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EUROPEAN PROJECT 'BLUEPRINT "NEW SKILLS AGENDA STEEL": INDUSTRY-DRIVEN SUSTAINABLE EUROPEAN STEEL SKILLS AGENDA AND STRATEGY (ESSA)' – THE FIRST YEAR OF IMPLEMENTATION

PROJEKT EUROPEJSKI „PLAN DZIAŁANIA NA RZECZ NOWYCH UMIEJĘTNOŚCI W ZAKRESIE STALI": UZGODNIONY Z PRZEMYSŁEM ZRÓWNOWAŻONY EUROPEJSKI PROGRAM I STRATEGIA W ZAKRESIE UMIEJĘTNOŚCI W ZAKRESIE STALI (ESSA)" – PIERWSZY ROK REALIZACJI

The article presents the general characteristics of the European project implemented by an international consortium, which includes the Łukasiewicz Research Network – Institute of Ferrous Metallurgy. The project concerns the preparation and improvement of personnel for the steel sector in the face of the rapidly approaching industrial revolution 4.0: WORK 4.0 for STEEL 4.0. The article presents the first results of the project obtained in 2019, highlighting the Institute's contribution. The four-year project (completed in December 2022) integrates the efforts in this area of a broad European consortium, consisting of 24 partners from 10 countries and 14 associated partners from 8 countries, in the ERASMUS + programme.

Keywords: steel sector, skills, Industry 4.0, blueprint

W artykule przedstawiono ogólną charakterystykę europejskiego projektu realizowanego przez międzynarodowe konsorcjum, w skład którego wchodzi Sieć Badawcza Łukasiewicz – Instytut Metalurgii Żelaza. Projekt dotyczy przygotowania i doskonalenia kadr dla sektora stalowego w obliczu szybko zbliżającej się rewolucji przemysłowej 4.0: WORK 4.0 dla STEEL 4.0. Przedstawiono pierwsze wyniki projektu uzyskane w 2019 r., podkreślając wkład Instytutu. Czteroletni projekt (zakończenie w grudniu 2022 r.) łączy w programie ERASMUS + wysiłki w tym obszarze szeroko zakrojonego konsorcjum europejskiego, w skład którego wchodzi 24 partnerów z 10 krajów i 14 partnerów stowarzyszonych z 8 krajów.

Słowa kluczowe: sektor stalowy, umiejętności, rewolucja przemysłowa 4.0, plan działania na rzecz (blueprint)

1. INTRODUCTION

A few years ago, the European Commission introduced a policy for supporting the development of human resources for various areas of economic activity in connection with the upcoming Industrial Revolution 4.0. As part of the ERASMUS + programme, Key Action 2 activities – Sector Skills Alliances, two competitions (2017 and 2018) were announced to develop the so-called Blueprints (action plans) for individual sectors of the economy. To date, funding has been granted to 12 sectors, including the steel industry, to develop these programmes.

Poland (Łukasiewicz Research Network – Institute of Ferrous Metallurgy and ArcelorMittal Poland) was invited to the consortium thanks to many years of active human resources activities in the steel industry at the European Steel Technology Platform (ESTEP), and especially at the Focus Group PEOPLE. It was there that the concept of building a consortium and developing an application for funding was born.

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2. PROJECT BACKGROUND (CONTEXT)

Economic, digital and technological development, as well as energy efficiency requirements, pose a number of challenges for the European steel industry. In particular, rapid and continuous changes taking place in the industry require continuous improvement of employees' qualifications, knowledge and skills. Current and future employees must adapt to digital transformations and changes in production processes (industrial revolution 4.0), as well as adapt to new work methods and work organisation patterns that are introduced as a result of such changes (Work 4.0).

The new and stricter energy efficiency and emissions regulations aimed at protecting the environment will also have an impact on the way the steel sector operates in Europe. To meet all these challenges, a more qualified, specialised and broadly skilled workforce is needed, while the industry is facing skill shortages, recruitment difficulties and talent management problems.

3. OBJECTIVES OF THE PROJECT

The main goal of the project is to develop an Action Plan (Blueprint) for a sustainable and approved European Steel Skills Agenda (ESSA) coordinated by the steel industry.

The programme will present a strategy to meet current and future skills requirements and will recommend the development of specific modules and tools to build awareness and implement new skills in a globally competitive industry. The goal is to anticipate and prepare new skills requirements and develop proactive practical activities to meet future industry requirements.

4. EXPECTED RESULTS

For the European steel sector to remain competitive, it is necessary to constantly adapt to emerging skill needs. A long-term skill development strategy that takes into account the needs of the industry will allow steel companies and vocational education and training institutions (VET) to:

- Adapt the workforce in a proactive manner, and thus implement new technologies aimed at optimising the production process;
- Continuously monitor and shorten the implementation of relevant industry qualifications in national VET systems;
- Develop and exchange modules and tools, as well as share experience from the implementation process of the new skills programme and strategy;
- Discuss and compare the developed Blueprint with the solutions / Plans (Blueprint) developed for other sectors;
- Increase the attractiveness of the steel industry and career in this sector for talented people (recruitment and retention).

The ESSA project will apply new modules and tools for the steel industry from the Blueprint sectoral Plan. The Blueprint plan will be supplemented with experience gained in the process of implementing the ESSA Programme in order to create a new skills strategy that will focus on the immediate implementation of new skills in the industry's training and vocational education and training systems.

The European Programme provides for an implementation plan in all major steel producing Member States.

Ten EU countries are directly involved in the Programme: Belgium, the Czech Republic, Finland, Germany, Italy, Lithuania, the Netherlands, Poland, Spain and the United Kingdom. In addition, associated partners from different countries participate in the Programme.

The consortium partners in the ESSA project are: 17 steel plants, RTOs and associations. Technische Universität Dortmund – TU Dortmund University (TUDO) (DE) is the leader of the consortium.

