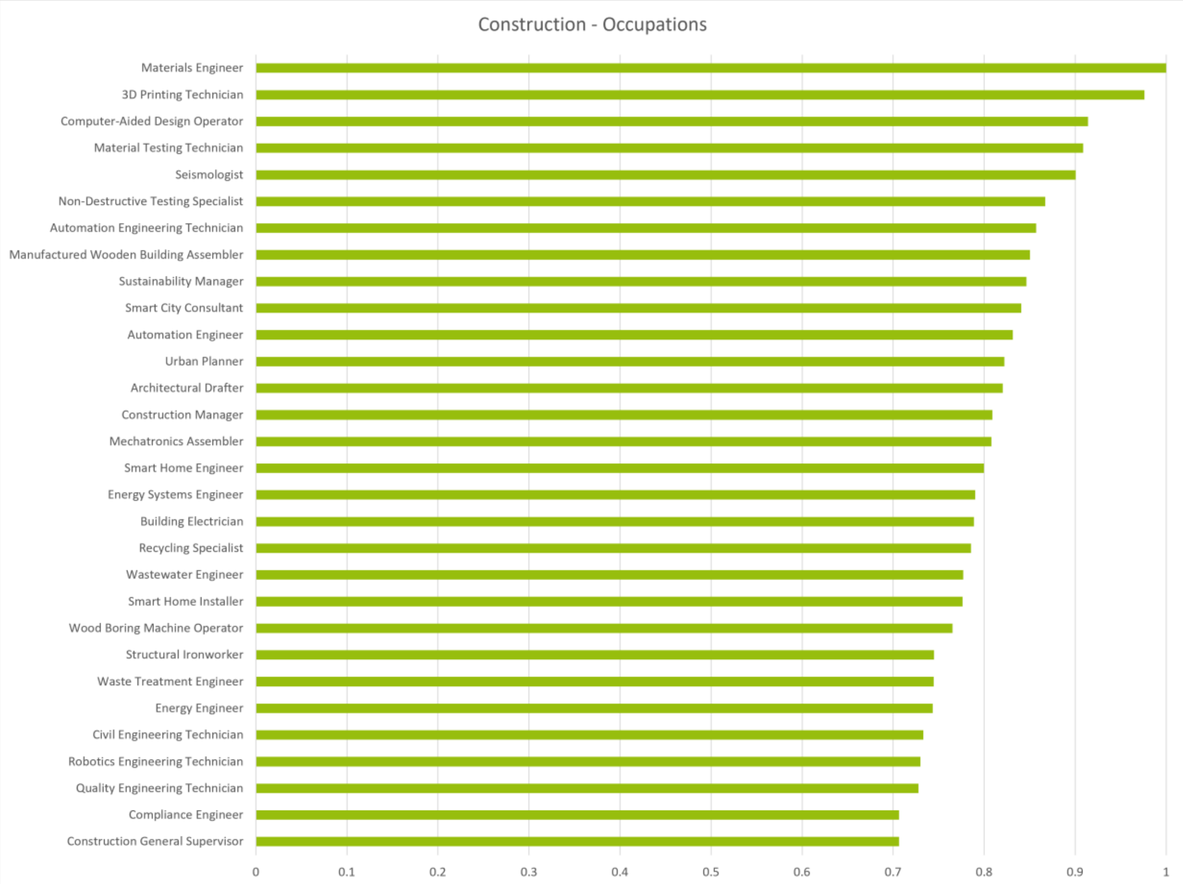
3.2 Occupations shaped by emerging technologies

Technological change is reshaping not only the skills required in Montenegro's construction sector but also the occupational profiles needed to deliver modern, digitalised and sustainability-focused building practices. Emerging technologies, ranging from advanced materials and prefabrication to automation, and smart-monitoring systems, are shifting workforce needs toward more specialised engineering roles, digitally enabled functions, and hybrid profiles that combine technical, analytical, and operational capabilities.

This chapter examines how global occupational trends translate into the structural, technical and organisational realities of Montenegro's construction sector. It explores which occupations are emerging as priorities, which remain essential to maintain sectoral continuity, and which are constrained by the country's current technological readiness, institutional frameworks, and labour market dynamics. Together, these insights highlight how Montenegro can build a competitive, future-ready workforce capable of supporting the green and digital transition in construction.

