

INDUSTRY 5.0 AS A DRIVER FOR THE COMPETENCIES OF THE FUTURE

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Abstract: Covid-19 forced the European Commission to take the step further and propose a new strategy Industry 5.0 since the Industry 4.0 was not able to provide solution to the challenges most companies faced. Industry 5.0 with tripod: people-oriented, environment-oriented, and resilience-oriented marks a transformative era where human-centric technologies and sustainable practices take center stage. This article aims to provide an overview of scientific papers on the topic of competencies required for future professionals and reflects on how technical university programs can adapt to meet these evolving needs of Industry 5.0 from the angle of competencies required. The focus is placed on identifying areas of knowledge and key skills of engineers and managers necessary in the Industry 5.0 environment.

Key Words: industry 5.0, competencies, engineers and managers

1. INTRODUCTION

Industry 5.0 is an industry that focuses primarily on the consideration of the critical role of humans and greater involvement of their knowledge and competencies in a cyber-physical production system. The interaction of human and artificial intelligence is paramount in Industry 5.0. Man and machine work together to improve the quality and efficiency of production [18]. At the same time, it promotes social goals in the workplace, e.g., it emphasizes workplace safety with next-generation technologies or human-machine relationships and external purposes, i.e., social and environmental responsibility. Industry 5.0 does not deny the necessity of digitizing societies, economies, and industries but rather extends it with social and environmental aspects. Industry 5.0 builds upon the foundations of Industry 4.0, emphasizing the synergy between humans and machines [1]. This new industrial paradigm is characterized by the integration of advanced technologies, such as artificial intelligence (AI), the Internet of Things (IoT), and robotics, with a focus on enhancing human capabilities and promoting sustainable practices. As we transition into this new phase, the competencies required for future professionals are rapidly evolving. Technical universities play a pivotal role in preparing students for these changes by integrating relevant skills and knowledge into their curricula.

2. CATEGORIES OF COMPETENCIES

The competencies required for Industry 5.0 are multifaceted, encompassing technical, transversal, and green skills. Critical thinking, problem-solving, and adaptability are paramount. Additionally, skills in digital literacy, collaboration, and sustainability are becoming increasingly important. Most researches emphasize the importance of human-centric skills such as emotional intelligence, creativity, and ethical judgment in the future workforce [11]. Therefore competencies could be summarized per following categories:

Technical competencies in Industry 5.0 include advanced knowledge of AI, machine learning, and data analytics. Professionals need to be proficient in managing and interpreting vast amounts of data, as well as understanding and implementing IoT devices and smart technologies [5]. Highlight is given on the need for expertise in cybersecurity to protect the integrity of interconnected systems.

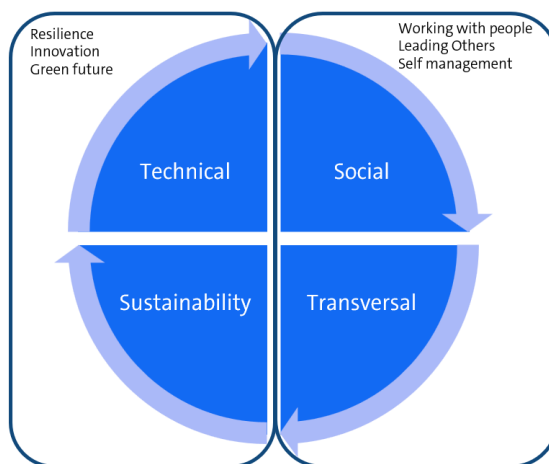
Transversal competencies, also known as soft skills, are equally crucial in Industry 5.0. These skills include communication, teamwork, and leadership. The ability to collaborate across disciplines and work effectively in diverse teams is essential. Leadership skills are critical for managing innovative projects and guiding teams through complex challenges.

Sustainability is a core component of Industry 5.0. Professionals must be equipped with knowledge of sustainable practices and environmental management. There is a stresses on the importance of green engineering principles and the need for integrating sustainability into every aspect of the industrial process.