The work in the project is organised in eight Work Packages (WP) – Fig. 1.

The Institute is a co-leader in package WP 4.

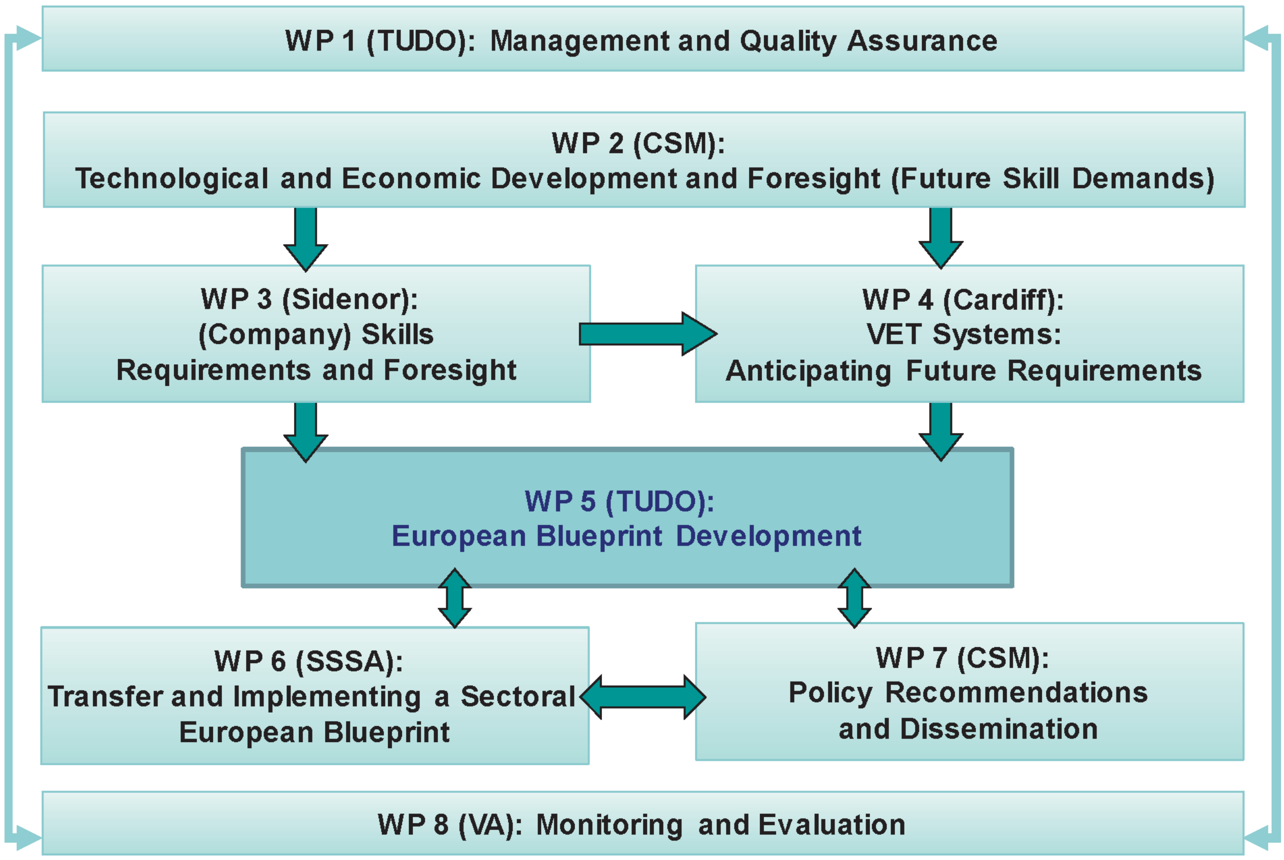

Fig. 1. Organisation of work in the project

Rys. 1. Organizacja pracy w projekcie

The project is being realised in accordance with the adopted schedule. The Institute mainly participates in the implementation of WP4, and in the others, it participates in discussions, submits comments or gives opinions on the progress of work.

5. WORK PACKAGES 1, 2 AND 3

In WP 1, coordinated by TUDO – project coordinator, the Institute fulfils its obligations by participating in face-to-face and online meetings and by completing quarterly working time sheets.

In WP 2, coordinated by CSM, in which the Institute is not directly involved, the document D2.1 (deliverable 2.1) Digital Transformation in European Steel Industry: State of Art and Future Scenario was developed. Representatives of the Institute took part in discussions and commented on this document at the stage of its development.

As part of the WP3 package, coordinated by SIDENOR, profiles of the professions analysed in the project are developed. These professions are described according to current industry requirements, and then, among others thanks to the developments in the WP 2 package, future requirements will be determined. These topics were intensely discussed during the year with the participation of representatives of the Institute.

6. WORK PACKAGE 4 – THE MAIN AREA OF THE INSTITUTE'S INVOLVEMENT IN 2019

The WP4 work package, coordinated by Cardiff University, is the main area of the Institute's operation in the project.

The main goal to be achieved is to develop a framework / matrix to optimise the delivery of skills to the European steel industry through VET systems by:

- establishing national benchmarks for vocational education and training in the current offer of skills in key professions for the steel industry;
- using WP2 and WP3 data for strategies to meet future skills needs through national VET systems;
- correlating professional skill sets with pan-European programmes and standards.

The WP4 results serve as the input and basis for developing the Blueprint under WP5.

Products (reports) that must be delivered to the Commission in January 2020 as a first draft.

The Institute actively participated in the implementation of task 4.1 (report D4.1) and preparation of the D4.4 report, providing its contribution – which will be presented later in the article:

- D4.1: Identification of national (sectoral) rules for qualifications and skills in vocational education and training (regulatory) for steel.

