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Skills Intelligence in the Steel Sector

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Abstract: To implement Intelligent Production Systems, two innovation approaches are to be combined: on the one hand, technological innovations produce intelligent solutions which harvest the potential of digital technologies and huge volumes of available data. On the other hand, social innovation processes are needed which introduce the skills perspective into innovative production systems. *Skills Intelligence* is a helpful concept that provides a good information base for informed decisions on skill needs and skill development. The article shows that this target can be achieved best through innovative tools which are developed based on an effective integration of different stakeholders and perspectives.

Keywords: Skill Intelligence, Social Innovation, Human factors requirements, Skills alliance, Skills observatory

1. INTRODUCTION

In the face of an increasingly fierce international competition in the steel sector, the European Commission adopted an action plan for a competitive and sustainable steel sector (see White Research et al., 2020). Instead of competing on cheap labour and low social standards, this action plan is based on a strategy to offer innovative and high-quality products and thereby staying ahead of the technological curve. Beside the implementation of new technologies (such as Intelligent Manufacturing Systems), a competitive, well-qualified and adaptable workforce is needed which possesses the right skills to contribute to this strategy. For the first time, a European Steel Skills Alliance (ESSA)[1] is being developed to tackle expected skill shortages emerging due to digitalisation and decarbonisation. This paper shows innovative methods how Skills Intelligence enables this alliance by creating a data basis for the European steel industry to identify and overcome skills shortages.

Skills Intelligence enables stakeholders to make informed decisions when it comes to skills. It has been defined by the European Union as follows: "Skills intelligence is the outcome of an expert-driven process of identifying, analysing, synthesising and presenting quantitative and/or qualitative skills and labour market information. […] To remain relevant, skills intelligence must be kept up-to-date and adjusted when user needs change" (Cedefop, 2019).

Skills Intelligence should benefit different user groups for whom the topic of skills plays a role; „policy makers, social partners, local providers of VET [Vocational Education and Training, the authors], career counsellors and learners" are named as examples. Crucial to the goal of Skills Intelligence is data preparation, which includes e.g. the identification of "users' information needs" and the matching of these with "available and reliable data and information" (Cedefop, 2019).

Currently, the European Union strives to realise Skills Intelligence with several Europe-wide tools, such as the online information platform *Skills Panorama,* the CV and recommendation tool *Europass* as well as *ESCO, a* classification of skills, competences, qualifications, and occupations.

However, these tools of Skills Intelligence cannot reflect the specific situations and needs of individual sectors and companies. The steel industry is facing the challenge of mastering two far-reaching transformations at the same time: the digital transformation and that of decarbonisation which require advanced digital tools and people with corresponding digital and green skills. Currently, a "difficulty in integrating new technologies and processes among site workers" is identified which raises the need for steel companies to develop capacities to adapt to fast technological changes (ibid., p. 13). This challenge has been taken up by the European Steel Technology Platform (ESTEP), under which umbrella the European Steel Skills Alliance (ESSA) is established[2]. This

[1] The project ESSA has received funding from the European Union's Erasmus+ programme under project reference No 600886-EPP-1-2018-1-DE-EPPKA2-SSA-B.

[2] Skills have also been considered as a building block for the Clean Steel Partnership run by ESTEP (https://www.estep.eu/assets/Uploads/CSP-SRIA-Oct2021-clean.pdf).

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EU-funded project has developed a blueprint to identify and meet skill needs of the steel sector. It is a collaborative approach integrating the knowledge and perspectives of all relevant stakeholders in the steel sectors: companies, research institutions, associations, trade unions, and training providers.

In this article, we will outline innovative methods to implement Skills Intelligence for the steel industry. This includes the development of a skills framework and first analysis of data on skill demand in the steel sector (s. *Section* 2). *Section 3* will present methods how to develop steel-specific Skills Intelligence by implementing innovative approaches such as a Skills Foresight and Observatory and an Online Training Ecosystem.