Figure 4 ranks the top 30 occupations associated to skills and technologies expected to influence the *Construction* domain in the future.

Figure 4. Top 30 ESCO occupations in Constructions sector



Source: Erre Quadro's own elaboration

Rising demand for materials-intensive and digitally enabled occupations. Figure 4 ranks the top 30 occupations associated with technologies likely to shape the *Construction* domain.

Materials-intensive and digitally enabled roles dominate the top positions, with Materials Engineer, 3D Printing Technician, CAD Operator, and Material Testing Technician leading the list. These roles rise because advanced materials, digital design, and automated fabrication processes are becoming central to modern construction. This aligns with Montenegro's strong base in traditional materials and the routine use of CAD tools, which increases demand for testing, specification, and precision-design occupations.

Traditional roles shifting toward digital-first competences. A second group of occupations, Architectural Drafter, Civil Engineering Technician, and Construction Manager, remains essential but now requires stronger digital capabilities. These profiles must work with BIM, digital permitting systems, and integrated project-delivery tools. However, slow BIM adoption and the absence of mandates weaken demand signals for BIM-dependent roles, even though the skills behind them sit high in stakeholder priorities.

Structural safety and monitoring roles on the rise. A third cluster of roles, Seismologist, Non-Destructive Testing Specialist, and Automation Engineering Technician, shows the increasing need for structural safety expertise, sensing technologies, and real-time monitoring. These occupations gain importance as construction shifts toward safer, more resilient, and more sustainable built environments. Stakeholders confirm the growing demand for monitoring, sensors, and safety-related competences, reinforcing the strong pull for these occupations.

New occupations are emerging at the intersection of digitalisation and sustainability. Further down the list, occupations such as Sustainability Manager, Smart City Consultant, and Smart Home Engineer signal a growing shift toward digitalised and environmentally focused construction services. These hybrid roles connect engineering, ICT, energy efficiency, and building-performance knowledge.

Their emergence reflects increasing activity in smart-building projects and energy-efficient renovation, even though market uptake remains uneven.

Future-critical automation and additive manufacturing occupations. The top 30 list includes roles such as 3D Printing Technician and Automation Engineering Technician, showing growing global demand for automated and additive methods. Montenegro's readiness for robotics and advanced automation is still low, so these occupations emerge slowly. Stakeholders highlight shortages in advanced-technology skills, which confirms why these occupations represent a future-critical but currently constrained demand area.

Sustainability and circular construction roles are gaining importance. The rankings also feature sustainability-linked roles driven by technologies in recycling and circular construction. Stakeholders identified acute shortages in recycling-related sub-sectors, which reinforces the relevance of roles connected to materials recovery, waste valorisation, and low-carbon material choices. Yet limited recycling infrastructure slows the development of a robust occupational market in this area.

Technician and craftsman shortage as the critical workforce bottleneck. Across all occupational clusters, the greatest constraint is the shortage of technicians, installers, equipment operators, maintenance staff, and craftsmen. Many occupations in the top 30 list rely on a strong technician pipeline, yet Montenegro faces declining vocational enrolments, emigration, and limited upskilling options. This bottleneck directly limits the deployment of new technologies and slows occupational growth in every priority area.

Administrative capacity is slowing demand for digitalisation-driven occupations. Stakeholders point to limited skills in permitting, procurement, and regulatory enforcement. These bottlenecks weaken the policy signals that normally accelerate the demand for BIM-capable managers, compliance specialists, and digital-documentation roles. Without stronger administrative capacity, occupational demand linked to digitalisation and performance standards will remain below potential.

Digitalisation and sustainability transforming traditional occupations. Even core roles, such as Construction Manager, Architectural Drafter, and Civil Engineering Technician, now require enhanced technological and environmental competences. This shift reflects the combined influence of digitalisation, new materials, environmental standards, and modern building methods on occupational profiles. Stakeholder views reinforce this integrated shift, as they consistently emphasise digital workflows, energy efficiency, circular economy, and quality standards across all technology clusters.