7. WORK PACKAGES 5, 6, 7 AND 8

Rhe implementation of WP5, coordinated by TUDO, will start in 2020 and the execution of WP6, coordinated by SSSA, will start later.

As part of WP7, coordinated by CSM, the project's website and a flyer were designed. The Institute's employees have translated the leaflet into Polish.

As part of the WP8 work package, coordinated by (VA), four documents have been created so far: D8.1_A_Monitoring plan, D8.1_B_Evaluation plan, D8.1_C_Survey questionnaires (for project monitoring and evaluation), Blueprint "New Skills Agenda Steel": Industry-driven sustainable European Steel Skills Agenda and Strategy (ESSA) – Key Performance Indicators. The Institute's employees did not participate in the creation of these documents and did not comment on them.

8. INSTITUTE'S CONTRIBUTION TO REPORT D4.1

Report D4.1 describes steel sectors (very briefly) and education system in five countries: Germany, the UK, Spain, Italy and Poland.

8.1. POLISH STEEL SECTOR

The Polish steel sector is one of the largest in the EU. In 2018, Poland among European producers, was ranked 5th in respect of the production of crude steel in the amount of 10.2 million tons (Eurofer: European Steel in Figures 2019). In the last few years, this production has changed from the lowest level of 8.5 million tons in 2014 to the highest – 10.3 million tons in 2017. Currently (2018) 24,700 people work in the Polish steel sector (Polish Steel Industry 2019, Polish Steel Association). Steel production in Poland at the integrated steel mill ArcelorMittal Poland in two locations in the south of Poland (Kraków and Dąbrowa Górnicza) accounts for 53.1% of crude steel production (Worldsteel Association, World Steel in Figures 2019). The remaining part of steel is produced in 6 steel mills in the EAF process. Electric steel mills are mainly located in Silesia (south of Poland), and there are three in central Poland. In addition, the steel sector in Poland consists of 12 metallurgical enterprises that deal with metallurgical processing based on external batch (so called re-rollers).

In the years 2003–2006, the steel industry in Poland was deeply restructured in consultation with the EC to match European standards. As part of this process, employment in metallurgy was reduced, production capacity (overcapacity) was reduced, and mechanisms preventing the use of forbidden state aid were introduced. All steel mills subjected to restructuring met the requirements of the viability test used by the EC to assess the effectiveness of restructuring processes.

In Poland, the steel industry belongs to the top ten largest industrial sectors. The value of sold production of this sector in 2018 amounted to PLN 37.5 billion (approx. € 0.85 billion), which represents 3% of industrial production. Sales production dynamics did not grow as fast as GDP – it amounted to 2.8%, while GDP growth in 2018 amounted to 5.1% (Polish Steel Industry 2019, Polish Steel Association).

8.2. POLISH VET SYSTEMS AND STEEL SECTOR RELATED QUALIFICATIONS

This chapter is mainly based on the following sources: Kontynuacja przemian, Raport o stanie edukacji 2011, Instytut Badań Edukacyjnych, Warszawa 2012 (*Continuation of changes, Report on the state of education 2011, Educa-*

tional Research Institute, Warsaw 2012) – in the historical part; Vocational Education and Training in Europe, Poland, CEDEFOP ReferNet Polska, VET in Europe Reports, 2018; other sources are mentioned in the text.

The directions of vocational education, its range and organisational forms are related to the level of economic development; they also depend on the socio-professional structure of the population of the given country and the political conditions, traditions and educational aspirations of the society. The development of vocational education at all levels is a response to the needs of the economy and is one of the tools for its development.

The perception of the VET system in Poland is shaped by the three stages of its:
- development during the post-war period: the expansion and predominance of VET education during the time of the state-run economy,
- collapse and diminishing role after the economic transition in the 1990s,
- recent reforms aimed at a revival of VET education in Poland.

Years 1945–1989

In the first years after World War II, vocational education experienced significant difficulties resulting from war damage. After the war, various levels of pre-1939 schools resumed their activities spontaneously. Vocational education was to prepare employees for the emerging industry and other developing areas of the economy. In 1951, a new vocational education system was introduced, which consisted of the following schools: basic vocational school, vocational upper secondary school, evening basic vocational schools and vocational upper secondary school, as well as correspondence for youth and working adults and specialised vocational courses. The possibility of creating vocational company schools has also been introduced.

Table 1 presents the development of vocational education (at the level of secondary education) in the years 1946–1990.

Although the dissemination of secondary education was one of the aims of the education policy, the most common type of school was a basic vocational school (about 55% of primary school graduates started it), preparing qualified workers who received jobs after graduation. This school of unequal opportunities became the final level of education for the vast majority of young people, mainly from working class and peasant families. Its main disadvantage was the narrowly understood specialised education and a very modest general education programme, which in consequence meant poor preparation for continuing higher education. Over 60% of young people studying in vocational schools acquired technical professions.

Years 1989-2016

Political and socio-economic changes that took place after 1989 made it necessary to prepare for participation in political, social and, above all, economic reality different than before. The area of vocational education faced special tasks. Discussions on education reform, including vocational education, continued since the beginning of the transition period, but no binding decisions were made in this area. Meanwhile, the number of vocational schools and students interested in such education decreased, and material resources did not guarantee the implementation of vocational training of appropriate quality.

