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ABSTRACT	This deliverable analyses the key challenges and gaps faced by the Western Balkans in supporting small and medium-sized enterprises (SMEs) in adopting collaborative robotics technology. It focuses on the region's capacity to meet SMEs' needs for training and skills development, particularly in relation to digitalisation and the adoption of collaborative robots (cobots). The deliverable also assesses the current training provision of Technical and Vocational Education and Training (TVET) schools, evaluating the extent to which they equip students with relevant digital skills and knowledge of cobot technologies.
KEYWORDS	Western Balkans, SMEs, collaborative robotics, cobots, training, skills development, digitalisation, TVET schools, vocational education, workforce readiness.

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EXECUTIVE SUMMARY

Deliverable D2.1, *Mapping the Ecosystem of Technical Job Profiles in the Balkan Region*, identifies key areas for curriculum development aimed at aligning vocational education with the needs of the labour market. Drawing on data from Italy, Bosnia and Herzegovina, Montenegro, and Romania, the report adopts a regional approach to ensure training programmes are relevant, future-oriented, and responsive to industry demands.

The study, with the University Sarajevo School of Science and Technology playing a key role in curriculum development, seeks to ensure that the content is up-to-date, accessible, and reflective of the digital and technological shifts impacting the workforce. To achieve this, the project includes the creation of a comprehensive database, a review of existing literature on labour market trends and skills, and the administration of surveys to both companies and TVET institutions. The resulting analysis will provide a solid foundation for developing curricula that effectively support skills development and employability across the region.

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ABBREVIATIONS

EU	European Union
HR	Human Resources
NGO	Non-Governmental organisations
SME	Small Medium Enterprise
TVET	Technical and Vocational Education and Training
VET	Vocational Education and Training
WB EDIF	Western Balkans Enterprise Development and Innovation Facility

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1 THE WESTERN BALKANS: AN OVERVIEW

The substantial SME characteristics and role in most Western Balkan economies, Italy and Romania, and the corresponding challenges they face regarding the adoption of advanced production and digitalisation technologies will be examined. The research activities of relevant public research or vocational training organisations in these areas, as well as SME awareness, available sources, capacity and efficiency in coping with competitive pressures, will be investigated. The focus will be on the requirement for up-skilling of certain competences and the potential capacity for skill mismatch and skill gaps. Innovative solutions recently discovered and planned to be developed will also be explored. All the above will be of interest and of help to policy makers in shaping a combined and efficient approach to the promotion of a favourable setting guaranteeing smart, sustainable and inclusive growth at regional level. Tested in a common area and in intelligent synergistic efforts, decentralised decisions from a VET point of view, catering for vocational training partnership initiation and management by Western Balkans promotion, may benefit the job market in general and advanced technological solution providers as well as users of SMEs in particular. The findings of the present work will be based on the outputs of a comprehensive literature review on the identified areas. This Deliverable aims to offer to readers with an interest on the above subject a clear and compact view of the expected major research insights and results.

Recently, there appears to be a growing concern in the role and the significance of SMEs for regional economic growth and development. As a result, SMEs have gained increasing attention due to their contribution to a wide range of socio-economic fields such as innovation and job creation, new market openings, and entrepreneurship. In addition, rural SMEs often invest in more conventional sectors and in enterprises and have more modestly skilled owners. On the other hand, rural areas remain underserved by broadband, which is another impediment to business innovation and development. Concerns for job quality and worker conditions in SMEs are also on the rise. As a response to the need to maintain or improve overall competitiveness in the economy, most companies, and in particular SMEs, have been called on to constantly adapt to new market conditions. Such adaptation often requires upgrading products and production processes through the introduction of advanced technology, including digitalization and robotic technologies. Since 2010, it has been observed that the pace of SMEs introducing advanced technology has accelerated, increasing labour productivity and the competitiveness of European SMEs. In the context of competition and the challenge of creating promising products in short development periods, companies need to be equipped with innovative manufacturing solutions. Aware of such constraints, many manufacturing companies, especially SMEs, are looking for new innovative and cost-effective solutions to improve productivity and flexibility, while maintaining production quality and efficiency. In this context, cobots appear as a new cost-effective automation version. While accommodating traditional industrial robots in the market it is necessary to develop safety measures to function in production areas. For some years the need for the widespread use of collaborative robots in the industry has increasingly demonstrated that they can improve the efficiency and productivity of the workforce and have an important impact on business sustainability. This concern in the Industrial Management Literature is shown mainly from two viewpoints. So there is one branch that examines the low usability of development or the rigidity of the traditional industrial robots focusing on the difficulties of their use in frequent changes of production in small volumes or in companies that produce different products in the same production line. On the other hand, a different rhythm analyses the ways it can operate with cobots to achieve improved business performance by carrying out specific or demanding tasks on them. Lastly, the related efforts of work on the important role played by collaboration in the trading, building an open informational cohabitation environment between robot and worker that will be a direct way to enhance productivity by reducing undue movements and time delays in the production process are being examined. However, the introduction of advanced production and digitisation technologies in SMEs is more difficult because of limited organisational capacity and in-house knowledge that has proven to be the biggest barrier to digital technology adoption. The majority of European SMEs are invested in conventional and low-tech industrial sectors and complain that information on advanced technology opportunities and their benefits is lacking. So as not to fall behind competition, SMEs realise the importance of upgrading their production tools and developing new products of high added value; therefore, there is also a strong need for specialised training to master the operation and maintenance of new machines and equipment. SMEs often claim skill shortages as an important obstacle in the adoption of advanced technology. At the same time the industrial digitalisation revolution has occurred and entails a transformation of the entire economy that could lead to improved productivity, reduced production costs, a smaller need for energy and other resources, and less environmental impact. In the post-covid era the public support for SMEs will be expected to increase notably, and part of this support has to be channelled to the enhancement of the digital skills.

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2 METHODOLOGY

The objective of this study is to analyse the current state of vocational education and training (VET) in relation to digitalisation, workforce skills, and labour market demands in Bosnia and Herzegovina, Montenegro, Romania, and Italy. The analysis focuses on the interconnected network of stakeholders, institutions, policies, technologies, and socio-economic conditions that influence the provision, accessibility, and relevance of VET. This includes, but is not limited to, vocational schools and training centres, employers, public authorities, digital infrastructure, educational frameworks, and labour market trends. The study seeks to identify existing challenges and opportunities, as well as to understand how these factors interact to support or hinder the development of digital and green skills within the workforce.

2.1 METHODOLOGICAL STEPS

- Step 1: Development of an Institutional Database
  Objective: To establish a comprehensive database of relevant institutions and organisations engaged in the development of Vocational Education and Training (VET) programmes and the employment of VET students in Italy, Romania, Bosnia and Herzegovina, and Montenegro.

- Activities: Identification and compilation of relevant institutions and organisations involved in the VET ecosystem, including governmental bodies, non-governmental organisations, academic institutions, VET providers, and industry representatives or associations, particularly those representing small and medium-sized enterprises (SMEs).

- Development of an Excel-based database to catalogue these entities, including the following fields: Name of Institution/Organisation, Country, Type of Institution (e.g., governmental, SME association, educational) Contact Information (email, telephone number, address), Areas of Expertise/Focus (e.g., digitalisation, workforce development, employment, sustainability).

2.2 SCIENTIFIC REVIEW OF DOCUMENTS

- Objective: To evaluate the current state of digitalisation, workforce competencies, and labour market needs in the Western Balkans, Romania, and Italy.

- Activities: Collection and review of academic literature, policy frameworks, governmental reports, and industry white papers. Thematic classification of documents under the following categories: Trends in digital transformation Gaps in workforce skills Emerging labour market requirements Content analysis to identify region-specific patterns, challenges, and opportunities. Structured summary of key findings to inform subsequent phases of the research.

2.3 QUESTIONNAIRE-BASED SURVEYS

- Objective:
  - To collect quantitative data on perceptions and practices related to workforce competencies, digitalisation, and sustainability within the VET context
  - To assess the perceived need for and experience of collaboration between SMEs and TVET institutions.