2. SKILLS INTELLIGENCE IN PRACTICE

In this section, we present two important aspects of Skills Intelligence: The definition of a framework to be able to collect information as well as, underpinned by several findings from the BEYOND 4.0[3] and the ESSA project, the relevance of skill information for different actors.

2.1 Defining a skills framework

To provide data on skill demands and supply, a common understanding of skills categories is needed which is shared by all parties in a sector which are affected by changing skill requirements due to the ongoing digital and sustainable transformation. Based on a systematic literature review and empirical fieldwork of the project BEYOND 4.0 it has become obvious that the digital transformation does not only require improved digital skills, but also non-digital skills, such as methodological (e.g. problem-solving), social (e.g. communication/collaboration) and personal skills (required personal traits, e.g. adaptability to technological changes). Also, a combination of professional and digital skills is needed to reflect the integration of the physical and virtual world of steel producing as the core of the Industry 4.0 concept. These findings have led to a framework of skill categories including digital, non-digital (personal, social, methodological), and professional skills.

Within the ESSA project, a similar skills categorisation was developed (see Bayón et al., 2021, pp. 50). Compared to the Beyond 4.0 classification, green skills as well as physical and manual skills are included as specific skill categories due to their importance for the steel industry. The further broad skill categories were digital, social, methodological, and individual-personal skills, while a couple of subordinated skills were also included. This skill categorisation served as framework and was used to assign skill demands and supply due to digitalisation and decarbonisation.

2.2 Collection and usage of skill demand data

In the two EU-funded projects BEYOND 4.0 and ESSA, the demand for skills in the steel industry was analysed based on quantitative and qualitative data which are presented here along the categories of the skills framework.

Within the BEYOND 4.0 project, an analysis of regional ecosystems was carried out. Based on interviews with company representatives and stakeholders, the skill demand in the steel ecosystem in the western Ruhr Valley (Germany) was explored. This results in policy recommendations to enable informed decisions how to increase responsiveness of Initial and Continuous Vocational Education and Training (IVET and CVET) to the challenges of the digital transformation.

In the ESSA project, a questionnaire-based survey, conducted from November 2020 to January 2021, quantifies the skill demand in the above-mentioned categories (see Bayón et al., 2021, pp. 9–19 for detailed results and more conceptual information). Mainly company representatives were asked about current and future skill demands within nine different occupations which are particularly important for the industry from a European perspective. The survey also served as a pre-check for a skills observatory (s. below) in the European steel sector, which is currently under development. The survey results mainly address policy makers and steel associations to inform them about the status quo in the sector and generate a basis for them to formulate needs regarding education and training offers by VET and training providers.

A quite generous finding in the survey was that participants clearly tend to assess the future skill demands higher as the current skill demands. The general diagnosis of an increase[4] of needed skills also varies across the different skill categories: The biggest increase in skill demand was detected for green skills (+ 0.7 points[5]), digital skills (+ 0.6 points), and social skills (+ 0.5 points). At the same time, the most important category of skill overall will be (as in the present) personal skills with 2.7 points (Bayón et al., 2021, p. 16).

According to interview results from the BEYOND 4.0 project, experts from a steel company in the Ruhr Area also emphasised the importance of ***personal skills*** as well as ***methodological skills***. The reason repeatedly cited by the experts interviewed was the speed at which changes occur in the course of digitalisation. Employees in the steel sector have to deal with new digital tools in relatively short intervals, so that further education and ongoing training on new technologies are of great importance, especially at middle and higher qualification levels. Therefore, employees are more than ever required to develop methods that enable lifelong learning (expert intermediary, 10_12_2020): “We notice in the entire labour market that changes that used to happen within 15 years now happen within months” (ibid.). Accordingly, the methodological learning skills essential for lifelong learning

[3] The project BEYOND 4.0 has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 8222296. It analyses impact of the new technologies on the future of jobs, business models and welfare.