During the economic transition, the role of vocational education and training diminished and a model of general education was pursued. This was caused by two main factors. First, the economic transition led to the closing of many state-owned enterprises that were managing VET schools. As a result, the supply of VET was reduced. Second, the educational aspirations of young people increased and more frequently they began to choose a general education path. As a result, VET education turned into a negative selection, the infrastructure of VET schools became outdated, and there were few links between VET and labour market needs (Chłoń-Domińczak et al., Edukacja zawodowa w Polsce (*Vocational education in Poland*), in: M. Federowicz and A. Wojciuk (eds.), Kontynuacja przemian. Raport o stanie edukacji 2011 (*The changes continue. Report on the State of Education 2011*] (pp. 169–249), Instytut Badań Edukacyjnych. Warszawa 2012; Kwiatkowski, S.M., Kształcenie zawodowe w szkołach ponadgimnazjalnych a oczekiwania pracodawców wobec absolwentów. Świat – Europa – Polska (*Vocational education in post-secondary schools and employers' expectations of its graduates. The world – Europe – Poland*), Edukacja 1 (27), pp. 20–31, Warszawa 2013; Lis, M., and Miazga, A., Ocena jakości polskiego systemu kształcenia zawodowego z perspektywy potrzeb rynku pracy (*Labour market perspective on the quality of vocational education in Poland*), Edukacja, 1 (136), pp. 5–22, Warszawa 2016; Magda, I., Wykształcenie zawodowe, elastyczne zatrudnienie a podnoszenie swoich kwalifikacji (*Vocational education, flexible employment and lifelong learning*), Edukacja, 1 (136), pp. 44–57, Warszawa 2016; Mazik-Gorzelańczyk, M., Kształcenie zawodowe w Polsce w perspektywie zmian i potrzeb gospodarki (*Vocational education in Poland in the perspective of economic changes and needs*), Warszawa 2016). Teaching practices were also quite rigid. In the same assessment, only 1 in 4 VET schools introduced manual-based and authorship-based teaching programmes.

In 1998, a reform of education was introduced, which was successful in the sense that the announced changes were adopted in the form of legal acts providing the basis for changes in the school system and introducing fundamental changes in the area of ensuring the quality of education.

The next reform of initial vocational education was introduced in 2012. The main goal of the introduced changes was to adjust the learning outcomes in the VET system to the needs of the labour market and the economy. The most important part of this change was developing separate qualifications within occupations, modifying the core curriculum, introducing learning outcomes, and making the validation of VET qualifications more flexible. VET schools also reorganised their functioning and introduced new solutions. Additionally, due to the improving labour market situation,

Table 1. Development of vocational education (at the secondary level) in the years 1946-1990

Tabela 1. Rozwój kształcenia zawodowego (na poziomie średnim) w latach 1946–1990

	1946	1950	1960	1970	1980	1985	1990
Total vocational (secondary) schools	2 830	5 606	5 709	8 704	10 864	9 413	9 673
Students, thous.	286.7	634.7	784.2	1 710.7	1 851.0	1 543.5	1 785.3

Source: Kontynuacja przemian, Raport o stanie edukacji 2011, Educational Research Institute, Warszawa 2012 the demand for qualified workers with technical VET education as well as craftspersons increased. This led to a growth of interest in VET education. (Mazik-Gorzelańczyk, M., Kształcenie zawodowe w Polsce w perspektywie zmian i potrzeb gospodarki (*Vocational education in Poland in the perspective of economic changes and needs*), Warszawa 2016).

Over the past three decades, Poland's education system has undergone several profound changes in its structure, forms of organisation and management, as well as the core curriculum. As a result of these changes, the following distinctive VET features were developed:

– a flexible VET system allows changing pathways at any point;
– a register classifying occupations (COVE), each comprising of one to three qualifications that can be acquired in IVET and CVET. The register is consistent with the classification of occupations in the labour market. A VET qualification diploma can be issued only when all qualifications required for an occupation have been acquired (on passing State vocational examinations);
– VET schools are autonomous in choosing optional curricula for VET: either subject-centred or modular curricula, which can be easily modified, depending on labour market needs;
– one VET core curriculum for all occupations. Separate VET qualifications within specific occupations are described in the core curriculum as a set of expected learning outcomes: knowledge, occupational skills, and personal and social competences allowing learners to handle their occupational tasks independently;
– vocational qualification courses allow adults to acquire qualifications faster than IVET learners;
– possibility to validate qualifications acquired in different learning contexts, including professional experience, by taking external examinations.

In Poland in the 2009/2010 school year there were a total of: 1,411 basic vocational schools for youth (excluding special schools), in which 204,974 people studied; 3,173 vocational upper secondary schools, supplementary vocational upper secondary schools and general art schools in which 612,500 students were educated (including 1,907 vocational upper secondary schools for young people with 517,124 students and 89 supplementary vocational upper secondary schools with 3,375 students); 245 public post-secondary schools attended by 33,300 students.

In the following years, the number of vocational schools was steadily decreasing: 3,954 basic vocational and vocational upper secondary schools operated in Poland in the 2014/2015 school year, and there were even fewer, just over 3,500 in the 2016/2017 school year.

From 2016 – now

Several recent initiatives undertaken by the Ministry of National Education address the following challenges:

– the Act on the Integrated Qualifications System (2016) has brought together the qualifications framework, register of qualifications that can be attained, quality assurance and validation principles. General and higher education level qualifications were included in the register. Non-statutory qualifications linked to CVET have been registered based on the initiative of VET providers or other stakeholders;
– the government has revised the incentive system to increase VET participation, develop the vocational guidance system, and expand the implementation of work-based learning in VET by promoting cooperation between schools and employers;
– the Ministry of National Education, together with the Centre for Education Development (ORE), continue the work on the development of new core curricula to be introduced in 2019;
– new sectoral skills councils are being established under the umbrella of the Polish Enterprise Development Agency, giving voice to sectoral stakeholders regarding the demand for competences at the sectoral level to improve education and labour market matching.

The above activities were related to another reform of the education system from 2016, which largely concerns vocational education. According to the assumptions, the target structure of schools includes: 8-year primary school, 4-year general high school, 5-year vocational upper secondary school, 3-year first stage sectoral school, 3-year special job-training school, 2-year second stage sectoral school, postsecondary school.

