



**MetaTech Exchange**

BRIDGING INDUSTRY 4.0 IN WESTERN BALKANS



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# COUNTRY REPORT

DIGITAL TRANSFORMATION,  
WORKFORCE DEVELOPMENT,  
AND VET REFORM FOR  
INDUSTRY 4.0

**BOSNIA AND HERZEGOVINA**



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## 1. Introduction

Bosnia and Herzegovina's (BiH) industrial landscape is at a pivotal point of transformation, with the metal sector positioned as a cornerstone of the country's economic future. As one of the leading contributors to national exports, the industry not only sustains thousands of jobs but also serves as a key indicator of BiH's industrial competitiveness on the global stage. Yet, shifting global demands, rapid technological advancements, and increasing sustainability expectations are reshaping the playing field, bringing both significant challenges and promising opportunities for growth. While the country's vocational education and training (VET) systems are designed to support industry needs, they often struggle to keep pace with evolving market requirements. Initiatives such as dual education models and EU-supported modernization efforts are steps in the right direction, but systemic barriers—like fragmented governance, outdated curricula, and insufficient modern training equipment—continue to hinder progress. Bridging this gap calls for deeper collaboration between educational institutions, industry stakeholders, and policymakers to align workforce development with the demands of Industry 4.0.

This report delves into the dynamic relationship between BiH's metal industry and its VET system, identifying critical obstacles to innovation and competitiveness while outlining actionable strategies for sustainable growth.

## 2. Metal industry in the country

The metal industry is a cornerstone of BiH economy, contributing approximately 32% to the nation's total exports. This sector encompasses the production of base metals, metal products, machinery, and equipment, with a significant presence in regions such as Zenica, Tuzla, and Banja Luka ((Foreign Trade Chamber (FTC), 2024).

### Recent Export and Import Trends

In 2022, BiH's metal industry experienced notable growth:

- **Exports:** Totaled 5.9 billion BAM, marking a 49% increase compared to the previous year
- **Imports:** Reached 7.9 billion BAM, reflecting a 36% rise.

Key contributors to this trade include iron and steel products, the electrical industry, and the automotive sector.

However, the first half of 2024 saw a downturn:

- **Exports:** Declined to 3.4 billion BAM.

- **Imports:** Increased to 5.4 billion BAM.

This decline is primarily attributed to reduced exports of iron, steel, and related products (Foreign Trade Chamber, 2024)

## Government Initiatives and Support

To bolster the metal industry, several initiatives have been launched:

- **Digital Transformation Support:** As part of its commitment to fostering economic development and industrial modernization in BIH, **GIZ has actively supported digital transformation initiatives** aimed at strengthening small, and medium-sized (SMEs) competitiveness and innovation capacity.
- **Green Recovery Efforts:** The EU4Business Recovery project, co-financed by the EU and the German government, aims to mitigate COVID-19's impact on SMEs in the metal and wood industries. This initiative focuses on developing green business models and promoting sustainable practices.
- **Financial Assistance:** A public call was issued SMEs in the metal and wood sectors to access €2.25 million in support, facilitating business continuity and access to new markets.
- **Project Implementation:** The GOPA-led project *“Strengthening the System of Secondary Vocational Education and Training in Bosnia and Herzegovina”* is a long-term initiative with substantial funding, focusing on improving secondary vocational education.

## Resource Potential

BIH possesses significant resource potential that can serve as a foundation for modern technological advancement, particularly in the metal industry. The country is endowed with abundant mineral reserves, including iron ore, bauxite, zinc, and lead, which have long supported its industrial base. Notably, recent geological surveys have confirmed substantial lithium deposits, estimated at around 1.5 million tons, positioning BiH as a potential key player in the rapidly expanding battery production sector. This discovery opens up transformative opportunities, especially in the context of the global shift towards electromobility and renewable energy storage solutions. With the growing demand for lithium-ion batteries driven by the automotive, energy, and tech industries, BiH could leverage these resources to attract investment in advanced manufacturing and processing technologies. Moreover, coupling the country's mineral wealth with innovations such as automated extraction techniques, smart mining solutions, and environmentally sustainable processing methods can enhance value chain integration and competitiveness. By embracing these new technologies, BIH has the potential not only to strengthen its domestic metal

industry but also to become a strategic supplier of critical raw materials for the European and global markets.