[4] Increase means that within a job profile assessment the future relevance of a skill was assessed higher than the current relevance of the skill. The terms “no change“ and „decrease“ are analogous to this.

[5] On a scale reaching from 0 to 4, metrical interpretation of a verbalised scale (0: Novice, 1: Awareness/Basic Actor, 2: Practitioner, 3: Expert, 4: Master).

are becoming more important, especially in the course of the digital transformation.

The high importance of lifelong learning in the steel sector is favoured by the fact that the leading companies in the steel ecosystem are characterised by low staff turnover. Accordingly, employees, even in the low-skilled sector, have a high retention rate in steel-producing and steel-processing companies, which in turn has a positive effect on the willingness of companies to provide further training: "We are a company that has almost no fluctuation, which is good on the one hand because we have an infinite amount of time to develop our people. That means that when we hire people, it's sometimes not a question of what they can do, but what they are capable of learning" (expert company, 15_12_2020).

In many cases, further education is taking place in-house, also against the background of digitalisation, so that the demands for potential applicants are initially manageable. In this context, *elementary* ***methodological skills***, which are mainly referred to as basic skills, including literacy and numeracy, are considered essential for the acquisition of digital skills and the use of digital technologies (expert intermediary, 10_12_2020). This is useful information for recruiters of steel companies as methodological and personal skills have become elementary requirements to applicants for job vacancies.

The above-mentioned conditions increase also the demands for ***personal skills*** such as adaptability to changes, which are ultimately also considered essential for successful lifelong learning by the experts surveyed in the steel sector. In this context, it is observed that learning skills are more likely to be present in employees who have completed a degree or training and, accordingly, familiarisation with new systems and structures is easier at these levels: "The higher my skills are, and also my human capital, the higher the possibilities are to prepare myself for other things and to be retrained" (expert intermediary, 10_12_2020).

These insights are underpinned by findings from the ESSA survey. Thereby, the most important non-digital skills both in terms of increase and overall demand in the future will be *adaptability and continuous learning* as well as *teaching and training others*. The same is true for the skill *adapt to change* which is one of the most important and increasing personal skills: In 97 percent of the assessments a future need of at least practitioner level skills was predicted and nearly two out of three profile assessments included an increase of this skill in the future. In the methodological skills, there was again a more or less constant increase in all sub-categories. Overall, basic numeracy and process analysis will be the most important methodological skills in the future.

At the same time, the digital transformation means that ***social skills*** are also becoming more important. For example, leading steel companies in the region often work on topics related to digitalisation in interdisciplinary teams (expert company, 15_12_2020). This exchange between different professional groups has increased the demands on teamwork. These skills enable decisions of recruiters formulating requirements to applicants. It is also relevant for (internal and external) training providers that trainings should also address social skills.

Regarding ***green skills***, both the increase and overall relevance of the skills are similar, with Energy Efficiency and Environmental awareness being the most demanded in the future (around 60 percent of the employees will require at least expert level skills here).

In the course of the digital transformation, the need for ***digital skills*** is naturally also increasing. However, the findings show that digital skills are of varying importance at different qualification levels. Highly qualified employees in particular are often required to have in-depth digital skills, while at the level of low-skilled employees, particular attention is paid to the user-friendliness of digital technologies (expert intermediary, 01_09_2020; expert research, 27_04_2020). Basically, however, experts in the steel sector confirm that ***basic digital skills*** are becoming increasingly important at all levels. In addition, it is also possible to speak of moderate digital skills, which play a role primarily in administrative activities and office jobs in the medium-skilled sector (expert company, 15_12_2020). In over the half of the job profile assessments it is stated that expert or master level skills in *basic digital skills* will be needed for this job, whereas other skills will be more needed on a practitioner level (*cybersecurity, use of complex digital communication tools, advanced IT*).