Basic vocational schools will replace two-stage sectoral vocational schools. On 1 September 2017, the first year of students started a first stage sectoral school. Its graduates will be able to continue their education at a second stage sectoral school, which will end with a professional secondary school diploma (certificate).

The changes for primary schools started in the 2017/2018 school year and will end in the 2022/2023 school year. In general upper secondary schools and vocational upper secondary schools, however, the reform will be introduced in the years 2019/2020 – 2023/2024.

In November 2018, an act introducing significant changes in VET was signed into law. The new law complements the recent structural reform of the education system initiated in 2016. Most changes will take effect at the beginning of the school year (2019/20) (https://www.cedefop.europa.eu/en/news-and-press/news/poland-vet-reform-continues).

The main aim is to restore the prestige of vocational education by improving its quality and effectiveness. Special emphasis is placed on strengthening the mechanisms of involving employers in the development of VET at all its stages, particularly in practical vocational training and in the systematic adaptation of VET to labour market needs by forecasting the demand for professions and skills.

According to the new law, the introduction of a new occupation in the classification of occupations will simultaneously determine its core curriculum, speeding up the reaction to labour market developments.

The education system in Poland is currently undergoing structural transformation. In December 2016, the Ministry of Education introduced reforms which aim at prolonging the time children spend within one educational institution and with one peer group, and to develop a vocational education system that is responsive to the needs of a modern economy. Key elements of the reform include:

a) phasing out lower secondary school (*gimnazjum*);
b) restructuring six-year primary education (*szkoła podstawowa*) into an eight-year programme, taking place in one institution, divided into two four-year parts (basic and lower secondary level);
c) extending the general upper secondary programme (*licea ogólnokształcące*) – to four years instead of three – and the vocational upper secondary programme (*technika*) to five years instead of four;
d) introducing two-stage sectoral programmes (*dwustopniowa szkoła branżowa*); the first stage sectoral school has replaced the basic vocational school (*zasadnicza szkoła zawodowa*) as of 2017/18, while the second stage sectoral schools will begin to operate in 2020/21.

Changes in the school structure are accompanied by the gradual development of new core curricula. Another significant package of VET system reforms will take effect in September 2019. This includes, among others: strengthening cooperation between schools and employers, introducing a new form of vocational learning for learners, introducing regular forecast of demand for employees in vocational education occupations, new rules for the functioning of second-stage sectoral programmes and post-secondary programmes, changes to vocational examinations, introducing compulsory training in companies for VET teachers, streamlined procedures of introducing new occupations to the system, changes in subsidies for local governments for VET education, changes in the structure of institutions providing vocational training, new vocational core curriculum and classification of occupations.

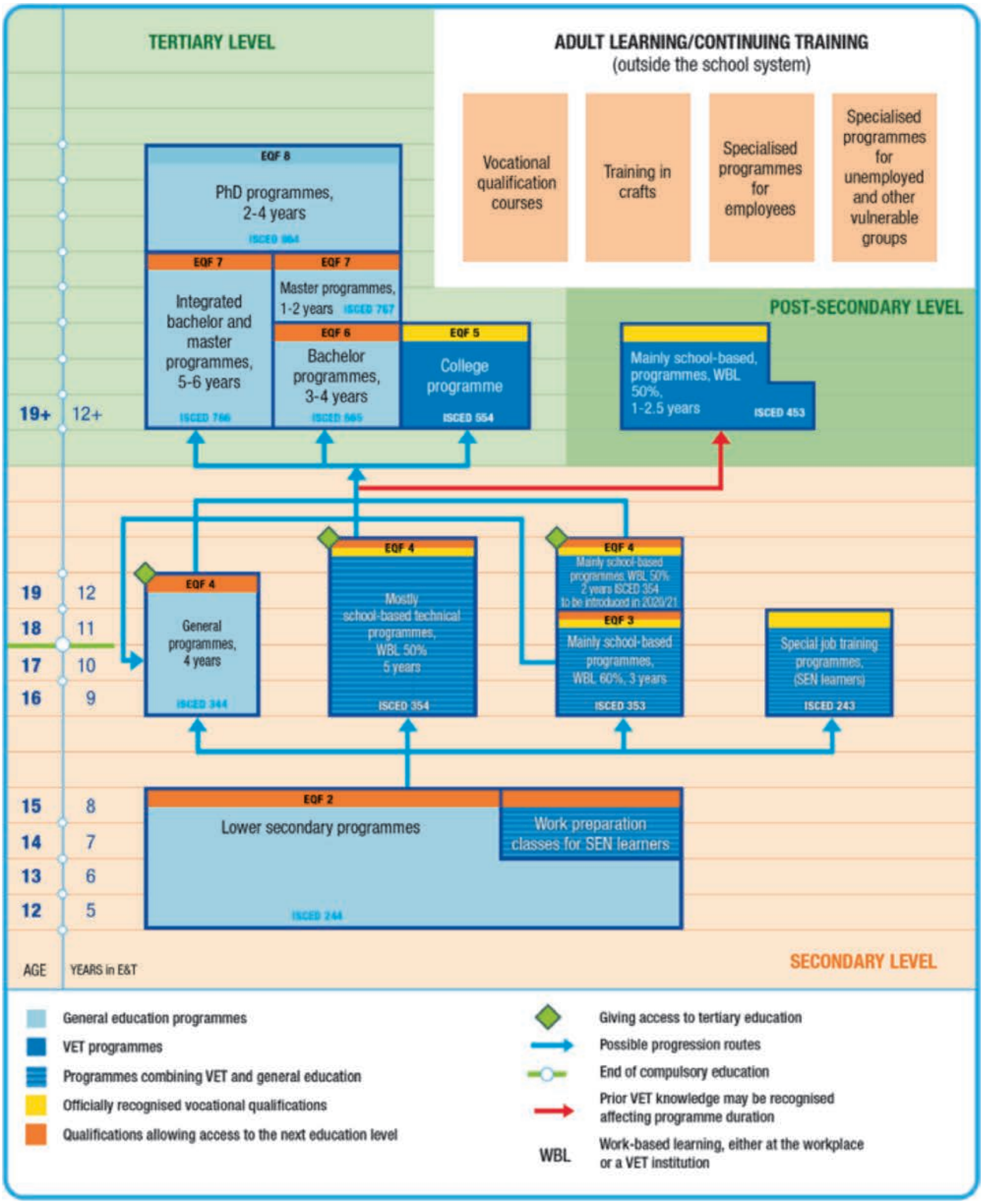

Fig. 2. VET in Poland's education and training system in 2018. ***Source: Cedefop and ReferNet Poland***