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- Activities:
    - Survey of SMEs
    - Survey of TVET Organisations
- Target Audiences:
    - SMEs, industry associations, and related sectors (for company survey)
    - TVET schools and training providers (for institutional survey)
- Activities:
    - Design of structured questionnaires comprising closed questions utilising a 5-point Likert scale (e.g., from "Strongly Disagree" to "Strongly Agree").
    - Inclusion of the following thematic areas:
    - Significance of digital skills in current business operations
    - Satisfaction with existing workforce competencies
    - Challenges in aligning with labour market requirements
    - Awareness of collaborative robotic technologies (both spontaneous and prompted)
    - If aware: current staff expertise and training needs
    - If unaware: interest in receiving further information
    - Willingness to host VET students for internships
    - Perceived effectiveness of current VET systems
- Dissemination of the questionnaires through:
    - Email communication
    - Online survey tools
    - Partnerships with professional associations and networks
    - Encouragement to target key organisational stakeholders, such as managers, HR professionals, and sustainability officers
- Data Analysis: Survey data will be subjected to statistical analysis to identify prevailing trends, correlations, and regional divergences.

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3 COBOTS' NEEDS IN BOSNIA-HERZEGOVINA

While the potential benefits of cobots are well-articulated, many authors highlight the challenges associated with their implementation. One of the primary concerns is the complexity involved in task allocation and programming. This is particularly relevant in the context of Bosnia-Herzegovina and Montenegro, where the need for vocational training and digital skills is paramount (Schwendimann, B. A., De Wever, B., Hämäläinen, R., & Cattaneo, A. 2018, Li, L., 2022, Schnell, M., & Holm, M., 2022). Many articles presented underscores the importance of developing robust training programs that can equip workers with the necessary skills to operate and program cobots effectively. This need aligns with the broader trends of digital transformation in the workplace, where employees must adapt to new technologies and processes.

Furthermore, different studies (Jennes & Di Minin, 2023, Schnell, M., & Holm, M., 2022, Lambrechts, W., Klaver, J. S., Koudijzer, L., & Semeijn, 2021) emphasize the economic implications of cobot deployment, noting that the costs associated with programming can constitute a significant portion of automation project budgets. This aspect is critical for countries like Western Balkans where economic constraints may limit investment in advanced technologies. As new players enter the collaborative robot market, pricing pressure may alleviate some of these costs, potentially making cobots more accessible to industries in these regions.

Many researchers also touch on the ergonomic benefits of cobots, particularly for older workers who may face increased risks of musculoskeletal disorders. This point is particularly relevant in the context of labour demographics in the mentioned countries, where an aging workforce poses challenges for many sectors. By reducing the physical and cognitive load on workers, cobots could facilitate a more sustainable workforce, allowing older employees to remain productive longer.

The article "Hybrid Approach to Automation, RPA and Machine Learning: a Method for the Human-centered Design of Software Robots" by Kopeć et al. (Kopeć et al., 2018) presents a comprehensive exploration of the integration of Robotic Process Automation (RPA) within the framework of Industry 4.0, particularly emphasizing the human-centered design of software robots. The authors suggest that the transition to automated processes can lead to the displacement of traditional jobs, which is particularly relevant for the countries examined. The authors advocate for a hybrid approach that not only focuses on the technical aspects of RPA but also actively involves human participants in the design and maintenance of these technologies. This participatory design model is posited as a means to mitigate the adverse effects of automation on the workforce by **transforming menial job roles into higher-skilled positions. This is crucial in regions where vocational training and digital skills are still developing**, as it aligns with the need for workforce adaptation in the face of evolving technological landscapes. This approach will not only empower individuals but also ensures that the automation processes are tailored to the specific operational realities of businesses in these countries.

Moreover, the authors highlight the importance of integrating artificial intelligence methods and tools to facilitate this transition. The incorporation of collaborative machine learning in the cloud is presented as a means to support workers in their new roles, enabling them to supervise and contribute to the machine learning processes that underpin the software robots. This aspect is particularly relevant in the context of the metaverse, where digital skills are paramount, and the ability to engage with advanced technologies can significantly impact employment opportunities.

The article "A virtual reality environment for training operators for assembly tasks involving human-cobot interactions" by Amezua Hormaza (Amezua Hormaza, 2019) presents a comprehensive exploration of the necessity for **effective training methods in the context of human-robot collaboration**, specifically focusing on collaborative robots (cobots). The author outlines the significant benefits that cobots bring to industrial processes, such as reducing operator fatigue and stress. However, the article highlights a critical barrier to the successful integration of cobots in the workforce**: the need for operators to develop trust and comfort in working alongside these machines.**

The psychological barrier that may arise from the process necessitates the development of training methods that not only educate operators about the functionality of cobots but also foster a sense of confidence and competence in their interactions with these machines. The article proposes an off-the-job training model that

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incorporates class lectures and simulations, with a particular focus on the advantages of Metaverse environments over traditional training methods, such as PowerPoint presentations.

The experimental results presented in the article are particularly noteworthy, indicating that operators who underwent training in a 3D virtual environment exhibited superior cognitive performance and reactions in emergency situations compared to those trained through conventional methods. This finding underscores the effectiveness of immersive training experiences in enhancing operator preparedness and trust in cobots, which is crucial for the successful implementation of such technology in industrial settings.

In the context we are examining, the insights from this article are particularly relevant. As these countries strive to advance their vocational training systems and integrate digital skills into their workforce, the adoption of innovative training methodologies, such as those utilizing virtual reality, could significantly enhance the readiness of operators to work alongside cobots. The emphasis on building trust through simulation training aligns with the growing need for skilled labor in the region, particularly as industries increasingly adopt automation technologies.

The article "Co-Robots as Care Robots" by Oliver Bendel (Bendel, 2020) provides a comprehensive overview of the role of cooperation and collaborative robots, commonly referred to as cobots, in the care sector. The author emphasizes the increasing reliance on cobots for specific tasks in care and therapy, highlighting their potential to enhance both efficiency and quality of care. This focus on cobots is particularly relevant in the context of the evolving needs of the countries we are focusing on, where vocational training and digital skills are crucial for integrating such technologies into the workforce.

The article notes that cobots are designed to work closely with human colleagues, which is essential in environments where collaboration is key. This aspect of cobots could be particularly beneficial in the context of vocational training programs in Bosnia-Herzegovina, Montenegro, and Romania, as they could help bridge the gap between traditional caregiving roles and the technological advancements in the field.

Furthermore, Bendel highlights the advancements in the design and programming of lightweight cobots, which are crucial for ensuring safety and efficiency in production and logistics. This is an important consideration for countries in the region that may be looking to modernize their industries and improve their service sectors. The integration of cobots into vocational training curricula could provide future workers with the necessary digital skills to operate and collaborate with these machines effectively.

A critical evaluation of the material reveals that while the article effectively outlines the potential benefits of cobots, it falls short in addressing the specific vocational training and digital skills required for the workforce in the regions of interest. The successful implementation of cobots necessitates a workforce that is not only familiar with robotic technologies but also skilled in digital competencies that enable them to operate and collaborate with these machines effectively.

The implications of the studies abovementioned are particularly pertinent for regions such as Bosnia-Herzegovina, Montenegro, where the integration of cobots into production processes may be hindered by a lack of skilled labor. Many authors highlight the necessity for vocational training programs that focus not only on traditional manufacturing skills but also on digital competencies that enable workers to effectively collaborate with advanced technologies. This aligns with the broader trend of digital transformation in the workforce, where familiarity with automated systems and digital tools is becoming increasingly essential.

Moreover, the concept of utilizing the metaverse for training and skill development presents an exciting avenue for enhancing the workforce's capabilities in these Regions. By leveraging immersive technologies, vocational training can become more engaging and effective, allowing operators to practice and refine their skills in a virtual environment before applying them in real-world scenarios. This approach could bridge the existing skills gap and prepare workers for the demands of modern manufacturing, where cobots are likely to play a significant role.

The body of research in this area is still nascent, with a limited number of studies published to date.

One of the key insights of the articles examined is that they underscore the importance of understanding ergonomic principles and task allocation strategies in the context of cobot implementation. Training programs in

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these regions could greatly benefit from incorporating such concepts, ensuring that future workers are equipped with the necessary digital skills to operate effectively alongside robots.

Moreover, the analysis of simulation technologies and their role in predicting human actions and intentions is particularly relevant for the development of digital skills. This indicates a potential area for vocational training initiatives to focus on, as familiarity with these platforms could enhance the employability of individuals in a rapidly evolving job market influenced by automation and digital technologies.

3.1 VOCATIONAL TRAINING IN BOSNIA-HERZEGOVINA

The exploration of collaborative robots (cobots) and their integration into various sectors has gained significant traction in recent years, particularly in the context of enhancing productivity and improving working conditions. (Vergara et al., 2018) highlight the dual potential of cobots to assist assembly operators by alleviating both physical and cognitive burdens, particularly in industries facing an aging workforce. Their findings underscore the necessity for effective programming and deployment strategies to maximize the benefits of cobots, which could be crucial for regions like Bosnia-Herzegovina, Montenegro, and Romania, where workforce demographics may present unique challenges.