Job profiles with an overall low skill level tend to be more oriented towards ***technical skills***, whereas technical skills play a subordinated role for the job profiles with a high level of needed skills (Bayón et al., 2021, p. 18). This clear distinction no longer exists for the other skills, which are altogether more transversal and equally necessary in the job profiles, even though there are some skill categories which seem to play a distinct role within single job profiles (e.g. social skills for the metallurgical manager and digital skills for the industrial electrician) (Bayón et al., 2021, p. 18).

3. PREPARING AND PRESENTING SKILLS INTELLIGENCE IN THE ESSA PROJECT

The information relevant to different target groups, also has to be specifically communicated to them. In this section it will be addressed, how in the ESSA project relevant steps – the survey, compilation and communication of information – are considered in an integrated manner. Possible target groups are already integrated in the creation of various tools: Companies, training providers and business associations, research institutions and trade unions are part of the ESSA consortium. Out of their interaction different tools are developed and geared to different perspectives and target groups. In addition to this, also other relevant actors are taken into consideration, for example the European Union as the funder of the project as well as Vocational Education and Training (VET) institutions are considered as well.

Skills Intelligence is better achieved by integrating many different actors, as the individual tools gain better points of connection – a common information base is created for these stakeholders. The positive correlation between the emergence of innovation and the involvement of actors and perspectives is also confirmed in the literature, for example by concepts originating from the *Triple Helix* model (for a recent literature

review on this topic see Galvao et al., 2019): These approaches originating in the 1990s examine the contribution the cooperation of different actors can have on economic innovations and growth. Initially centred on synergies between universities, governments, and industry (*Triple Helix*), more recent works also integrated other actors (e.g. from civil society) and contexts (e.g. smart cities, the environment, (business) ecosystem) into their models, which then were called *Quadruple* or *Quintuple Helix* (ibid.).

In the following, tools and concepts of Skills Intelligence, that are currently being developed and partly deployed as a part of the ESSA project will be outlined. In each case, we will explain which users are addressed by tools and how the data is created respectively, selected and presented to facilitate the decisions of these actors

Table 1: Tools of the ESSA project and connection to Skills Intelligence.

	Providing skills-related data to stakeholders		
Skills Intelligence Characteristics / ESSA Tools	**Target Group**	**Data preparation via**	**Data presentation via**
ESSA Foresight Panel	The public, esp. scientists, industry representatives and political stakeholders	Delphi methodology (Online survey and panel discussion)	Diverse channels (reports, online training ecosystem etc.)
ESSA Assessment Tool	Companies (internal)	Self-declaration in questionnaire	Compact, classifying presentation of the results
ESSA Online Training Ecosystem	Demanders and suppliers of training	Collection of training materials, connections to diverse frameworks	Online platform
ESSA Sector Skills Matrix	VET institutions, sector associations, political stakeholders	Case studies	Deliverables

3.1 ESSA Foresight Panel & Observatory

The ESSA Foresight Panel and Observatory aims to make skill demand visible at the European steel sector level and therefore works on a very fundamental level. As a rough directional indicator, it is not a final decision-making aid, but rather helps to calibrate larger-scale strategies of political stakeholders and sector associations. The panel's data will make it possible to draw a uniform picture of the industry's situation at European level.

The tool combines a survey among company representatives with a discussion of experts for skills in the steel sector (see Schröder et al., 2020, pp. 62–64). Currently, a first wave of the tool is being prepared for 2022, but a preliminary version of the questionnaire part was already tested in 2020 and 2021, and the results have been presented in *Section 2.2*. The aim of the panel is to record technological developments and future and current skills requirements on a European sectoral level regularly, i.e. approximately every two years. The approach is based on a modification of the Delphi approach, which is a social science method focusing on condensing expert knowledge into predictions of the future via group communication processes (Häder & Häder, 2014, p. 587).

A two-stage research design is being applied: First, the survey will be conducted online in several languages. The central results will then be the basis for a panel discussion of experts, who will identify a holistic picture of the situation in the European industry. In this variant of the Delphi approach, two types of experts are included: on the one hand, the representatives of companies who are experts for the skills needs in their company, but who do not necessarily have an eye on the overall situation of the European steel industry. And then the experts in the panel, who will be more widely networked and have already gained an overview of the situation. This methodology corresponds to a bottom-up process in which assessments are collected from different perspectives and then cumulated in consensus-based forecasts.