3.3 Structural constraints shaping skills demand and technology adoption

The technician-level skills are among the most important levers for raising productivity and accelerating the green and digital transition. However, a set of interconnected structural gaps across qualification approval, programme design, VET provision, workforce supply and institutional capacity continues to slow modernisation:

Need to accelerate the accreditation of qualification programmes. Accreditation and licensing procedures are highly time-consuming and involve multiple compulsory steps and bodies, some of which add limited value. As a result, the system remains rigid and struggles to adapt to emerging technologies and changing industry needs. Delays are further exacerbated when one or more responsible bodies (such as Sectoral Committees or the Council for Qualifications) do not operate regularly, creating bottlenecks for new programmes and curricula. Streamlining and accelerating the accreditation process would help ensure that qualifications keep pace with technological developments and labour-market requirements.

Emergence of hybrid occupational profiles. New occupational profiles increasingly combine traditional construction competences with expertise in digital technologies, data analytics, sustainability, and environmental management. These profiles span areas such as environmental protection, infrastructure development, ecological impact assessment, and circular economy applications. Their emergence reflects a growing demand for hybrid profiles across the construction ecosystem. However, the formal education system has limited capacity to respond rapidly to these evolving needs. As a result, flexible learning pathways, particularly short-cycle training, modular courses, and other non-formal provision, offer an alternative to address emerging labour market demand.

Interdisciplinary programmes are not in place to support emerging hybrid occupations. Although interdisciplinary programmes are more impactful than traditional vertical study pathways, demand remains sluggish and both universities and secondary schools continue to prioritise single-discipline curricula. This limits the development of hybrid profiles that combine broad interdisciplinary competencies with specialised technical depth. Programme adaptation cycles remain too slow to keep pace with rapid technological change, and current accreditation plans do not foresee the introduction of interdisciplinary programmes.

Need to adjust pace of skills acquisition to rapid technological change in a small-scale labour market. In the formal education system, it typically takes at least five years, and often six to seven, from the initial design of a new curriculum to the entry of trained technicians or engineers into the labour market. In the context of rapid technological change, this timeframe is increasingly misaligned with industry needs. Over such a period, several new generations of technology may emerge, rendering the original curriculum concept partially outdated. Stakeholders unanimously agreed that the most effective response lies in lifelong learning, delivered through specialised non-formal training, modular courses, short programmes, and micro-credentials. Upskilling, reskilling, and flexible learning pathways are therefore essential for meeting demand in high-growth occupations and for preparing graduates for hybrid roles combining engineering, ICT, and environmental competences. These approaches also reflect the scale of the Montenegrin labour market, where organising numerous formal interdisciplinary programmes may be neither efficient nor sustainable.

Cooperation between universities, secondary schools, and employers remains weak. Practical training exists but is not systemic, and programmes do not sufficiently reflect industry needs or technological change. Businesses should play a structured role in the (re)accreditation of VET and university programmes, as well as in strengthening and expanding practical training provision.

Significant and ongoing challenges remain in VET and adult learning provision. The most significant skills gaps are in VET and adult learning. VET suffers from low attractiveness and slow curriculum renewal, while adult learning opportunities remain limited in both scale and relevance. Montenegro could consider gradually expanding micro-qualifications, specialisation courses, and short modular trainings in adult learning, while also strengthening the training infrastructure that supports them. Modernising teaching methods and curricula would improve responsiveness to labour-market needs. Upgrading training facilities, including those related to construction-materials production and circular-economy practices such as construction-waste reuse, would further enhance the relevance and attractiveness of VET programmes.

Need to strengthen workplace training. Practical, workplace-based training requires concrete, scalable solutions. Certification routes delivered through schools or Adult education centres could expand training options. Employers seek structured, scalable mechanisms to support practical training aligned with technological change.

Need for industry-engaged and professionally updated teaching staff. Teachers are making efforts to keep pace with technology, but these efforts are not systematic and remain uneven across institutions. Attracting industry professionals into teaching roles is essential to bridge the gap between technological change and training provision. The concept of dual professionalism, combining up-to-date industry expertise with teaching roles, is particularly critical for the construction sector.