Social competencies of which the most important ones that will require special educational attention are [2,4]:

- The ability to communicate clearly - problems in communication often cause issues at work, conflicts, and demotivation;
- Sincerity - an individual who has learned to communicate in accordance with their thoughts and feelings will have simpler communication with other people;

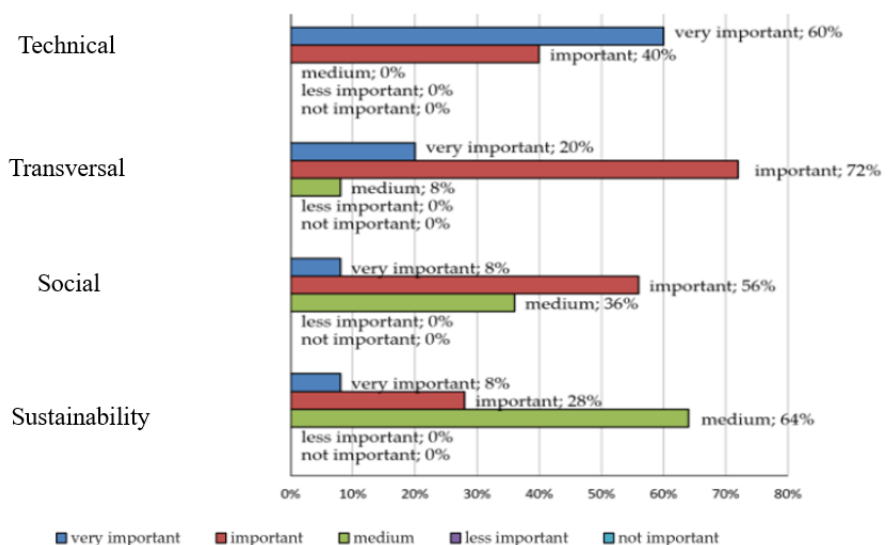
- Enthusiasm in cooperation with other people - constructive and positive energy expressed through ideas, emotions, behavior, and communication style;
 - Optimism is a trait that develops and is learned, and often contributes to noticing favorable opportunities for achieving goals;
 - Self-confidence - self-confident people understand and respect their own needs and rights, but also respect the needs and rights of other people. Their communication is calm, honest, direct, and positive, and they are willing to help others selflessly, as they do not see others as personal competitors;
 - Openness to new ideas and changes is an essential characteristic of development;
 - Consistency - if something is said, it must be done, and in social frameworks it is the basis for establishing trust and understanding;
 - Empathy - the willingness to understand the feelings of others and understand other people's needs, which facilitates the creation of desirable social frameworks;
 - The ability to listen - a skill that is easier to learn than some others, and is important for the quality of communication
 - Wit - represents a cohesive fabric in social relations, and it is learned, and can contribute to the development of both groups and individuals;
 - Creativity – finding new, creative solutions or finding creative, unusual ways to solve problems, as well as the ability to communicate with others in a creative and clear way creates developmental social frameworks;
 - Tolerance to diversity and tolerance to failure – rigidity in thinking and behavior is a consequence of personal insufficient psychological development dominated by fear and negative motives. Therefore, it is extremely important to develop tolerance, which is developed and exhibited only in the presence of others;
 - Responsibility towards oneself and others-represents the basis of quality interpersonal relationships.
- Social and transversal sets of competencies could be grouped in :
- Working with people & leading others
 - Self management