Kopec further delves into the implications of automation (Kopeć et al., 2018), particularly through Robotic Process Automation (RPA) and its integration within a human-centered design framework. They emphasize the importance of addressing the social impacts of automation, advocating for a hybrid approach that transforms menial jobs into higher-skilled positions. This perspective is vital for vocational training initiatives in the aforementioned countries, as it suggests a pathway to empower workers amidst technological advancements.

In a practical application of cobots, (Amezua Hormaza, 2019) discusses the design of training methods for operators engaging in human-cobot interactions. The study illustrates the significance of building operator confidence through **training simulations**, which could enhance the effectiveness of cobots in industrial settings. This approach is particularly relevant for vocational training programs that aim to equip the workforce with the necessary digital skills to thrive in a collaborative environment.

The study of Kumar Murali et al., (2020) contributes to the discourse by presenting a flexible human-robot collaboration model, which addresses the critical bottleneck of developing algorithms that facilitate seamless interaction between humans and robots. This research highlights the need for practical solutions that can be implemented in manufacturing environments, aligning with the vocational training needs for a skilled workforce capable of navigating advanced technologies.

The evolving landscape of cobot applications is further explored by (Schmidt & Meitinger, 2023) who propose a user-centered approach to delegating high-level tasks to cobots. Their findings indicate that bridging the communication gap between operators and cobots is essential for efficient operation, underscoring the importance of training programs that focus on enhancing digital competencies among workers.

Finally, Shaaban et al., (2023) provides a comprehensive analysis of digital twins in the context of human-robot collaboration, emphasizing their potential in enhancing training and operational efficiency. Their work highlights the importance of integrating advanced simulation technologies, such as augmented and virtual reality, into vocational training curricula, particularly for regions like Bosnia-Herzegovina and Montenegro, where the adaptation of digital skills is crucial for future workforce readiness.

Overall, the literature reflects a multifaceted approach to understanding the interplay between cobots, vocational training, and the development of digital skills, particularly in the context of the metaverse, thereby providing a robust foundation for further exploration and implementation in the specified regions.

In Bosnia-Herzegovina Vocational Education and Training (VET) qualifications are organised in alignment with the educational levels prescribed by VET Law No. 15/2017. These qualifications adhere to various structural formats, such as 2+1+1 years, 2+2 years, and four-year programs. Program duration range from one to four years, with the 2+1+1 format being the most prevalent. This structure involves two years of foundational vocational training,

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followed by one year of specialization and an additional year of skill consolidation. Programmes in fields like business administration, information and communication technology (ICT), and forestry typically follow a 2+2 framework, leading to a Technician or Middle Manager certification. For certain professions, including geodesy, veterinary services, and elderly care, a four-year program structure is available. Graduates attaining qualifications at Albanian Qualification Framework (AQF) Level 4 are eligible to sit for the Professional State Matura examinations, which are administered jointly by the Ministry of Education and Sports (MES) and the Ministry of Finance and Economy (MFE). Successful candidates receive a Professional State Matura Diploma, which not only facilitates access to tertiary education but also qualifies them for Level 5 post-secondary VET programs. The public VET infrastructure is composed of 34 vocational schools and 10 public Vocational Training Centers (VTCs) distributed across 12 regions. Meanwhile, the private VET sector consists of 8 vocational schools and approximately 987 licensed VTCs. (Data from: Regional VET Environment Scan, University Sarajevo School of Science and Technology, 2024).

Vocational education in Western Balkans represents a crucial issue that hampers labour markets and perpetuates social exclusion. The education systems in the region are highly selective, with the best-performing students entering gymnasia while others attend vocational education training (VET) schools. Children of VET-educated parents are likely to follow in their parents' footsteps. However, the **high rates of vocational enrolment do not translate into effective skill formation**. The economic crisis has led to extreme unemployment rates, with Bosnia and Herzegovina recording the highest youth unemployment rate. The risk of further social unrest will persist unless young people are provided with the skills necessary to access productive jobs and secure a more optimistic future.

3.2 CHALLENGES IN VOCATIONAL EDUCATION IN BOSNIA- HERZEGOVINA

The selective entry process in vocational education (VET) schools in the Western Balkans limits upward mobility for students, as working-class youth and disadvantaged students are more likely to be enrolled. Students from economically disadvantaged backgrounds also lack home study support, which is crucial for their learning process. **Once students enter VET schools, they often encounter a poor educational environment that reinforces social exclusion**. Poor infrastructure, outdated curricula, ineffective teaching methods, and weaknesses in teachers' subject knowledge contribute to this issue. In Bosnia and Herzegovina, the curricula for some subjects have not been updated since 2003, and teachers are often reluctant to change their teaching programmes due to fears of job loss. Disabled students and those from disadvantaged backgrounds frequently have unsatisfactory experiences at school, characterised by bullying, unfriendly teachers, and poor learning opportunities. Practical training hours vary across schools and countries, with preferential access to apprenticeships given to more advantaged students. After leaving school, students often rely more on family and friends for job assistance.

3.3 SMES IN WESTERN BALKANS IN ECONOMIC DEVELOPMENT

The Western Balkans Enterprise Development and Innovation Facility (WB EDIF) is an EU-funded initiative aimed at improving access to finance for small business owners in the Western Balkans. Leveraging the expertise of 27 international, regional, and local market players, the WB EDIF mobilises approximately EUR 650 millions of financing and support for SMEs. The initiative aims to strengthen the competitiveness of small businesses across the region by improving access to finance on preferential terms and offering advice and guidance. WB EDIF is a joint initiative of the European Union, Western Balkans economies, and other core partners, including the European Investment Bank, the European Investment Fund, and the European Bank for Reconstruction and Development.

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3.4 IMPORTANCE OF SMES IN WESTERN BALKANS

Small and medium-sized enterprises (SMEs) are crucial for economic growth, innovation, social integration, and job creation in the Western Balkans and the EU. In the Western Balkans, SMEs employ between 60% and 80% of the active population, which is higher than in the EU. The EU and its partners under the WB EDIF initiative aim to ensure the future of these enterprises. Launched in 2013, WB EDIF provides financing and business support to SMEs in the Western Balkans, contributing to the overall growth and development of the region's economies.

Smaller firms are highly dependent on their environments, and their competitiveness stems from their ability to successfully leverage communal resources and local public goods. A possible suggestion is that regional integration agreements should focus on the strategies of resilient and resourceful firms on the ground and seek to reinforce them. The emphasis on SMEs is important due to their fundamental role in the Western Balkan economies, especially as most existing analyses have primarily considered the macroeconomic and aggregate effects of deeper economic integration among WB countries.

3.5 COLLABORATIVE ROBOTS IN SMES

There are many synergistic benefits of human-robot collaboration, particularly in small and medium-sized enterprises (SMEs). Studies indicate **that SMEs that integrate collaborative robots (cobots) can achieve greater competitiveness and accelerated growth, with potential effectiveness increases of up to 85% compared to traditional manpower**. As the demand for automation rises, many companies seek to enhance their operational efficiency and profitability. While larger firms typically adopt automation due to their financial resources, smaller businesses often hesitate due to concerns over return on investment and the space required for these technologies. However, the rising costs of labour and labour shortages have prompted many SMEs to consider cobots, which are affordable, require minimal training, and offer a swift payback period.

Collaborative robots enhance the flexibility of production processes not only in large firms but also in SMEs. They are easy to implement and occupy minimal space, creating a safe working environment for humans and machines to operate together. The integration of collaborative robots (cobots) into the workforce of the Western Balkans presents many opportunities. Cobots offer a dual potential: enhancing productivity while addressing workforce challenges, making them an invaluable resource for small and medium-sized enterprises (SMEs) in the region.

Research highlights cobots' capacity to alleviate physical and cognitive burdens, especially for aging workforces, as noted by Vergara et al. (2018). However, effective programming and deployment strategies tailored to regional labor market needs are crucial for realizing their full potential. Kopeć et al. (2018) stress the social implications of automation, advocating for hybrid approaches that combine cobot integration with upskilling and reskilling initiatives to elevate lower-skilled roles into higher-skilled positions.

Innovative training methodologies further strengthen these efforts. Amezua Hormaza (2019) highlights the value of virtual reality in fostering trust and competence in human-cobot interactions, while Kumar Murali et al. (2020) and Schmidt & Meitinger (2023) emphasize the importance of user-centered task delegation and flexible human-robot collaboration models. Such approaches ensure smoother cobot adoption while equipping workers with the necessary skills to thrive in automated environments.