Workforce shortages limiting technological uptake. The sector faces shortages of engineers, technicians, and craftsmen, which directly limit the uptake of new technologies. Faster specialisation, retraining pathways, access to modern equipment, and stronger cooperation with companies and international partners are essential to address these shortages.

Challenges in career orientation and graduate transition. Students lack adequate guidance in career choices, and transitions from education to the labour market remain uneven. Limited data on VET graduate employment outcomes restricts evidence-based planning. Expanding re-qualification programmes, improving learner motivation through wages and working conditions would support better transitions. Enhanced professional development opportunities for engineers would strengthen overall workforce readiness.

Institutional capacity in procurement, permitting, and regulatory enforcement remains limited. These gaps slow BIM uptake, digital permitting, energy-efficiency and circular economy requirements. Weak administrative and regulatory capacity also suppresses demand for digital-ready occupations and reduces the sector's ability to adopt modern construction technologies.

Insufficient offer across diverse learning modes. There is a growing need to clarify, expand, and ensure certification for multiple learning pathways, initial and continuing VET, micro-credentials, short-term technology-specific trainings, and modular upskilling. The current landscape lacks coherence and sufficient training volume across these modes.

Teacher and trainer professional development remains limited. Teachers and trainers need continuous professional development to keep pace with new technologies. Investment in school equipment and partnerships with private companies are necessary to ensure learners have access to modern tools, devices, and practical training environments. Curricula and textbooks also require systematic adaptation to reflect emerging technologies and smart specialisation priorities.

Need for alignment with European skills initiatives. Keeping pace with European platforms such as the Pact for Skills, net-zero academies, sectoral cooperation frameworks, Centres of Vocational Excellence (CoVEs), and joint VET and university diplomas will be essential to ensure Montenegro's competitiveness and integration into the evolving EU skills ecosystem.

A coherent and accelerated reform effort will be important in the years ahead. Updating the qualifications programmes, introducing more flexible and interdisciplinary study options, and deepening cooperation between education providers and employers will help the system respond more effectively to evolving technological and labour-market needs. Continued modernisation of VET and higher education, together with broader opportunities for adult learning and more systematic workplace training, will further strengthen workforce development. At the same time, reinforcing institutional capacities, ensuring that teachers and trainers can maintain up-to-date professional expertise, and improving access to modern equipment will enhance the sector's ability to adopt new technologies. Taken together, these steps will help Montenegro advance its smart specialisation objectives and support the green and digital transition.

4. Operationalising smart specialisation

Chapter 6 translates the analytical findings on technologies, skills and occupations into concrete priorities for action. While previous chapters examined global innovation trends, Montenegro's readiness to adopt key technologies, and the resulting implications for skills demand, this chapter focuses on how the smart specialisation agenda can be operationalised through targeted investment in human capital and skills ecosystems. It identifies the technology–skill combinations that offer the highest potential productivity gains and outlines how education, training and workforce development systems can be mobilised to support their deployment.

Building on stakeholder consultations and evidence from the technology readiness and skills analysis, the chapter highlights a limited number of high impact technology clusters that are critical for Montenegro's future competitiveness. For each cluster, it clarifies the skills priorities required across qualification levels and proposes structured actions for vocational education and training, higher education, adult learning and business support organisations. Together, these actions provide a coherent framework for aligning skills development with smart specialisation objectives, strengthening implementation capacity, and ensuring that the workforce can effectively support the adoption, operation and scaling of priority technologies.

4.1 High-impact technology clusters and related skills priorities

Montenegro's construction sector is entering a period of significant transformation, driven by rapid technological progress, expanding digital tools, new sustainability requirements, and growing labour-market pressures. The analysis shows that Montenegro can rely on strong engineering traditions, established material, design and construction methods, and alignment with EU regulatory standards. At the same time, modernisation will require substantial improvements in human capital, more agile education and training provision, and stronger cooperation between institutions and industry.

Montenegro's future competitiveness will increasingly depend on adopting technologies that deliver the highest productivity gains and support the smart specialisation vision. Three technology clusters stand out.