Picture 1. Group of competencies linked with impact inside Industry 5.0 scope

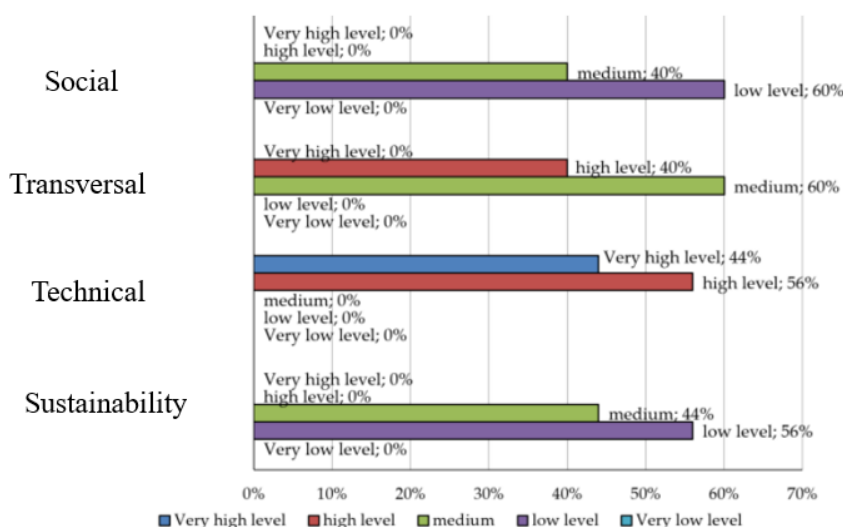
3. CATEGORIES OF COMPETENCIES VS EXPECTATIONS

The demand and expectations for engineers responsible for implementing Industry 5.0 in manufacturing companies vs categories of competencies experts declared using 5-point Likert scale (Picture 2.). Technical skills (understanding IT security, process understanding, AI skills and machine learning) for an Industry 5.0 engineer are very important (60%) and important (40%). Transversal competencies (creativity, entrepreneurial thinking, problem and conflict solving, analytical skills, decision making, research skills) were most often assessed as important (72%) and very important (20%). Eight (8%) percent of experts considered this group of competencies moderately important. Another group social competencies (communication skills, networking and integration skills, ability to work in a team, intercultural skills, ability to be compromising and cooperative, leadership skills), is important (56%) and medium (36%). Only 8% of the experts considered social social competencies to be very important. The last group assessed were Sustainability competencies (green engineering, social responsibility, reverse engineering). Most experts (64%) consider sustainability competencies moderately important, 28% as important, and only 8% as very important [14].



Picture 2. Group of competencies vs expectations for engineers in manufacturing companies [14]

Let us reflect on experts view how educational system in Europe is corresponding to the expressed expectations for Industry 5.0 engineers (Picture 3.). The assessment was carried out using like to like method as above. Social competencies, according to experts, these competencies are at a low level (60%) and a medium level (40%). Transversal competencies – rated as medium level (60%) and high level (40%). Technical competencies rated these competencies in engineers as high level (56%) and as very high level (44%). Sustainability competencies – according to experts, they are at a low level (56%) and medium level (44%) [14].



Picture 3. Group of competencies vs assesment of educational output for Industry 5.0 engineers [14]

4. CONCLUSION

Technical universities need to be uniquely positioned to address the competencies of the future. Programs need to be tailored to offer a blend of theoretical knowledge and practical experience, preparing students for the challenges of Industry 5.0. These programs emphasize interdisciplinary learning, project-based approaches, and collaboration with industry partners [17]. Key is to integrate real-world problems into the curriculum to help students develop critical thinking and problem-solving skills. To effectively prepare students for Industry 5.0, technical universities must continuously update their curricula. This includes incorporating courses on AI, IoT, and robotics, as well as emphasizing sustainability and ethical considerations. Most of prestige universities advocate for the inclusion of interdisciplinary courses that bridge engineering, computer science, and environmental studies. Additionally, practical training through internships, co-ops, and industry projects is essential for providing students with hands-on experience [15].

As we embrace Industry 5.0, technical universities must continue to evolve their programs to equip students with

the necessary social and sustainability competencies where even though the focus has been shifted still significant improvements need to be made. By fostering more intensively these two categories institutions can ensure that future professionals are well-prepared to navigate the complexities of the modern industrial landscape. The collaboration between academia and industry is vital for creating a workforce that is not only technically proficient but also capable of driving innovation and sustainable development.

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