3.2 ESSA Assessment Template

The ESSA Assessment Template (see Schröder et al., 2020, p. 42) is based on the questionnaire needed for the ESSA Foresight Panel & Observatory, but is optimised for company internal usage. Company representatives are helped to gain a better overview on the situation in their company and on the skills needed in the future and the present. For this purpose, the questionnaire will be shortened to a central part, with the help of which the current and future skill needs within occupations in the company can be assessed.

By becoming aware of the current situation, room for action is opened up. The ESSA Assessment Tool will work as a guideline, for example for deciding which occupation will need the most attention regarding further education in the future and also the types of skills which are needed. Combined with the specified knowledge about the company, possible effects can be seen in the areas of further education and training programmes as well as recruiting of new staff.

3.3 ESSA Sector Skill Set Matrix

The VET institutions are further relevant actors when it comes to Skill Intelligence in the steel sector. The skills and competences of young professionals are also dependent on the programmes national VET institutions offer. A steel industry that has defined a demand for skills in view of upcoming challenges – e.g. with the help of the tools presented in previous sections – will also have an interest in VET institutions that correspond to these needs. The ESSA Sector Skill Set Matrix provides transparency on the extent to which existing VET programmes connect to potentially needed transversal skills (Antonazzo et al., 2021, p. 7).

Five case studies in five countries (Germany, Poland, Italy, Spain and the UK) were conducted to capture this connection. It includes information on relevant IVET and CVET qualification programmes, the specific link between these qualification programmes and jobs relevant for the steel industry, learning outcomes concerning transversal skills, the "compatibility/ alignment with/ use of a range of European VET tools" as well as an assessment of the current and the future skill provision (Antonazzo et al., 2021, p. 7).

Three functions are defined for the usage of the matrix: First, it can be used as an information base on different occupational qualification programmes, in particular on the learning outcomes related to transversal skills; second it can be used to be connected to work of other ESSA tools; and thirdly, it allows to compare different occupational profiles within, but also between countries (Antonazzo et al., 2021, pp. 7–9).

The matrix is connected to other ESSA tools: It includes the transversal skill categories that are also used for the Foresight Panel & Observatory and the Assessment template (see Antonazzo et al., 2021, pp. 13–15), it also includes learning outcomes, which are the central point of connection for the ESSA Online training ecosystem.

3.4 Online Training Ecosystem

The ESSA online training ecosystem called steelHub[6], is used to collect and provide various training resources relevant for the steel industry (see Bayón et al., 2021, pp. 36–45; Schröder et al., 2020, pp. 64–66). The goal of the platform is to facilitate the matching between the skill supply of available training materials and skill demands of steel companies. On the platform, both sides are linked via learning outcomes (Bayón et al., 2021, p. 36), which are defined as "the statements of what a learner knows, understands and is able to do on completion of learning process" (European Parliament & European Council, 2008, p. 4).

On the demand side, relevant occupations which are affected by changes due to digitalisation and/or decarbonisation are defined by the project as well as companies. Identifying the tasks of these occupations and related skill demands, learning outcomes that are necessary to achieve the needed skills can be defined. On the supply side, training providers input training courses and their learning outcomes. This allows steel companies to identify those training courses which are needed to reduce skill gaps (see Bayón et al., 2021, pp. 36–39). Other stakeholders as for example "associations, […] other blueprints, VET systems, […] research and development organisations, individuals" (Bayón et al., 2021, p. 41) are also addressed by the platform. The training materials themselves are not developed in the course of the ESSA project; instead only the infrastructure for an exchange of these materials is established.