Rys. 2. Kształcenie i szkolenie zawodowe w polskim systemie edukacji i szkoleń w 2018 r. ***Źródło: Cedefop and ReferNet Poland***

The school system will be transitioning until 2022/2023. During this period, the previous programmes will be functioning alongside the new ones until they are completely phased out. In the following section, the structure of the new, reformed system is presented. Fig. 2 presents the VET in Poland's education and training system in the year 2018.

Education in Poland is compulsory up to 18 years of age, while full-time school education is compulsory up to age 15. Compulsory education for 15–18 year-olds can be carried out as part-time education, both in and out of school, e.g. in the form of short qualification courses or vocational training for juvenile workers.

VET provided at the secondary level:

a) the three-year first stage sectoral programme (7) (*branżowe szkoły I stopnia – BSI*, ISCED 353, EQF 3) introduced in 2017 is a part of the formal education and training system. This programme is available to primary school graduates (usually 15-year-olds), that is those who received a primary school graduation certificate (this also applies to lower secondary school graduates during the transitional period). The first stage sectoral programme combines general and vocational education and leads to a vocational qualifications diploma for a single-qualification occupation (after passing the State vocational examination). The completion of this programme provides access to further education: at the second year at general upper secondary schools for adults or in the two-year second stage sectoral programme.
b) the two-year second stage sectoral programme (*branżowe szkoły II stopnia – BSII*, ISCED 354, EQF 4) will begin to operate in the 2020/21 school year. This second stage sectoral programme aims at further developing the vocational qualifications attained in the first-stage sectoral programme and will be available to graduates of the first-stage sectoral programmes – usually 18-year-olds. BSII will operate without division into schools for youth and adults. Depending on the profession being taught, education in it will be available in full-time or extramural forms. The second stage sectoral programme will lead to a vocational qualifications diploma for occupations consisting of two qualifications (after passing the State vocational examination). Second-stage sectoral programme graduates will be eligible to continue to tertiary education after passing the secondary school exit examination (*matura*).
c) The five-year vocational upper secondary programme (10) (*technika*, ISCED 354, EQF 4) is a part of the formal education and training system. This programme is available to primary school graduates, usually 15-year-olds, that is those who received a primary school graduation certificate. The vocational upper secondary programme combines general and vocational education and leads to a vocational qualifications diploma for occupations consisting of two qualifications after passing the State vocational examination. Graduates of these programmes, after passing the secondary school exit examination (*matura*), are eligible to continue to tertiary education.
d) the three-year special job-training programme (*szkoły specjalne przysposabiające do pracy*, ISCED 243) for learners with special education needs (SEN) leads to a job-readiness certificate. This programme is designed for learners with moderate and severe intellectual disabilities or multiple disabilities.
e) work preparation classes are available for SEN learners in seventh and eighth grade of primary school (lower secondary level) for pupils aged 15 and older (*oddziały przysposabiające do pracy*, ISCED 244, EQF 2). Classes combine general education and work preparation – both adapted to the individual learner's needs and capabilities.

Post-secondary level

At the post-secondary non-tertiary level, vocational qualifications can be attained in one- to two-and-a-half year school-based programmes (*szkoły policealne*, ISCED 453). Post-secondary programmes are part of the formal education and training system and are available to the graduates of general and vocational upper secondary programmes (usually 19 and 20 year-olds), as well as in the future – the second stage sectoral programmes (usually 20-year-olds).

These programmes are strictly vocational and do not include general education.

Adult learning and out-of-school VET

Adult learning and out-of-school VET is available in continuing education centres, practical training centres, further training and professional development centres (the structure of institutions providing VET training started to change as of September 2019), and initial VET (IVET) schools offering:

– vocational qualification courses (*kwalifikacyjne kursy zawodowe – KKZ*) based on the curricula for a qualification in a given occupation; they allow learners to take the State vocational examination and obtain a vocational qualification certificate;
– vocational skills courses based on the core VET curriculum, including learning outcomes for a qualification or common learning outcomes for all occupations;
– at least 30-hour general skills courses that are based on the general education curriculum;
– theoretical courses for juvenile employees.

Adults, including the unemployed, may also undertake vocational training through courses provided by training companies and other non-formal education institutions. Since 2016, the qualifications based on the curricula of such courses can be included in the national qualifications framework.

VET in higher education

The law on higher education in Poland distinguishes different types of higher education institutions: academic, vocational and others, such as medical or military. The second type of school offers first (Licentiate degree) and second (Master's degree) cycle study programmes as well as uniform master's studies, but not doctoral programmes. Higher education vocational schools are also not obliged to conduct scientific research and educate academic staff.

Apart from higher education institutions, colleges of social work (*kolegia pracowników służb społecznych*) exist, offering programmes at the ISCED 5 level. These colleges provide three-year programmes for the social worker occupation.