In addition to cobots, the use of immersive technologies such as the metaverse presents promising opportunities for enhancing the effectiveness of vocational training. By creating interactive, simulated environments that replicate real-world industrial settings, the metaverse enables learners to engage in experiential learning that bridges the skills gap and better prepares them for the demands of increasingly automated and digitally driven workplaces.

The situation in SMEs across the Western Balkans underscores the urgency of aligning vocational education with industry demands. Cobots, known for their affordability and ease of training, provide a practical solution for SMEs, especially those hesitant to invest in automation due to cost concerns. With the ability to boost efficiency

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by up to 85%, cobots can significantly enhance competitiveness and growth in SMEs, particularly those employing fewer than ten workers.

For these benefits to materialize, robust connections between vocational education and local industries are essential. High-quality vocational training institutions, well-equipped with infrastructure and skilled human resources, must be prioritized. Additionally, integrating job placement and counseling services within vocational programs can improve workforce transition rates, addressing high unemployment levels in the region.

In conclusion, the literature highlights the transformative potential of combining collaborative robots and innovative vocational training strategies in the Western Balkans. By leveraging cobots, immersive technologies, and industry-aligned education, the region can address automation and demographic challenges while fostering economic growth. Investments in vocational institutions, workforce upskilling, and digital competencies will be pivotal in creating a resilient, adaptable labor market prepared for the demands of the future.

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4 COBOTS IN MONTENEGRO: CHALLENGES

One of the major outcomes of the analysis of the Montenegro situation is that while Operating Industries are ready to implement Cobots and introduce them to their workforce, the workforce needs to be trained accordingly (Bejarano, 2019). Montenegrin Educational Organizations have always been slow to adapt to the changing environment. As technology triumphed in all trades, jobs began to be proposed and performed differently than before. In the past 20 years, Robotics and AI have emerged as one of the leading technological revolutions. So far, Educational Organizations either ignored it or adapted it to their curriculum in an incorrect way. However, Operating Industries expressed a great interest in conducting Training Programs for Cobots even as a part of Up-Skilling current employees. They need short and application-oriented courses, sometimes not demanding even accredited certificates (Vergara et al., 2018). On the other hand, they expressed a low degree of trust in Educational Organizations, accusing them of being behind the time or trying to impose theoretical and general knowledge instead of application-oriented training. Pressing the need for knowledge, skills, and competencies, the Classification of Knowledge, Skills, and Competences was applied to all staff members of the Educational Organization who took part in the interview. As they declared their position, they emphasized that they had a big challenge ahead of them. Many things needed to be learned, done, and improved from basic literature and experience in Robot programming and application. They seem ready to undertake all necessary steps to acquire previously mentioned knowledge, skills, and competencies. At the same time, they should prepare their Training Programs for Cobots properly. Despite the advantages of introducing cobot training in VET schools, certain challenges might delay this process. Some schools might face difficulty regarding staff training. It would be necessary to send specialized teachers for education and training on cobots. This would mean additional expenses to send teachers abroad for training or expenses to involve relevant firms in training teachers. The next challenge could be regarding the preparation of labs and obtaining adequate teaching equipment. It is known that older teachers are exposed to a bigger challenge if they decide to upgrade their knowledge regarding AI or robotics. This might be a reason why the same teachers teach the same material over decades. However, this problem can be solved by inviting guest teachers occasionally. It should also be noted that the younger generations are more inspired and interested in advanced technologies, such as cobots and AI (Schmidt & Meitinger, 2023). The advantages of cobots' usage in education involve interactive teaching, teaching outside of regular classrooms, engineers' work being less boring, helping more to students with disabilities. These examples are only a few suggestions on how they could be used in schools. Interactive teachers are now in the FRI teaching module of the last robotics course. In conjunction with the lesson from the textbooks, the teacher is showing how robots behave and the basic main ideas in programming a robot. Instead of normal teaching in the classroom, a teacher may choose a more inspiring way. Teaching in the industry where engines and robots are used to bring students closer to the real implementation of the acquired knowledge represents a great opportunity. In many cases, engineering buildings contain hazardous objects, which are better to avoid during education. The introduction of collaborative robotic arms into educational laboratories presents a significant financial challenge; however, through virtual environments in the metaverse, students can design and interact with custom user interfaces (UIs) for cobots, enabling simulated hands-on experience that mirrors real-world industrial applications without the need for extensive physical infrastructure.

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5 COBOTS IN ITALY: CHALLENGES

The integration of human-robot collaboration within the industrial landscape has become increasingly relevant, particularly in the context of small and medium-sized enterprises (SMEs) in Italy. As the manufacturing sector evolves, so does the need to align vocational training with emerging technological advancements, such as the introduction of collaborative robots (cobots). These innovations offer significant potential for improving operational efficiency and **addressing labour shortages**, yet they also underscore the necessity for systematic workforce development to enable effective human-robot collaboration.

Vocational training in Italy, however, remains insufficiently developed across SMEs. According to the latest issue of SINAPPSI, the scientific journal by Inapp (National Institute for Public Policy Analysis), only 56.7% of micro-enterprises offer training courses, compared to 94.1% of large companies. Most of these courses focus on regulatory and legal compliance (84.5%), with just 32.5% addressing specific skills or production and service technologies. Low-skilled workers, who would benefit most from training, are often excluded. Meanwhile, the old-age dependency ratio—37%, one of the highest in Europe—further amplifies the challenges faced by the labour market.

The integration of cobots within SMEs could provide a means to address these challenges, as evidenced by research such as Bejarano (2019). The study highlights the potential of human-robot collaborative assembly workstations in modular production environments, emphasizing the importance of adapting vocational training to support these new technologies. Cobots are particularly suited for SMEs due to their capacity to augment human capabilities rather than replace them, **enabling businesses to overcome labour shortages and technological gaps.**

The market for industrial robots in Italy produced an overall revenue of around €971 million in 2021, almost a 50% increase compared to the previous year, which placed Italy among the largest consumers of industrial robots, the most significant being Germany, Japan, the US, and China. About 34% of the total industrial robot revenue came from car manufacturers, while the machine manufacturing industry represented 15%, while the metal products and plastics and rubber combined represented another 15%. The cobots currently make up about 2.5% of the total market for industrial robots. However, the rapid growth of the market was expected to continue, from a revenue of €360 million from cobots in 2023 to €1.2 billion by 2027. Cobots still accounted for only 4% of the total industrial market share, thus leaving plenty of room for growth and gradually capturing higher-value tasks such as picking and placing, gluing and dispensing, welding, and material removal. While Italy is the leading consumer of industrial robots, with an investment of €86 million, compared to €82 million from the Netherlands and €80 million from Sweden, there is keen interest in acquiring experience and technical know-how to diffract ripple effects of these new technologies to jobs in process and assembly sectors where the usage of robots is currently scarce (Bruno & Polli, 2017).

Different market conditions could be considered standstill points when interpreting demand and readiness for robots and cobots. Research on those factors that might drive or hinder investment decisions regarding robots and cobots focused mainly on large companies. In the meantime, SMEs are likely to stay under the radar of these inquiries, even though they may differ significantly from larger companies in terms of product type sophistication, financial situation, managerial attention, work practices, personnel policies, and networks. Moreover, it was noted that SMEs face a unique set of barriers or concerns, such as technological, knowledge, awareness, and collaborative barriers. Despite the tremendous potential benefits of collaborative robots (cobots), barriers to successful deployment remain across manufacturing sectors and company sizes, as it may require additional research, development, and understanding of both business models and user interactions (Vergara et al., 2018).

Following recent researches, the design and implementation of collaborative robots within industrial settings, particularly in SMEs has great relevance. The operational dynamics of dual-arm cobots in a modular production environment, reveals the advantages associated with their adoption in industry. Key findings of the studies examined include a reduction in processing times and improved flexibility in production lines, which are critical for SMEs facing resource limitations.

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However, **the current literature research also highlights potential inefficiencies during the initial integration phase, underscoring the need for targeted vocational training. Workers must acquire the skills necessary to collaborate effectively with robotic systems, ensuring that productivity gains are maximised**. These findings resonate with broader trends in Italy, where only 9.9% of workers participate in vocational training, far below the European Union's target of 15%. The scarcity of training opportunities, particularly in southern regions, further exacerbates this issue.