### **Current State of Digitalization and Industry 4.0 Adoption**

A 2019 study assessing the readiness of BiH's manufacturing companies for Industry 4.0 revealed that the average development level was 2.19 on a scale from 1 to 4, indicating a position between the second and third industrial revolutions. This suggests that while foundational elements are in place, significant advancements are necessary to fully embrace Industry 4.0 (Bajrić, et al., 2021).

Key areas identified for improvement include:

- **Product Development:** Scored at 1.54, highlighting a need for enhanced design and innovation processes.
- **Product Lifecycle Management (PLM):** With a score of 1.87, indicating limited integration of PLM systems.
- **Application of Green and Lean Production Principles:** Rated at 1.97, suggesting room for adopting sustainable and efficient manufacturing practices.

### **Government and Institutional Initiatives**

To address these gaps, various initiatives have been launched:

- **International Collaboration:** Projects like Metatech 4.0 Exchange focus on bridging Industry 4.0 concepts across the Western Balkans, involving partners from BiH to promote knowledge exchange and implementation of advanced manufacturing technologies.
- These initiatives are supported by organizations such as the **Enterprise Europe Network (EEN)** and the **European Digital Innovation Hubs (EDIHs)**, which are integral to helping BiH businesses and SMEs **access international markets, expertise, and resources** in digital transformation and innovation. Through EEN, BiH companies can engage in cross-border collaborations, gain access to funding opportunities, and learn from the best practices in **digitalization and sustainability**.

### **Challenges and Opportunities**

Despite these efforts, challenges persist:

- **Resource Constraints:** Many SMEs face limitations in financial and human resources, hindering the adoption of advanced technologies.

- **Skill Gaps:** There is a need for workforce upskilling to effectively implement and manage Industry 4.0 technologies.

However, opportunities exist in leveraging BiH's rich mineral resources and strategic initiatives to foster a more innovative and competitive metal industry.

### 3. Vocational Education in Bosnia and Herzegovina

#### Structure of Vocational Education in BiH

The VET system in BiH is **decentralized**, with responsibilities divided between the entities: **Republika Srpska, the Federation of Bosnia and Herzegovina (FBiH), and Brčko District**. The system is influenced by European educational trends and reforms, particularly those aligned with **EU VET policies** and **the European Qualifications Framework (EQF)**.

#### Governance and Institutional Framework

- **Republika Srpska:** The Ministry of Education and Culture of RS oversees VET policies, curricula, and accreditation.
- **Federation of BiH:** The system is further decentralized among 10 cantonal ministries of education, each responsible for its own VET policies.
- **Brčko District:** Has an independent education system managed by the local Department of Education.

At the national level, **the Agency for Pre-primary, Primary and Secondary Education (APOSO)** coordinates reforms and harmonization with EU standards.

#### Levels of Vocational Education

VET in BiH is structured into three levels:

- Three-year vocational education (ISCED 3C)**
  - Prepares students for direct employment in specific trades.
  - Includes practical training and internships in companies.
  - Covers fields like metal processing, mechanics, construction, and services.
- Four-year technical education (ISCED 3B)**
  - Offers advanced vocational training with general education elements.
  - Graduates can continue to higher education or enter the labor market.
  - Focuses on industrial, IT, and engineering professions.
- Post-secondary and adult education**

- Includes **specialized training programs** and **reskilling initiatives** for adults.
- Implemented through vocational schools, private training centers, and EU-supported projects.

### Key Challenges and Areas for Improvement

- **Mismatch between curricula and industry needs:** VET programs often do not align with **modern industrial requirements** (e.g., Industry 4.0, digitalization).
- **Limited practical training:** Companies are reluctant to offer **apprenticeships and dual education opportunities**.
- **Outdated infrastructure:** Many VET schools lack **modern equipment and digital tools** for practical training.
- **Teacher training gaps:** Educators need **continuous upskilling** in new technologies and industry practices.

### Recent Reforms and Government Initiatives

- **Introduction of dual education models** to strengthen collaboration between VET schools and companies.
- **GIZ-supported projects** promoting digitalization and industry-oriented skills development.
- **EU IPA-funded programs** enhancing VET curricula and supporting modern **technical training centers**.
- **Development of qualifications frameworks** aligned with labor market needs.