VET system for the steel sector

On 16 May 2019, the Minister of National Education issued a regulation on the core curricula for vocational education in vocational education and additional professional skills in the field of selected vocational education professions. Annex 16 to the regulation contains the core curricula for 5 vocational education professions assigned to the metallurgy industry:

1. foundry modeller,
2. operator of foundry machines and devices,

3. operator of machinery and equipment for the metallurgical industry,
4. foundry technician,
5. technician of the metallurgical industry.

Out of these professions, only occupations 3 and 5 coincide with the ESSA Blueprint area of interest.

Some technicians continue their education in the profession of metallurgical technician. Education in this field enables the acquisition of knowledge and skills in the use of machinery and equipment used in metal and powder metallurgy processes; making products by means of plastic deformation and powder metallurgy; conducting quality control; supervising the work of employees and machines and devices. A student may acquire the following qualifications while studying:

– M.6. use of machinery and equipment used in metallurgical processes,
– M.7. using machines and equipment for metal forming (plastic deformation),
– M.38. organisation and carrying out of metallurgical processes and metal forming.

Universities

There are a number of national HE providers/universities, which offer courses related to steel and non-ferrous metals. These are:

– AGH University of Science and Technology, Faculty of Metals Engineering and Industrial Computer Science,
– Silesian University of Technology, Faculty of Materials Science and Engineering,
– Częstochowa University of Technology, Faculty of Production Engineering and Materials Technology,
– Warsaw University of Science and Technology,
– Wrocław University of Science and Technology.

9. INSTITUTE'S CONTRIBUTION TO REPORT D4.4

The implementation of the project requires the creation of several databases, which should be publicly available online and editable for a specific group of users. The Institute has developed a general approach to this issue.

The execution of the Blueprint ESSA project requires the development and online presentation of databases related to broadly defined professional qualifications and skills, as well as occupations and their profiles. While the development of databases, apart from the enormous effort in obtaining and properly organising the data that should be in such a database, is not technically complicated and can be achieved, the way of using them, including online availability, is larger the challenge, the more information a database contains.

The use of databases must take into account two obvious conditions:

– the method of using the database must be user friendly,
– the database must be periodically updated to maintain its fitness for specific purposes.

The above-mentioned updating of the database must be limited to a narrow circle of people with specific permissions and skills in order to enter only verified information, as well as enter it in a way that prevents its damage.

Using the database also has its conditions. The ESSA project assumes public access to the database, so the number of possible queries can be significant. Thus, the user-friendly user interface, as already mentioned, must give the opportunity to ask these questions, and the program that supports the database should be able to search for the desired information in the database and present it to the user in a transparent manner.

Nowadays, the widespread use of computers, internet and various databases, and the software associated with the use of these databases has been greatly expanded. There are over 600 programs to use databases, which does not make it easier to choose. An additional difficulty for dedicated databases, and such are the databases in the ESSA project, is the need for the user to create their own interface elements that will facilitate the creation of queries and finding data for them in the database.

Currently, several Blueprint projects for various industries are being realised at a European level. Their overall goal is to facilitate the preparation of personnel for industry 4.0. Hence, one can imagine that these projects also create databases similar to those in the ESSA project. Therefore, it seems logical to create a common database platform for those sectors that implement Blueprint projects. It would be an excellent tool for employers in these sectors. If you agree with this, then the way you use and update databases on this platform should be very similar for all sectors, and this in turn would require the use of the same software tools.

Some Blueprint projects are currently completing the second year of realisation, and some – the first. Perhaps among the projects realised for a longer time, appropriate solutions have already been proposed that could be used in other Blueprint projects. Establishing cooperation with the implementers of other Blueprint projects in this area could be beneficial for all teams implementing these projects, and more importantly for future users of the results of these projects.

9.1. GENERAL INFORMATION ABOUT DATABASES AND HOW TO USE AND PRESENT THEIR CONTENT

The general information about databases, their structures and ways of using them, as well as their advantages and disadvantages, is presented below. This material can be helpful in deciding how to further develop methods of public use of created databases through their online presentation.

Database concept

A database is an organised collection of structured information. In computer science, this term refers to sets of information saved in the computer's mass storage that are controlled by the database management system (DBMS). With the help of this system, all operations on the data, creating database queries and generating reports on all or part of the set are possible. The user working with the database uses the application that creates a user-friendly and convenient interface for data management using DBMS. The data and the DBMS system along with related applications create a database system popularly referred to as the database.

Types of databases

Due to the storage location of the database, we can distinguish:

- ***Local databases*** – these are the simplest databases, which are all located on one computer and are in the form of one table, e.g. a list of company employees. The user modifies individual records independently and directly in the database. Example: spreadsheets in Microsoft Excel, simple databases in Microsoft Access.
- ***Client-server databases*** – the database is stored on a server connected to the network, and access to it is pos-

sible for many users. Users working on their computers are also connected to the network, and the database is not used directly, but by using applications called clients. The most common solutions are Oracle, Microsoft, IBM, Sybase.

The above division is the basic division of databases, which results in the greatest differences between them. The databases created in the spreadsheet are a good solution for one or several users working locally who do not need complicated data manipulation functions. On the other hand, databases located on servers enable many users from different parts of the world to access data at the same time and work safely and quickly. It is also possible to create multiple access levels for individual users.

Databases can also be divided by architecture, although this division often overlaps with the previous one:

- ***Single-layer databases*** – in this architecture, the program that provides the user with the content of the database has direct contact with it and is also used to make changes to the data. Most local databases are based on this model.
- ***Double-layer databases*** – the database is located on a edicated server, and the program that provides the user with the contents of the database is installed on the user's computer and communicates with DBMS via the network using dedicated network software.
- ***Three-layer databases*** – in this architecture, there is an application server between the users' computers and the database server. On this server, applications are made available in the form of html pages or Java applets, and the user on their computer has access to them via a web browser. The user issues commands to the applications, and the application server sends requests to DBMS. DBMS executes commands on data and sends the results to the application server, which in turn sends them to the users' applications.