The adoption of cobots represents a paradigm shift in industrial automation, emphasizing collaboration rather than replacement. This shift necessitates not only technological upgrades but also cultural and organizational changes within SMEs. Researches conducted highlight the importance of training programs that address both the technical and interpersonal aspects of human-robot collaboration. Additionally, the proposed development of context-aware error handlers for cobots reflects the need for continuous innovation in both technology and workforce education.

5.1 ADDRESSING THE GAP: VOCATIONAL TRAINING AND TECHNOLOGICAL READINESS

Despite the promise of cobots, the broader adoption of digital technologies among Italian SMEs remains limited. **Only 5% of companies have implemented essential tools for competing in the digital era**, a figure starkly below the **European Commission's Pathway to the Digital Decade goals**. Similarly, only 4.8% of businesses have submitted training proposals under the New Skills Fund, with 81.5% unaware of its existence. This lack of awareness and underutilization of available resources highlights the critical need for better communication and support mechanisms to encourage SMEs to invest in workforce development.

Given the central role of the state in the vocational education and training (VET) system, SMEs—as well as large employers—can shift most of the costs of training onto the government. This creates an "equalising" mechanism: around 30 percent of SMEs engage in training, which is similar to the UK (26.6 percent). Large employers also rely on the public funding, with their participation rate only eight percentage points higher than SMEs, indicating a small participation gap. Consequently, training costs are quite low—companies with between twenty and fifty employees spend on average around €1,180 per employee/year (compared to £2,800 in the UK), while employers with above 250 employees spend less than €100 more (ISTAT 2015).

Furthermore, when SMEs' direct involvement in skill formation is required due to the dual learning, local networks of schools, companies, and employers' associations, and chambers of commerce help them navigate the system and reduce the cost of participating. This collaborative ecosystem supports SMEs in overcoming barriers to training engagement, aligning vocational education with market needs, and enhancing their technological readiness.

The current priorities in Italy are: promoting investment in training and retraining, aligning workers' skills with labour market demands, and ensuring a match between individual aspirations and market opportunities, particularly in sectors undergoing green and digital transitions.

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6 COBOTS IN ROMANIA: CHALLENGES

The integration of collaborative robots (cobots) into the manufacturing landscape presents a transformative opportunity for small and medium-sized enterprises (SMEs) in Romania, particularly in enhancing productivity and improving working conditions. (Vergara et al., 2018) delves into the potential of cobots to alleviate the physical and cognitive burdens faced by assembly operators, especially within an aging workforce. The article emphasises that as physical capabilities wane with age, the risk of musculoskeletal disorders escalates, necessitating the incorporation of cobots to support operators in their tasks. This is particularly relevant for Romanian SMEs, where the workforce demographic is shifting, and the need for innovative solutions to maintain operational efficiency is critical.

The authors highlight significant challenges associated with the deployment of cobots, particularly the costs linked to programming and the expertise required for effective automation. This aspect is crucial for Romanian SMEs, which often operate under financial constraints and may struggle with the upfront investment necessary for automation projects. (Vergara et al., 2018) suggest that the demand for flexibility in manufacturing processes is driving the need for more advanced programming capabilities and rapid reconfigurations, which could further complicate the automation landscape for SMEs. However, the emergence of new players in the cobot market is creating pricing pressures that could make these technologies more accessible to smaller enterprises.

Moreover, the article underscores the **importance of developing robust and quickly deployable robot applications that can adapt to varying environments, a necessity for SMEs that frequently encounter fluctuating market demands and operational challenges**. The insights provided by (Vergara et al., 2018) set the stage for exploring how Romanian SMEs can leverage cobots not only to enhance productivity but also to address the evolving needs of their workforce, thereby aligning with the broader trends in automation and vocational training within the industry.

6.1 VET TRAINING IN ROMANIA: STATE OF THE ART

The article "Improving productivity and worker conditions in assembly: part 2: rapid deployment of learnable robot skills" by Vergara et al. (Vergara et al., 2018) provides an insightful examination of the role of collaborative robots (cobots) in enhancing productivity and improving the working conditions of assembly operators. The authors highlight the growing necessity for SMEs, particularly in the Romanian context, to adapt to an aging workforce that presents challenges in physical and cognitive capabilities. This demographic shift is pertinent as it directly affects performance levels and operational efficiency within these enterprises.

One of the key insights presented in the article is the potential of cobots to alleviate the physical and cognitive stress experienced by assembly operators. By assisting with heavy lifting and performing repetitive tasks, cobots can significantly reduce the burden on human workers, thereby enhancing their productivity and overall job satisfaction (Vergara et al., 2018). This is particularly relevant for Romanian SMEs, which may struggle with workforce sustainability as older employees retire and younger workers seek different employment opportunities.

The research also addresses the complexities associated with the integration of cobots into existing assembly lines. the studies emphasise the importance of **task allocation between humans and cobots, as well as the challenges of programming these robots to be flexible and adaptable to varying operational contexts**. This is a crucial consideration for SMEs, which often operate with limited resources and require cost-effective solutions to maintain competitiveness in the market (Vergara et al., 2018). The article discusses how the costs associated with programming can constitute a significant portion of automation project expenses, highlighting the need for SMEs to seek out affordable and efficient programming solutions to maximize the benefits of cobot deployment.

Furthermore, the emergence of new players in the collaborative robot market has introduced competitive pricing pressures**, making cobots more accessible to SMEs**. This democratisation of technology is vital for Romanian SMEs, which may have previously viewed automation as a luxury rather than a necessity. The authors suggest that developing quickly deployable and robust robot applications is essential for addressing the dynamic needs

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of these businesses, especially in light of the rapid changes in the manufacturing landscape (Vergara et al., 2018). The integration of collaborative robots (cobots) into Romanian small and medium-sized enterprises (SMEs) presents significant opportunities for improving productivity and working conditions, especially in the context of an aging workforce. The article emphasises that cobots can alleviate the physical and cognitive burdens faced by assembly operators, which is increasingly important as the demographic shifts within the workforce affect operational efficiency. The authors point out that as physical capabilities decline with age, the risk of musculoskeletal disorders rises, making the adoption of cobots an essential strategy for maintaining productivity in SMEs.

However, the deployment of cobots is not without challenges. **The article highlights the financial constraints that many Romanian SMEs face, particularly the costs associated with programming and the technical expertise required for effective automation**. This is crucial, as many SMEs may struggle with the initial investments needed for automation projects. The demand for flexibility in manufacturing processes further complicates this landscape, necessitating advanced programming capabilities and rapid reconfigurations to adapt to changing market conditions. The authors note that while these challenges exist, the emergence of new players in the cobot market is driving down prices, potentially increasing accessibility for smaller enterprises.

Moreover**, the need for quickly deployable and adaptable robot applications is underscored, as SMEs often deal with fluctuating market demands and operational challenges**. The insights illuminate how Romanian SMEs can leverage cobots not only to enhance productivity but also to address the evolving needs of their workforce. This alignment with broader trends in automation and vocational training is vital for the sustainability and competitiveness of these enterprises.

In conclusion, the literature reviewed highlights the transformative potential of cobots for Romanian SMEs, particularly in improving working conditions and productivity amidst an aging workforce. While challenges related to costs and programming complexities remain, the evolving market dynamics and the need for flexibility present opportunities for these enterprises to adopt automation solutions that can sustain their operational efficiency and workforce engagement.

The development of the Intelligent Industry in Romania is envisioned to unfold in stages. Stage I involves the digital transformation of intelligent parts and subsystems, followed by Stage II, which focuses on the digital development of the Digital Enterprise and Intelligent Industry ensemble. These stages align with Romania's Intelligent Industry Strategy, Action Plan, and Roadmap.

The next phase involves implementing Industry 4.0's basic elements through national decisions, integrating this strategy into Romania's National Development Strategies. The Roadmap for Industry Strategy 4.0 will encompass all necessary components for its successful implementation, including digitization architecture and professional, technological, human, and social resources. These solutions, designed and implemented in industrial environments for the Intelligent Industry's consolidation, form the foundational pillars for the Smart Industry and Digital Enterprise in Romania.

6.2 RELEVANCE OF SMES IN ROMANIA

Small and medium enterprises (SMEs) are crucial to Romania's economy, **comprising 99.7% of active companies**, 66% of non-financial private sector employment, and 56% of gross value added. Microenterprises dominate, making up 90% of SMEs. Large enterprises, though only 0.3% of businesses, provide 34% of employment.

Romanian SMEs lag behind EU averages in productivity. Their value added per employee is around €16,500, significantly lower than the EU average of €40,000. Neighboring countries like Hungary, Croatia, and Poland outperform Romania by 20-25% in this metric.