The key to a good link between skill demand and supply in the online training ecosystem is a good classification of training materials. This is especially enabled by linking them to existing frameworks, such as the *ESSA Foresight Panel & Observatory*, European tools as the *European Qualifications Framework (EQF)*, the *ESSA Skill Set Matrix,* and the *European Skills, Competences, Qualifications and Occupations* (ESCO). With this approach, a connection between a known demand for skills and the training resources can be created. Different perspectives are connected and more informed decisions are enabled. With regard to the multitude of actors and findings that are integrated, it can be seen as collection point to combine different types of information and actors (Schröder et al., 2020, p. 64).

3.5 Regional skills ecosystems

While education policies are created particularly at the national level, it is at the regional level that such skill strategies are adapted, facing specific dominant sectors, labour markets, qualification structures, educational infrastructures and regional innovation strategies. As skill shortages are more and more proving to become bottlenecks for the digital transformation, regional and sectoral innovation strategies are aligned with skill supply (potential) in the region. Against this background, Skills Intelligence is needed to unfold the full potential of regional skill ecosystems to support regional and entrepreneurial innovation strategies. The skills ecosystem approach assumes that networks of institutions and actors heavily shape and influence the development, supply, demand and deployment of skills in a given industry or region (cf. Anderson & Warhurst, 2012, p. 117).

For example, the steel sector in the Rhine-Ruhr region shows that a skills strategy, also in the form of a clear division of roles between the relevant companies and stakeholders, is needed to determine which actor can take on which tasks in the context of skill development and utilisation. This is facilitated by Skills Intelligence.

[6] Which has been developed by steeluniversity, see https://steeluniversity.org/support/steelhub/

The ESSA project is contributing in the form of a regional rollout in which the aforementioned tools and results of the ESSA project are being transferred to selected steel regions in Spain, the United Kingdom, Poland, the Czech Republic, the Netherlands, Italy, Finland and Germany. The aim is to initiate a co-creation process in the selected regions which includes strong stakeholder engagement. This will firstly be carried out in the framework of workshops, in which economy, policy, science and education and civil society are involved. Collaboration is thereby be fostered among ESSA and the respective regional stakeholders and companies to expand existing synergies among steel regions in order to implement large-scale upskilling and reskilling strategies. Skills Intelligence is a strong enabler for these strategies.

4. CONCLUSION

Innovations in the steel sector require adjustments that go beyond purely technical changes: The skills of the employees must also be adapted to challenges of new technologies and also to new work what is often related to technological innovation. For the first time, a Steel Skills Alliance is developed to tackle expectable skill shortages on a European scale when digitalisation and decarbonisation are progressing. Skills Intelligence is an approach to provide appropriate data on changing skill requirements, emerging skill gaps and needed trainings. “Skills intelligence is the outcome of an expert-driven process of identifying, analysing, synthesising and presenting quantitative and/or qualitative skills and labour market information” (Cedefop, 2019). It improves the ability of actors to make (better) informed decisions.

Within the ESSA project, several tools are developed which enable Skills Intelligence for the steel sector. The main challenge here is that different actors are encouraged to contribute to solutions - but for effective cooperation, a common information base is crucial. The *Skills Foresight Panel and Observatory* provides data on skill demands at the European steel sector level and enables calibrate larger-scale strategies of political stakeholders and sector associations.

The *ESSA Assessment Template* (see Schröder et al., 2020, p. 42) is based on the Foresight Panel and Observatory, but is optimised for company internal usage to get a better overview on the situation and related skill needs in the company. The *ESSA Sector Skill Set Matrix* is another Skills Intelligence tool providing transparency on the extent to which existing VET programmes connect to potentially needed transversal skills. Last, but not least, the *ESSA Online Training Ecosystem* is a tool that allows a matching of skill demand and skill supply based on learning outcomes which are needed by changing job tasks and which are to be provided by trainings. These tools form a Skills Intelligence approach which enable stakeholders on European and regional level to make better informed decisions on skill development and, thereby, to contribute to unlocking the full potential of technological innovations.

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