### Initiatives to Improve Vocational Education for the Metal Industry

Several initiatives have been introduced to bridge the skills gap and modernize VET in the metal sector:

- a. **Introduction of Dual Education** – Some vocational schools in RS are piloting **dual education programs**, where students gain practical experience in metal industry companies. This model is inspired by successful systems in Germany and Austria.
- b. **EU and International Projects** – Programs like **EU4Education**, **Interreg**, and **Erasmus+** support the modernization of vocational education by improving curricula and equipping schools with better technology.
- c. **Company-Led Training Centers** – Large metal industry companies such as **Mahle**, **Kolektor** and **ELAS** have established their own training centers to provide additional specialized education tailored to their needs.

- d. **Public-Private Partnerships** – Some technical schools have partnered with leading BIH companies to offer specialized courses in **CNC machining, welding, industrial automation, and 3D modeling**.
- e. **Specialized Training:** The Faculty of Mechanical Engineering, Univeristy of Banja Luka, provides specialist training programs for engineers and company employees, enhancing sectoral skills and competencies.

## Future Needs and Recommendations

To better align vocational education with the needs of the metal industry, further reforms are needed:

- **Modernizing Curricula** – Integrating **digitalization, robotics, and AI applications** into metal industry education programs.
- **Strengthening Dual Education** – Expanding cooperation between **schools and companies** to ensure students receive hands-on experience.
- **Upskilling Teachers** – Providing continuous professional development for VET teachers in **Industry 4.0 technologies**.
- **Investing in Equipment** – Equipping schools with **modern machinery, simulation software, and digital tools**.
- **Encouraging International Cooperation** – Leveraging **EU-funded projects** to implement best practices from advanced VET systems.

## Key Expectations for VET Reform

To bridge the gap between education and industry needs, VET in BIH must focus on **adaptation and modernization** in the following areas:

### Curriculum Modernization

- Integrate **Industry 4.0 concepts** into metal industry education.
- Strengthen subjects related to **automation, digital manufacturing, and smart production systems**.
- Include **green production principles** in line with **EU sustainability goals**.

### Stronger Industry Collaboration & Dual Education

- Expand **dual education** programs where students split time between school and **workplace training in metal industry companies**.
- Increase **internships and apprenticeships** in cooperation with leading manufacturers.
- Establish **specialized company-led training centers** to bridge skill gaps.

## Investment in Modern Tools & Technologies

- Equip VET schools with:
  - **CNC machines** for precision metalworking.
  - **Industrial robots and automation systems.**
  - **3D printing technologies for prototyping.**
  - **AI and IoT-based monitoring systems.**
  - **Advanced welding and laser-cutting machines.**
  - **CAD/CAM software for digital design and simulation.**

## Upskilling of Teachers & Trainers

- Provide **continuous professional development** for VET teachers in **modern industrial processes.**
- Offer **industry placements for teachers** to gain firsthand experience with the latest technologies.

## International Cooperation & Funding

- Utilize **EU programs (Erasmus+, Interreg, Horizon Europe)** to modernize VET curricula.
- Engage in **regional knowledge-sharing** with more advanced VET systems, such as those in **Germany and Austria.**

## Future Outlook & Recommendations

For vocational education to effectively support the **metal industry's transformation**, immediate reforms are needed to:

- Align training programs with **smart manufacturing and Industry 4.0.**
- Expand **school-industry partnerships** for **real-world learning.**
- Invest in **state-of-the-art training equipment** and **digital tools.**
- Ensure **teachers receive continuous upskilling** to match industry advancements.

By implementing these changes, the **VET system will be better equipped to produce a workforce that meets the demands of modern metal production, innovation, and competitiveness.**

## 4. Target Groups for the Report

The conclusions and recommendations presented in this report are based on an analysis of **key stakeholders** in the **metal industry, digitalization, industrial transformation, and vocational education sectors**. The target groups are categorized as follows:

### a. Metal Industry Enterprises

#### **Large, Medium, and Small Enterprises (SMEs) in Metal Processing and Manufacturing**

- Companies engaged in **metal production, processing, machining, fabrication, and assembly**.
- Manufacturers of **automotive parts, machinery, tools, and industrial equipment**.
- Export-oriented firms facing **international competition and regulatory compliance challenges**.
- Businesses seeking to **implement digitalization, automation, and smart manufacturing**.