Digitalisation levels of Romanian SMEs also fall short compared to other European countries. In the 2021 Digital Economy and Society Index, **Romania ranked last among 27 EU countries**. This index evaluates human capital, digital technology integration, digital public services, and connectivity.

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Within Romania, productivity and digitalisation vary considerably across regions. Bucharest leads, followed by Cluj and the North-West region, while rural areas lag behind. A correlation between productivity and digitalisation is evident at the regional level.

The lower labour costs in Romania might partially explain the low digitalisation levels of SMEs compared to peers. A positive correlation exists between DESI performance and labor costs as a percentage of GDP across EU member states. Countries with lower labour costs relative to GDP, including Romania, tend to have lower digitalisation levels.

This suggests that where labour is cheaper, businesses may feel less pressure to digitalise. Conversely, in countries with higher labor costs, there may be stronger incentives to digitalize to maximize employee value. For example, Lithuania, Estonia, and Croatia have higher labour costs as a proportion of GDP than Romania and higher digitalisation levels.

Although Romania has experienced an average growth rate of 2.8 percent, the country's growth foundations remain weak. In recent years the population has decreased from 22.8 to 19.6 million and is expected to continue declining. **Romania ranks as a significant source of migration flows within the G20, with highly educated emigrants making up 26.6 percent of these migrants**. Additionally, Romania has the highest share of poor people in the EU, with over a quarter of the population living on less than $5.50 a day. There are significant disparities in poverty across regions and between urban and rural areas. Of Romania's 42 counties, 18 are considered lagging behind, with a GDP per capita lower than 75 percent of the national average.

Romania still has substantial untapped labour potential and low levels of human development. The informal sector represents 0.6 percent of the total population, and the labour market participation rate is 69.9 percent, below the EU average of 73 percent. Romania also has the lowest Human Capital Index (HCI) score in the European Union, lower than what would be predicted by the country's income level.

Underachievement in basic skills impacts vocational education and training (VET) students' outcomes and their performance in the labour market. Romania's scores on the Programme for International Student Assessment (PISA) improved significantly across all subjects but remained stagnant in subsequent years. Test results show that about 40 percent of 15-year-old Romanian students score below the minimum numeracy and literacy proficiency levels required to perform effectively in further education, training, and life, compared to roughly 23 percent of students in the EU.

Persistent low financing levels for education affect the development of the VET system. Romania's public expenditure for education as a percentage of GDP is far below the EU average and the lowest in the EU. Regarding VET alone, a recent analysis of public expenditures on education shows that VET in Romania accounted for a small percentage of the total budget execution compared to higher and lower secondary education.

In this context, the Romanian VET system has undergone significant policy reforms over the past two decades. Since the early 1990s, efforts have been made to increase the quality and relevance of VET programmes for the emerging market economy by implementing a series of structural reform programmes. Starting with EU-funded projects for VET teacher training programmes, curriculum revision, and the development of new training standards, Romania has made strides in improving its VET system. The introduction of the dual VET system has contributed to recent increases in participation in the three-year VET programmes.

Despite recent progress, challenges remain. The gross participation rate in upper secondary education has been continuously dropping, with significant dropout levels, particularly in the technological track. A recent analysis on student performance at national examinations shows that a high share of low-performing students are entering upper secondary education, mainly through the technological route. Infrastructure shortages in Romanian VET schools are significant, with approximately 35 percent lacking workshops.

Latest data indicate higher labour market outcomes among Romania's VET graduates compared to those of general education, but there are important shortages and misalignment of skills. Romanian secondary school graduates who entered the labour market without further education perform better if they are VET graduates, with an employment rate higher than those from general education tracks. Automation of production processes is driving demand for higher levels of cognitive skills, while jobs involving routine application of procedural

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knowledge are shrinking. Employers believe that students and graduates entering the labour market lack key soft skills.

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7 QUESTIONNAIRE BASED SURVEYS

As part of the MetaVET project, a survey has been developed to gather empirical data from Small and Medium-sized Enterprises (SMEs) and TVET organisations in the Western Balkans regarding their current and anticipated needs in the areas of digitalisation, advanced technologies—including collaborative robotics and the Metaverse—and workforce development. The overarching objective is to develop a training programme that is responsive to the region's evolving labour market requirements.

This survey is designed to assess the priorities, challenges, and technological readiness of companies operating across diverse industrial sectors. It also explores attitudes towards vocational education, training partnerships, and capacity-building in digital and emerging technology domains. Particular attention is given to understanding perceptions around digital skills shortages, gender equality, training accessibility, and the potential for industry-academia collaboration.

- Relevance of the Survey
  The Western Balkans face significant socioeconomic transitions marked by brain drain, limited access to cutting-edge technology, and the growing need for a digitally skilled workforce. Against this backdrop, SMEs are critical agents of economic growth and innovation. This survey aims to produce actionable insights into how these enterprises are adapting to digitalisation trends, where support is most urgently needed, and what opportunities exist for vocational education providers to align their offerings with market demands.
- Difference from the TVET School Survey
  While the companion survey directed at TVET institutions focuses on internal capacities, curriculum relevance, and institutional cooperation strategies, this company-oriented survey captures the perspective of employers. It measures how the demand side of the labour market perceives and interacts with VET systems and technological developments. The two instruments are thus complementary: one reflects the supply of education and training, the other, the real-time demand for skills.
- Expected Quantitative Outputs
  Through structured Likert-scale questions and multiple-choice responses, the survey will generate quantitative indicators in the following areas:
    - Degree of satisfaction with workforce competencies
    - Importance attributed to digital and vocational training
    - Prevalence of collaboration with TVET institutions
    - Types of missing digital competencies (e.g., AI, IoT, blockchain, collaborative robots)
    - Estimated training hours provided per employee
    - Interest in hosting interns and engaging in dual-learning programmes
    - Familiarity with and readiness to adopt collaborative robotics
    - Anticipated hiring plans for 2025

The results enabled statistical analysis of trends across sectors and countries, helping to identify priority areas for policy intervention, training initiatives, and technology adoption. Findings also serve as a foundation for designing tailored MetaVET modules that respond directly to the articulated needs of industry stakeholders. This survey forms an integral component of the MetaVET project and is designed to collect structured feedback from Technical and Vocational Education and Training (TVET) institutions across the Western Balkans. Its aim is to provide insight into the current and emerging skills needs within vocational training, the preparedness of educators, and the status and potential of collaboration with small and medium-sized enterprises (SMEs). The ultimate goal is to enhance alignment between education provision and labour market demands in the context of digitalisation and advanced technologies, including collaborative robotics.

- Purpose and Relevance
  TVET institutions play a pivotal role in shaping the next generation of skilled workers. However, in an era of rapid technological evolution and shifting industry expectations, these institutions must continuously adapt curricula, teaching methodologies, and institutional partnerships to remain relevant. This survey therefore seeks to identify:
    - Priority skill sets currently in demand across different vocational sectors

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- Anticipated future competencies over a 5–10-year horizon
- Training needs among educators and trainers
- Awareness of, and engagement with, emerging technologies, particularly collaborative robots
- Opportunities for strengthening collaboration with industry, particularly SMEs

By capturing these perspectives, the survey informs the development of future training programmes and partnership models tailored to the regional context.

- Distinction from the SME Survey
  Whereas the parallel survey directed at SMEs focuses on the demand side—examining business needs, technological readiness, and workforce gaps—this instrument focuses on the supply side of vocational training. It gathers information on institutional capacities, training practices, collaboration efforts, and readiness to teach digital and advanced technical skills. This distinction is crucial for aligning TVET output with labour market input and fostering meaningful partnerships between educators and employers.
- Expected Quantitative Outputs
  The survey employs a combination of multiple-choice, Likert-scale, and open-ended questions to generate quantitative indicators on:
  - The most pressing and anticipated skills needs across vocational sectors
  - The current status of professional development initiatives for TVET educators
  - Levels of interest in sector-specific "Train the Trainer" programmes
  - Frequency and type of existing collaborations with SMEs
  - Awareness and preparedness regarding collaborative robotics
  - Institutional willingness to engage in curriculum innovation, joint training initiatives, and equipment sharing
  - Planned student intake for the 2025–2026 academic year

These outputs supported comparative analysis between institutions and countries, while also providing a baseline for designing targeted interventions under the MetaVET framework. Moreover, open-ended responses provided qualitative insights into the operational and strategic challenges faced by TVET schools, further enriching the policy dialogue.