Table 3. Top 3 high impact technology clusters and associated skills for Montenegro's construction sector and future competitiveness

Technology	Associated skills
Digital design and modelling tools (CAD, Digital Twin, BIM)	**Skills in digital design and modelling, BIM-based workflows, and construction standards and technical documentation management** Engineers and managers need stronger modelling and workflow competences, while technicians require practical skills in drafting, data entry, digital workflows, and model maintenance.
Monitoring and sensing technologies (sensors, NDT, drones, computer vision systems)	**Skills in inspection and monitoring technologies, safety procedures, and quality control across construction processes** Demand will grow for technicians trained in operating sensing equipment, conducting structured inspections, and managing digital safety routines.
Energy efficient and smart building systems (BMS/BAS and advanced energy management solutions)	**Skills in installation, operation, and maintenance of energy-efficient and smart building systems across the building lifecycle.** Installers and maintenance technicians need updated competences in smart system integration, digital controls, and modern retrofitting techniques.

Source: Authors

4.2 Mobilising the skills ecosystem to support technology adoption

The following three recommendations translate the high-impact technology–skill pairings into concrete action areas. They outline where Montenegro should prioritise investment and reform to raise productivity, strengthen competitiveness and support the green and digital transitions across the *Construction* domain.

Priority action area 1 – Strengthening digital design and modelling skills across the construction sector

Of the three high-impact technology–skill pairings identified, this one is both the most urgent and the most readily achievable. Montenegro already has a solid foundation in digital skills provision at higher-education level. Both the University of Montenegro (UoM) and the University of Donja Gorica (UDG) embed digital competences across civil engineering, architecture, and polytechnic programmes at all three higher-education levels.

At ISCED 6, this includes bachelor programmes in Civil Engineering at UoM and Polytechnics at UDG. At ISCED 7, digital skills are further developed through a wide range of specialised master's programmes at UoM—covering structures, infrastructures, management in civil engineering, and architecture—as well as master's programmes in Polytechnics at UDG. At ISCED 8, doctoral programmes in Civil Engineering and Architecture at UoM provide advanced analytical and modelling competences. Despite this strong academic base, the digital skills and knowledge acquired during formal education are not sufficient to meet current professional requirements. Graduates typically require additional upskilling at the start of their careers, most often through self-directed learning or in-house training within their employing organisations.

By contrast, digital skills provision at secondary VET level remains limited. Construction technicians (ISCED 3) are insufficiently exposed to advanced digital tools during initial education. This affects all construction-related technician programmes currently offered in Montenegro, including building construction, civil and hydraulic engineering, geodesy, and architecture and interior design. As a result, technicians cannot rely solely on skills acquired in secondary education to operate effectively in increasingly digitalised construction environments. At craftsman level (ISCED 2), digital skills are largely absent from curricula. While the Engineering Chamber of Montenegro occasionally offers short courses and workshops for engineers, and larger companies—particularly subsidiaries of international firms—provide in-company training, these opportunities remain fragmented and unevenly accessible.

Table 4. Measures to strengthen digital design and modelling skills across the construction sector

VET (secondary and non-tertiary level)	Higher education	Adult learning	
		CVET	Business support organisations (BSOs)
Modernise VET curricula to include hands-on training in CAD, Digital Twin, and BIM basics, supported by practical assignments in digital drafting, model interpretation, and digital documentation workflows. Create digital construction labs in VET schools equipped with CAD/BIM software, sample models, and datasets that allow	Strengthen civil engineering and architecture programmes with advanced modules on integrated digital design, BIM coordination, workflow optimisation, model-based collaboration, and Digital Twin applications. Create interdisciplinary programmes combining civil engineering, architecture, ICT and	Offer short, stackable upskilling modules in CAD, Digital Twin, and BIM fundamentals, data entry standards, and model-based communication[1]. Provide practical on-site training on tablets, scanners, digital documentation tools, and digital workflow routines	Deliver BIM/CAD/Digital-Twin bootcamps for SMEs, focusing on practical workflows: model interpretation, data entry, digital documentation, and file exchange standards. Establish shared digital-construction labs where SMEs can access licensed software, high-performance

[1] See for example Building Information Modeling (BIM) education and training at the Metropolia University of Applied Sciences, Helsinki, Finland. Available here.