Most client-server databases rely on a multi-layered data architecture model.

Due to the data model, the database can be divided into:

- ***Simple databases,*** which are divided into *flat-file* and *hierarchical*. *Flat-file bases* are in the form of one data table, which is an independent document and cannot cooperate with other tables. An example of such a database could be a phone book or a list of books. *Hierarchical databases* store data as master – child records, which resemble a tree structure. Each record (except the master) is associated with exactly one parent record. An example of such a model is the directory structure on a computer's hard drive.
- ***Relational databases*** – in this model, the data is placed in two-dimensional tables (containing columns and rows), and many tables can work together. Relational databases have internal programming languages (usually SQL), which are used to create advanced data-handling functions. At present, the relational database technology provides the most effective and flexible way to access structured information. Relational databases and the SQL language are based on a few simple rules:
  1. All data values are based on simple data types.
  2. All data in the relational database are presented in the form of two-dimensional tables. Each table contains one or more rows and one or more columns. Each row consists of equally arranged columns filled with values, which in turn can be different in each row.
  3. After entering data into the database, it is possible to compare values from different columns, usually also from different tables, and merge rows when their values match. This enables data binding and relatively complex operations across the entire database.
  4. All operations are performed based on relation algebra, regardless of the position of the table row. The rows in the relational database are stored in a completely arbitrary order – it does not have to reflect either the order in which they were entered or the order in which they were stored.
  5. Due to the inability to identify a row by its position, there is a need for one or more unique columns within the entire table to find a specific row. These columns are referred to as the "primary key" of the table.
- ***Object-oriented databases*** – a set of objects whose behaviour, state and relationships are determined according to the object-oriented data model. The object-oriented database management system is a system supporting the definition, management, maintenance, security and provision of the object-oriented database. Their advantage is sharing data in the object-oriented form, i.e. the same in which the data is stored in programs written in object-oriented programming languages. The need for mapping between the object model and the relational model disappears, as is the case when using a relational database.

There are many other data models used in databases, e.g. network, object-relational, stream, non-relational, or temporal. However, in commercial applications, the two previously described are the most common, i.e. relational and object-oriented.

Table 2 shows the pros and cons of both solutions.

Due to the number of data storage places used, there are centralised systems with one database and distributed systems with more than one database included in the system. In distributed systems, databases are most often located in different locations, which increases security, while the cost of infrastructure and database maintenance also increases.

Database design

A good database design is crucial to properly meet the requirements set for it and working with it is not burdensome. This requires a systematic approach. Design works are divided into several stages:

1. Requirements analysis – consists in collecting initial information and requirements regarding processed data, their hierarchy and connections between them.
2. Logical modelling – based on the collected information, creating a modular database model that contains specific types of data. This allows to specify the basic elements of the database, i.e. tables, and the relationships between them. Tables are basic logical units that contain a specific data type, while relationships symbolise a network of their interrelationships.
3. Physical modelling – involves designing search mechanisms and creating a user-friendly interface to operate the database. Depending on the type of database and users' needs, the search mechanisms and interface can be very different. The most popular interface types are a dedicated client application or web interface (i.e. support via a web browser). In practical terms, interface design is usually associated with the analysis of users' expectations and rights.
4. Implementation and testing of the database – this stage involves the implementation of a database system for physical equipment and checking the correct operation.

Table 2. Pros and cons of relational and object-oriented databases

Tabela 2. Zalety i wady relacyjnych i obiektowych baz danych

	Relational databases	**Object-oriented databases**
Advatages	• independence from the programming language • proven, well-defined theory • the ability to manage large amounts of data • the ability to enter complex search criteria • the ability to access physical data • good data access control mechanisms • views mechanism	• fairly easy representation of the world • accurately represent complex relationships between objects • ease of operation on complex objects • high susceptibility to change • the ability to define one's own types, methods • good integration with general purpose programming languages (e.g. C ++, Smalltalk)
Disadvantages	• many of tables for more difficult problems • not very natural representation of data • limited susceptibility to changes • no complex data types • difficulty to handle complex data • difficulty to operate on distributed data in a heterogeneous network • incompatibility with the model used by general-purpose languages	• linked to one programming language • poor data search support • no commonly accepted query language • no possibility of query optimisation • difficult or even impossible access to physical data • poor access control • limited possibilities for server optimisation
Better when...	• data is simple, not nested, easy to put into an array • data is passive and processes that use the data are constantly changing • one often needs to search for data that meets a variety of conditions	• data has a complex or nested structure • data creates hierarchies • data is dispersed in a heterogeneous network • data dynamically changes size
As of today	They dominate in commercial applications (about 95% of the database market)	Less popular, however, they are constantly being developed
Examples of systems	Oracle, DB2, Access, Informix, Sybase, Ingres, Progress	GemStone, O2, Persistance, Versant, POET, Objectivity, ODI

The information above does not exhaust the complex topic of database systems. Only basic information and differences between databases were presented. Due to the multitude of commercial solutions and the key role of good design of the entire database system, the help of experienced specialists is highly recommended.

A simple type of data used in the project (verbal descriptions of skills and professional qualifications, division into industries, countries, etc.) and the natural opportunity to present the data in the form of interrelated tables encourage the use of the relational model. The use of the SQL language gives the possibility of virtually any creation of database queries and, in response, present personalised reports. Due to the possibility of cooperation with high-level programming languages, the SQL-based relational database gives wide range of possibilities to create an appropriate interface for database support and data presentation (dedicated program, support via a web browser). The use of the client-server model will ensure online access for many users to one central database. In addition, the fact that relational SQL databases have been used on the market since the 1970s means that the mechanisms of action are well known and clarified, and the multitude of solutions and companies specialising in creating and implementing this database model allows to create a database system exactly tailored to the needs of the project.