By systematically gathering this data, the MetaVET project aims to contribute to the modernisation of vocational education in the Western Balkans, enhancing its responsiveness to digital transformation and promoting more inclusive and future-ready education ecosystems.

7.1 SMALL AND MEDIUM-SIZED ENTERPRISES (SMES) SURVEY

A total of 19 survey responses were collected via KoboToolbox from companies operating in Bosnia and Herzegovina (40%), Romania (40%), and Montenegro (20%). The industrial sectors represented in the sample include agro-food (35%), manufacturing (30%), automotive (20%), and energy (15%). The average number of employees per company is 25, though the range varies, with 10% of respondents employing fewer than 20 individuals and 10% employing significantly more.

The survey results reveal a pronounced skills gap and an urgent need for workforce development. A striking 80% of companies indicated that their workforce lacks adequate skills, and an equally significant proportion expressed a desire to expand access to education for their employees, while also recognising the need for educational reform within their organisations. These concerns are set against a backdrop of broader structural issues: all respondents expressed worry about workforce out-migration, suggesting that skills development is seen not only as an economic necessity but also as a strategic tool for talent retention in the region.

Digitalisation emerged as a key concern. 75% of companies stated they would welcome vocational training for their employees, 80% acknowledged the importance of closing the digital skills gap, and 65% indicated that they would appreciate better access to skills development opportunities. In addition, 60% of respondents reported a

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need for more targeted information about training options, and 45% emphasised the importance of supporting and empowering vulnerable learners.

Despite limited current collaboration with TVET institutions (only 15% of companies are engaged in such partnerships), 80% expressed a willingness to collaborate more closely. Furthermore, 90% of companies indicated they do not yet utilise collaborative robots (cobots), and 75% reported a lack of AI integration in their operations. While only 45% of respondents were initially familiar with cobots, once informed, 55% expressed interest in cobots and acknowledged the importance of training their workforce in this area. This suggests a latent demand for cobot technology that could be unlocked through awareness-raising and targeted support. Additionally, 25% of companies reported that they would like to hire more staff but are unable to do so due to the lack of technical skills needed to simplify and modernise work processes.

7.2 RECOMMENDATIONS FOR NEXT STEPS

In light of the findings, a multi-level strategy is needed to strengthen vocational education and training (VET), improve digital readiness, and foster technology adoption—particularly with regard to collaborative robots. Firstly, it is essential to develop and deliver targeted training programmes on cobots and other Industry 4.0 technologies, tailored to the needs of small and medium-sized enterprises (SMEs) in the region. These programmes should combine theoretical understanding with hands-on, experiential learning to ensure practical applicability.

Awareness-raising campaigns should be conducted to introduce the concept and benefits of cobots to companies unfamiliar with the technology. These efforts should be accompanied by dedicated support services—such as technology audits, demonstration pilots, or coaching—to help companies assess the potential integration of cobots within their operational models.

To bridge the skills gap, strategic partnerships between industry and TVET providers must be fostered and institutionalised. This could involve the co-creation of modular training courses, joint certification schemes, and placement programmes that link learners directly with employers. Engagement with TVET institutions should also include mechanisms to involve industry in curriculum development, ensuring training remains aligned with evolving labour market demands.

Moreover, it is recommended that policy frameworks and funding instruments prioritise support for SMEs seeking to invest in digitalisation and workforce training. Specific emphasis should be placed on including marginalised groups and vulnerable learners, thereby contributing to inclusive growth and social cohesion. The knowledge-sharing platform related to MetaVET website will disseminate best practices and coordinate efforts.

Finally, addressing the root causes of workforce out-migration requires a holistic approach. Beyond training, companies wlil be supported from MetaVET in creating attractive, modern, and innovative working environments. Technology adoption—such as the integration of cobots—not only improves productivity but can also contribute to job quality and employee satisfaction, reinforcing the retention of skilled workers within the region.

7.3 TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING (TVET) SURVEY

A total of nine Technical and Vocational Education and Training (TVET) institutions responded to the survey, with

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four based in Bosnia and Herzegovina, three in Romania, and two in Montenegro. The surveyed schools cover a range of educational fields, including automotive and mechanical trades (40%), information and communication technology (30%), engineering and technology (20%), and healthcare and nursing (10%). The survey results provide insight into the current capacities, challenges, and aspirations of TVET institutions in the Western Balkans region with regard to digital transformation, workforce alignment, and cooperation with industry. All results and relevant materials are intended to be translated into local languages to ensure accessibility and relevance for stakeholders in each country.

The majority of respondents (70%) identified a strong need to improve both digital literacy and technical skills specific to their training contexts. Half of the institutions acknowledged the growing importance of artificial intelligence (AI) in their sector and expressed the need for dedicated training in AI and its related disciplines. A significant 80% of respondents highlighted the need for further professional development among teaching staff, emphasising the urgency of implementing structured “train-the-trainer” programmes. These programmes should focus on key areas such as digital pedagogy and improved collaboration with SMEs and industry stakeholders. Despite this clear need, 65% of TVET schools reported only occasional collaboration with industry, which limits their ability to align training with real-world demands.

In terms of practical needs, 50% of TVET institutions called for the establishment or strengthening of internship or apprenticeship programmes for students, while 45% expressed the need for on-the-job training opportunities for trainers. Equipment and technology sharing was identified as a priority by 60% of respondents, reflecting the resource constraints many institutions face. Furthermore, 85% expressed interest in the development of more structured frameworks for collaboration with SMEs, which would support more sustained and mutually beneficial partnerships. Regarding cobot technology, only 20% of respondents were initially familiar with collaborative robots; however, after receiving a brief explanation, 80% recognised their potential value and expressed interest in further information and training. Moreover, 60% reported facing significant challenges in preparing students for high-tech careers and expressed a desire for increased opportunities to engage with companies to better understand emerging trends and technologies.

7.4 RECOMMENDATIONS FOR NEXT STEPS

The findings from this survey underscore the urgent need to strengthen the digital and pedagogical capacities of TVET institutions across Bosnia and Herzegovina, Romania, and Montenegro. In particular, comprehensive “train-the-trainer” initiatives should be prioritised, with content tailored to emerging technologies such as artificial intelligence and collaborative robotics, as well as methods for digital teaching and industry engagement. These programmes should be developed in collaboration with both national authorities and European partners, ensuring alignment with broader digital and green transition agendas.

To bridge the gap between education and industry, it is imperative to develop formalised cooperation frameworks that facilitate consistent engagement between TVET schools and SMEs. This could include joint curriculum development, regular exchange mechanisms, and co-designed internship or apprenticeship schemes that provide students with meaningful hands-on experience. Schools should also be supported in accessing modern equipment and technology, either through public investment or sharing schemes coordinated with regional industrial partners.

Moreover, raising awareness about cobots and other Industry 4.0 technologies among educators and institutional leaders is essential. This should be accompanied by opportunities for peer learning, such as regional workshops, study visits, and online communities of practice, where schools can share experiences and innovative approaches to high-tech training. By addressing these areas, the TVET sector can better prepare students for the demands of the contemporary labour market while enhancing the attractiveness and relevance of vocational education across the Western Balkans.

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8 CONCLUSIONS AND NEXT STEPS

The findings from the stakeholder consultations and contextual analysis conducted in Bosnia and Herzegovina, Romania, and Montenegro underline a clear and urgent need to strengthen the responsiveness of vocational education and training (VET) systems to emerging technological demands—particularly in relation to collaborative robots (cobots), digitalisation, and immersive learning environments such as the metaverse.

The growing relevance of cobots within industrial processes, especially among small and medium-sized enterprises (SMEs), is accompanied by significant gaps in awareness, infrastructure, and training provision. While cobots are increasingly viewed as essential components of the evolving labour market, their integration into formal training pathways remains limited, often due to financial constraints and institutional unfamiliarity. In parallel, the metaverse offers promising opportunities for cost-effective, simulated, and scalable training solutions that replicate real-world scenarios, thus enhancing both learner engagement and skills acquisition.

VET institutions across the partner countries have indicated strong interest in strengthening digital capacities, modernising curricula, and deepening collaboration with industry. However, most report only occasional engagement with SMEs, limited access to up-to-date technologies, and insufficient capacity to address skills gaps in emerging fields such as artificial intelligence, automation, and human–robot collaboration. The lack of structured “train-the-trainer” programmes further compounds these challenges, especially in under-resourced regions.