VET (secondary and non-tertiary level)	Higher education	Adult learning	
		CVET	Business support organisations (BSOs)
students to practise data entry, model updating, and quality-control routines. Introduce modules for technicians on: digital drafting and model maintenance digital workflows on worksites standardised data entry for BIM environments Embed structured work-based learning, where students participate in real digital-modelling tasks under supervision of construction firms. Ensure all VET students achieve baseline competences in digital workflows, file management, data quality, and digital site documentation.	energy efficiency, reflecting the hybrid technical roles emerging from construction digitalisation. Introduce postgraduate certificates in: BIM Management Digital Project Delivery Digital Twin Modelling Require universities to maintain formal cooperation with industry, enabling students to participate in applied projects, pilot deployments of Digital Twin and BIM simulations, and digital permitting processes. Support dual-professionalism by enabling industry digital specialists to teach part-time in HE.	used on modern construction sites. Expand certification routes for BIM-capable technicians and site supervisors responsible for digital documentation and model maintenance. Deliver refresher modules on digital workflows, structured inspections, safety documentation, and digital permitting systems to increase adoption among experienced workers. Introduce public co-funding or vouchers to support SMEs and individual workers attending digital-skills training.	computers, and digital tools such as scanners or digital permitting platforms. Act as a bridge between SMEs and VET/HE to ensure training reflects real digital-workflow needs and to support placement of students in digitalised firms. Offer digital-maturity assessments for SMEs and help them identify priority areas for adopting CAD/BIM workflows, support the planning and implementation of construction projects with BIM. Support SMEs with shared procurement schemes for CAD/BIM licences, Digital Twin tools, and digital documentation equipment. Help companies prepare for emerging Digital Product Passport requirements by providing training and guidance on data structures, file formats, and compliance workflows.

Source: Authors

Implementing the above measures would:

- Ensure consistent and systematic use of CAD, Digital Twin, and BIM tools across all qualification levels.
- Strengthen modelling, coordination, and workflow competences among technicians, engineers, architects, and managers.
- Equip technicians with practical skills in drafting, digital documentation, data entry, and model maintenance.
- Increase interoperability and data quality across construction projects through shared standards and digital workflows.
- Accelerate the diffusion of digital design practices across SMEs, training providers, and public authorities.
- Improve project planning, execution quality, and lifecycle management by embedding digital tools into education and continuous training.
- Enhance productivity, efficiency, and competitiveness of Montenegro’s construction sector in line with smart specialisation objectives.

Priority action area 2 - Advancing skills for monitoring, sensing and inspection technologies in construction

These skills are not adequately recognised within Montenegro's formal education system, either in VET or in higher education. There are no dedicated study programmes, courses, or modules focused on monitoring and sensing technologies. Coverage is limited to a small number of individual teaching units within existing programmes—for example, *Testing of Structures* at master's or PhD level at the Faculty of Civil Engineering (UoM), and *Testing of Structures* in secondary VET technician programmes—which address only selected aspects, such as sensors and non-destructive testing (NDT). Drones and computer vision are largely absent from curricula and appear only in isolated cases at PhD level, where they are driven by the specific focus of individual research projects.

Table 5. Measures to advance skills for monitoring, sensing and inspection technologies in construction