### b. Workforce and Employees in the Metal Industry

#### **Skilled and Semi-Skilled Workers**

- Machine operators, welders, CNC programmers, metal fabricators, and technicians.
- Workers requiring **upskilling in digital manufacturing technologies and green production methods**.
- Employees at risk of **job displacement due to automation and industrial transformation**.

#### **Engineers and Technical Experts**

- Mechanical, electrical, and industrial engineers specializing in metal processing.
- Experts in **CAD/CAM, IoT-based production, and AI-driven manufacturing systems**.
- R&D professionals working on **new materials, lightweight structures, and advanced production processes**.

### c. Vocational Education and Training (VET) Institutions

#### **Secondary Schools and Vocational Training Centers**

- Schools offering **metalworking, mechanical engineering, and industrial technology programs**.

- Institutions that need to **modernize curricula to include Industry 4.0 and digitalization topics.**

### **Universities and Research Institutions**

- Engineering faculties focused on **metallurgy, mechanical engineering, robotics, and automation.**
- Applied research centers working on **innovation in materials science, additive manufacturing, and industrial AI.**
- Providers of **lifelong learning programs for industry professionals.**

### **Government and Policymakers in Bosnia and Herzegovina**

BiH has a **complex and decentralized governance structure**, with responsibilities divided between **state-level institutions, entity governments (Republika Srpska and the Federation of BiH), Brčko District, and cantonal administrations.** The involvement of various governmental bodies is crucial for **industrial development, digital transformation, and vocational education reform.**

#### **a. Public Sector Authorities**

##### **State-Level Institutions**

- **Ministry of Foreign Trade and Economic Relations of BiH (MOFTER)** – Coordinates industrial policy at the national level, facilitates international trade agreements, and supports alignment with EU regulations.
- **Directorate for European Integration (DEI)** – Oversees EU accession-related reforms, including industrial competitiveness and regulatory harmonization.

##### **Republika Srpska (RS) Institutions**

- **Ministry of Economy and Entrepreneurship of RS** – Responsible for industry policies, investment incentives, and economic development strategies.
- **Ministry of Education and Culture of RS** – Leads reforms in vocational education to better match labor market needs and Industry 4.0 demands.
- **Science Technology Park of RS (STPRS)** – Supports entrepreneurship, technology transfer, and digital innovation among SMEs.

##### **Federation of BiH (FBiH) Institutions**

- **Federal Ministry of Energy, Mining and Industry** – Develops industrial policies and incentives for manufacturing and export-driven industries.

- **Federal Ministry of Education and Science** – Supports modernization of vocational training and higher education to align with technological advancements.
- **Cantonal Ministries of Economy and Education** – Implement regional policies tailored to specific industrial needs within the Federation.

### **Brčko District Institutions**

- **Department of Economic Development, Sports, and Culture** – Manages economic policies and business incentives in the district.

#### **b. Regulatory Bodies and Standardization Agencies**

### **Institutions Ensuring Compliance with Industrial and EU Standards**

- **Institute for Standardization of BiH (ISBIH)** – Oversees the adoption of EU industrial standards, CE marking, and quality certification processes.
- **Foreign Trade Chamber of BiH (VTK BiH)** – Supports businesses in meeting international trade and industrial compliance standards.
- **Entity-level Environmental Protection Agencies** – Ensure that industrial activities comply with environmental regulations, emissions controls, and sustainability requirements.
- **Market Surveillance Agency of BiH** – Monitors compliance with product safety standards, including those relevant to the metal industry and advanced manufacturing.

#### **c. Key Government Initiatives and Trends**

**Industrial Modernization** – Government support for digital transformation, smart manufacturing, and Industry 4.0 adoption.

**Vocational Education Reform** – Efforts to align VET curricula with industry demands, including dual education models and digital skills training.

**EU Integration Efforts** – Regulatory harmonization with European standards to enhance industrial competitiveness and export potential.

**SME Development and Innovation Support** – Financial and advisory programs promoting entrepreneurship, R&D, and technology transfer.

BiH's institutional landscape plays a **pivotal role in fostering industrial growth, digital innovation, and workforce readiness** for the evolving economic landscape.

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