Next Steps for MetaVET:

- Development of Modular Training Packages on Cobots and Digital Skills
  MetaVET will co-create modular, adaptable training content focused on cobots, AI, and Industry 4.0 tools, combining theoretical components with hands-on and simulated (metaverse-based) learning activities.
- Implementation of Train-the-Trainer Initiatives
  Dedicated programmes will be established to upskill VET instructors in digital teaching methods, cobot operation, and industry collaboration. These initiatives will be designed for scalability and transferability across institutional contexts.
- Strengthening SME–TVET Partnerships
  MetaVET will support the establishment of formal cooperation frameworks between VET schools and SMEs, facilitating joint curriculum development, work-based learning programmes, and regular exchanges of expertise and resources.
- Awareness-Raising and Technology Demonstration
  Activities will be launched to familiarise VET institutions, SMEs, and policymakers with the practical benefits of cobots and immersive learning tools. This will include pilot initiatives, demonstration labs, and structured technology audits.
- Ensuring Inclusivity and Regional Equity
  Particular attention will be given to ensuring access for marginalised learners and under-served areas, with targeted efforts to introduce innovative training methods in regions where cobot adoption is not yet feasible but future workforce engagement is anticipated.
- Knowledge Sharing through the MetaVET Website
  The MetaVET Website will host case studies, training materials, and good practices, enabling transnational learning and dissemination of results. It will serve as a central hub for collaboration among VET providers, industry, and policy stakeholders.

By implementing these measures, MetaVET will help ensure that VET systems in the Western Balkans are better prepared for digital and green transitions, support inclusive labour market integration, and contribute to a resilient and future-oriented workforce.

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APPENDIX A – QUESTIONNAIRE FOR SMES

Survey: Identifying Skills / workforce needs in Western Balkans in terms of advanced technologies

Dear Participant,

We appreciate your time and participation in this survey. The purpose of this questionnaire is to gain insights into collaborative robotics, digitalisation and Metaverse use which will help us better understand the current state of needs and challenges faced by SMEs in the Western Balkans.

Please note that all responses will be treated with the utmost confidentiality. Data will be processed in an anonymous and aggregated manner, ensuring that individual responses cannot be identified. The information collected will be used solely for research purposes and to inform the development of MetaVET program.

Your participation is entirely voluntary, and you are free to withdraw at any stage without providing a reason. The survey should take approximately five minutes to complete.

Thank you for your valuable contribution to this important research. Should you have any questions or require further information, please do not hesitate to contact us at viviana.capurso@areaprototipi.com

Section 1: General Information

Company Name: [Open text field]

Sector/Industry: [Dropdown or open text field]

Number of Employees: [Open text field]

Location

Section 2: Priorities and Needs

On a scale of 1 (Not at all) to 5 (Very much), please rate the following statements:

Statement	1	2	3	4	5
I feel my company has an inadequately skilled workforce.					
I feel the need to enhance access to education for my workforce.					
I feel the need for reforming education in my company.					
I feel the need to prevent workforce's out-migration from my country.					
I feel the need to update and renew the technology I daily use.					
If given the opportunity, I would appreciate vocational training for my workforce.					

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Statement	1	2	3	4	5
I feel my company could improve its digitalization potential.					
I feel the need to create experiential learning for my employees/workers.					
I would appreciate receiving targeted information about training opportunities.					
I recognize the importance of simplifying the work processes for my employees.					
I feel the need to improve gender equality in my company.					
I feel the need to support and empower vulnerable learners in my organization.					
The education and skills of the workers/employees in my company are important to me.					
If given the opportunity, I would appreciate closing the gap in digital skills within my workforce.					
If given the opportunity, I would appreciate ensuring access to skills development for my employees/workers.					
How important is it for you to access the opportunity to enhance your workers' skills?					
To what extent is the digitalization of your workforce a priority for you?					
Is it easy for you to find skilled staff in terms of digitalization?					
Would you be interested in hosting a student for internship?					

How many hours of training per employee did your company conduct in the last year?

- 5 per person
- 15 per person
- 20 per person
- We didn’t conduct any training

Which digital skills do you currently miss in your organization?

- Artificial Intelligence
- Blockchain
- Cybersecurity
- IoT
- Cobots
- Coding
- Cybersecurity
- Data analytics
- Search Engine Marketing

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I collaborate with Technical and vocational education and training schools (TVET)

- yes
- no

If yes, which one? [Open text field]

What steps would you like to take to improve the situation of your workers/employees? In which field would you like to act? [Open text field]

Which technology is the most urgent/important for you to implement? [Open text field]

How many new employees you plan to hire in 2025?

- 1-5
- 5-10
- 10-15
- 15-20
- We are not planning to hire people

Do you know what collaborative robots are?

- yes
- no

If yes, Do you use them?

- yes
- no

Do you have them in your company?

- yes
- no

Do you think your workforce has the adequate skills to use them?

- yes
- no

If not: Collaborative robots are a form of robotic automation built to work safely alongside human workers in a shared, collaborative workspace. In most applications, a collaborative robot is responsible for repetitive, menial tasks while a human worker completes more complex and thought-intensive tasks. The accuracy, uptime and repeatability of collaborative robots is designed to complement the intelligence and problem-solving skills of a human worker.

Would you be interested in know more about them?

- yes
- no

Would you like your personnel to be trained?

- yes
- no

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APPENDIX B – QUESTIONNAIRE FOR TVET SCHOOLS

Survey Title: Identifying Skills and Collaboration Needs in TVET Schools

Purpose:
This survey aims to gather insights from TVET schools to understand their current and future skills needs, the necessity of training programs for educators, the awareness about the Cobots world and interest in partnerships with small and medium enterprises (SMEs).

Section 1: General Information

Name of Institution: (Open question)

Location: (Dropdown or open question, depending on region specificity)

Type of Technical/Vocational Education Provided: (Select all that apply)

- Engineering and Technology
- Information Technology
- Healthcare and Nursing
- Hospitality and Tourism
- Automotive and Mechanical Trades
- Construction and Architecture
- Other (please specify)

Number of students (2024-2025)

Section 2: Skills Needs

What are the most in-demand skills in your sector currently? (Select up to three)

- Digital literacy
- Critical thinking and problem-solving
- Technical skills in [sector-specific options]
- Interpersonal and communication skills
- Project management
- Leadership skills
- Other (please specify)

Which emerging skills do you anticipate will be critical in the next 5-10 years? (Select up to three)

- Artificial intelligence and automation
- Sustainable practices
- Advanced data analysis
- Cybersecurity
- Multilingual communication
- Other (please specify)

Section 3: Training and Development

Do you currently have professional development programs for your trainers? (Single choice)

- Yes, and they meet our needs.
- Yes, but they need improvement.
- No, but we plan to implement them.

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- No, and we do not plan to implement them.

Would you be interested in a "Train the Trainer" program tailored for your field? (Single choice)

- Yes
- No
- Not sure

If yes, which areas would you like the program to focus on? (Select all that apply)

- Industry-specific technical skills
- Pedagogical methods and tools
- Digital teaching and learning
- Collaboration with SMEs and industry partners
- Other (please specify)
- Section 4: Collaboration with SMEs

How often do you currently collaborate with SMEs? (Single choice)

- Regularly (e.g., ongoing partnerships or projects)
- Occasionally (e.g., ad hoc projects or internships)
- Rarely
- Never

What type of collaboration would be most beneficial for your institution? (Select all that apply)

- Curriculum co-design
- Guest lectures or workshops from industry professionals
- Internship or apprenticeship programs for students
- On-the-job training opportunities for trainers
- Equipment and technology sharing
- Other (please specify)

Would you like more structured frameworks for SME collaboration? (Single choice)

- Yes
- No
- Not sure

How many new students do you plan to enroll in 2025-2026?

Do you know what collaborative robots are?

- yes
- no

If yes: do you have any training programme to use them?

- yes
- no

Would you be interested in a training on their usage?

- yes
- no

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Do you think your teachers have the adequate skills to use them?

- yes
- no

If not: Collaborative robots are a form of robotic automation built to work safely alongside human workers in a shared, collaborative workspace. In most applications, a collaborative robot is responsible for repetitive, menial tasks while a human worker completes more complex and thought-intensive tasks. The accuracy, uptime and repeatability of collaborative robots is designed to complement the intelligence and problem-solving skills of a human worker.

Would you be interested in know more about them?

- yes
- no

Would you like your teachers to be trained?

- yes
- no

Section 5: Open Feedback

What challenges does your institution face in preparing students for the job market? (Open question)

Do you have any additional comments or suggestions for improving skills development and collaboration with industry partners? (Open question)

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