VET (secondary and non-tertiary level)	Higher education	Adult learning	
		CVET	Business support organisations (BSOs)
Integrate hands-on training in sensors, non-destructive testing (NDT), drones, and basic computer-vision tools into all construction-related VET programmes. Establish practical inspection labs in VET schools where students can practise structured inspections, digital safety routines, and handling of sensing devices. Introduce micro-modules on drone operation for surveying, digital safety documentation, and NDT basics, aligned with certification standards. Ensure all VET students acquire baseline competences in digital site monitoring, data recording, and equipment maintenance.	Expand civil engineering and architecture programmes to include advanced modules in sensing technologies, structural monitoring, computer-vision analysis, and remote inspection methods. Support the creation of interdisciplinary courses combining civil engineering, ICT, geospatial technologies, and safety engineering. Introduce postgraduate certificates in Digital Inspection Engineering, NDT Technologies, and Drone-based Asset Monitoring. Strengthen collaboration with industry to ensure students take part in applied inspection projects, including site-based monitoring assignments.	Offer short, modular upskilling programmes in: Sensor operation and calibration Drone-enabled inspection NDT procedures Digital safety routines and inspection reporting Use of tablets, scanners, and computer-vision tools on site Provide practical on-site training using real inspection equipment and typical construction assets. Expand access to certification routes for drone operators and NDT technicians. Develop refresher courses for supervisors on digital safety management, structured inspections, and regulatory compliance.	Deliver BIM–inspection–monitoring bootcamps for SMEs, focusing on drones, sensors, NDT, and digital safety documentation. Establish shared inspection labs offering SMEs access to drones, NDT tools, high-performance computers, and computer-vision software. Act as a bridge between SMEs and VET/HE providers to ensure training reflects real inspection-technology needs. Facilitate work-based learning placements where students participate in live inspection and monitoring tasks. Operate shared procurement schemes to reduce the cost of equipment and software licences.

Source: Authors

Implementing the above measures would:

- Build a workforce capable of applying monitoring and sensing technologies, including sensors, NDT methods, drones, and computer vision systems, across construction processes.
- Ensure technicians acquire practical competences in data collection, inspection techniques, real-time monitoring, and equipment operation.
- Strengthen engineering and technical programmes with advanced skills in data analysis, interpretation, and integration of sensing technologies into construction workflows.
- Enhance cooperation between VET providers, universities, research institutions, and industry to support hands-on training and technology uptake.

- Improve the quality, safety, and reliability of construction projects through continuous monitoring, early detection of defects, and data-driven decision-making.
- Accelerate the adoption of advanced monitoring and sensing technologies across Montenegro's construction sector.
- Increase efficiency, reduce maintenance costs, and enhance lifecycle management in line with smart specialisation objectives.

Priority action area 3 - Advancing skills for energy-efficient and smart building systems in construction

In Montenegro, education and training related to energy-efficient and smart building systems (EE & SBS) are developing but remain fragmented and insufficiently aligned with sector needs. Provision is far from systematic or comprehensive.

There are currently no dedicated study programmes focused on EE & SBS at either VET or higher-education level. A pilot interdisciplinary master's programme (*Energy Efficiency, Renewable Energy Sources and Environmental Impact*) was offered at the University of Montenegro (UoM) between 2014 and 2016, but it was not sustained. At present, the interdisciplinary PhD programme *Sustainable Development* at UoM partially addresses EE & SBS topics, though coverage remains limited and not directly tailored to the construction sector.

Elements related to EE & SBS are included in selected courses across VET and higher education, but typically only as a small number of lectures or individual study units. As a result, exposure remains uneven and does not provide a coherent skills pathway.

Business support organisations, notably the Engineering Chamber of Montenegro and the Chamber of Economy of Montenegro, occasionally offer workshops or short training activities for engineers and companies in the field of EE & SBS. In addition, in-company training exists within large firms, particularly Montenegrin subsidiaries of international companies. However, these opportunities are sporadic and unevenly accessible, especially for SMEs.

Adult learning plays an important role in introducing EE & SBS concepts, but current provision is largely project-based, short-term, and uneven in reach, limiting its capacity to support sustained skills development at scale.

Table 6. Measures to advance skills for energy-efficient and smart building systems in construction

VET (secondary and non-tertiary level)	Higher education	Adult learning	
		CVET	Business support organisations (BSOs)
Modernise VET curricula to include hands-on training in BMS/BAS basics, smart-system components, sensor networks, and digital controls used in energy-efficient buildings. Create smart-building practice labs in VET schools equipped with demo controllers, sensors, actuators, and small-scale BMS training panels that allow students to practise installation, wiring, commissioning, and troubleshooting.	Strengthen civil engineering, architecture, and energy programmes with advanced modules on integrated building energy management, BMS design, system optimisation, digital controls, and data-driven facility operation. Create interdisciplinary programmes combining electrical engineering, ICT, civil engineering, energy efficiency, and automation to reflect emerging hybrid roles in smart buildings.	Offer short, stackable upskilling modules in installation, configuration, operation, and maintenance of BMS/BAS systems, digital controllers, field devices, and metering equipment. Provide practical on-site training on commissioning, system optimisation, alarm-handling, remote monitoring tools, and digital O&M routines used in modern energy-efficient buildings. Expand certification routes for BMS installers,	Deliver BMS/BAS and Energy-Management Bootcamps for SMEs, focusing on practical integration workflows: device configuration, commissioning routines, digital documentation, and fault-diagnostics. Establish shared smart-building labs where SMEs can access controllers, sensors, test rigs, and energy-management software to practise installation, calibration, and optimisation tasks.

VET (secondary and non-tertiary level)	Higher education	Adult learning	
		CVET	Business support organisations (BSOs)
Introduce micro-modules for technicians on: smart-system integration and device configuration energy-efficient retrofitting techniques digital controls, alarms, and fault-detection routines Embed structured work-based learning, where students participate in real installation, commissioning, and retrofit tasks under supervision of licensed installers, maintenance companies, and BSOs. Ensure all VET students acquire baseline competences in system documentation, data entry, digital maintenance logs, and safe operation of smart-building components.	Introduce postgraduate certificates in: Smart Building Systems Engineering BMS/BAS Integration & Commissioning Advanced Energy Management and Digital Controls Require universities to maintain formal cooperation with industry, enabling students to participate in applied projects on BMS integration, energy-management optimisation, and retrofit planning in real buildings. Support dual professionalism by enabling industry specialists (BMS integrators, energy managers, automation technicians) to teach part-time in HE.	commissioning technicians, facility-maintenance technicians, and energy-management operators. Deliver refresher modules on digital controls, fault detection, performance monitoring, energy-efficiency standards, and safe retrofit practices for experienced workers. Introduce public co-funding or vouchers that help SMEs and individual workers access specialised BMS/BAS and energy-management training programmes.	Act as a bridge between SMEs and VET/HE providers to ensure training content matches real installation and maintenance needs and to support placement of students in companies working on energy-efficient retrofits. Offer energy-efficiency and smart-building maturity assessments for SMEs and help them develop priority roadmaps for adopting BMS/BAS solutions. Support SMEs with shared procurement schemes for BMS/BAS devices, commissioning tools, energy-management platforms, and digital maintenance-log equipment. Help companies prepare for energy-performance and renovation requirements by providing guidance on compliance workflows, documentation standards, and data-quality requirements for BMS/BAS.

Source: Authors

Implementing these measures would:

- Build a workforce capable of installing, operating, and maintaining modern BMS/BAS and energy-management systems.
- Ensure technicians gain practical competences in smart-system integration, digital controls, commissioning, and retrofit techniques.
- Strengthen civil engineering and architecture programmes with advanced skills for system design, optimisation, and data-driven facility management.
- Enhance cooperation between VET providers, universities, installers, BSOs, and SMEs to support practical, workplace-based learning.
- Increase the quality, safety, and performance of energy-efficient and smart buildings through consistent use of digital monitoring and control systems.
- Accelerate adoption of smart-building technologies across Montenegro’s construction sector.
- Improve renovation capacity, energy performance, and overall competitiveness in line with smart specialisation objectives.

ACRONYMS

AGV	Automatic Guided Vehicles
BAS	Building Automation System
BIM	Building Information Modelling
BMS	Building Management System
BSO	Business Support Organisation
CAD	Computer-Aided Design
CoVE	Centres of Vocational Excellence
CV	Computer Vision
CVET	Continuing Vocational Education and Training
DPP	Digital Product Passport
DSS	Bid Management Decision Support System
EDP	Entrepreneurial Discovery Phase
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
GIS	Geographic Information System
HE	Higher Educations
ICT	Information and Communication Technologies
NDT	Non-destructive testing
NLP	Natural Language Processing
PPE	Personal Protective Equipment
R&D	Research and development
SME	Small and Medium Enterprise
VET	Vocational Education and Training

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