



Pathways to HE

Version – November 2022



Project Title	Alliance of Centres of Vocational Excellence in the Furniture and Wood Sector
Project Reference	621192-EPP-1-2020-1-ES-EPPKA3-VET-COVE
Project acronym	AllView
Related Work Package	WP2 "Blended learning library for the W&F sector"
Related Task	T2.5 "Study of the pathways to HE"
Deliverable title	D 2.5 "Pathway to HE"
Nature of deliverable	Report
Dissemination Level	Public
Date of deliverable	November 2022
Reviewer	NIVET (Internal), Dermot O'Donovan (external)
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Acknowledgement

We are grateful to all the project partners and stakeholders who contributed and helped us to shape the report. The authors would like to warmly thank the representatives of the companies, schools and experts that were interviewed during the preparation of this report. Special thanks go to those who provided their connections and expertise in the initial phase of the process being especially grateful to Bernard Likar and Erika Valentinčič (Wood Industry Cluster in Slovenia); Maria Sanchez Melero (Amuebla); Jelle Loosveld (VDAB); Oliver Jancke (Innovawood), and colleagues from University of Ljubljana, Biotechnical Faculty (Teja Bizjak Govedič, Matej Jošt, Petra Grošelj and Dominika Gornik Bučar).



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This project has been funded with the support of the Erasmus+ programme of the European Union

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Co-funded by the
Erasmus+ Programme
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Abbreviations

VET - Vocational education and training

HE - Higher Education

CE - Circular Economy

I4.0 - Industry 4.0

AAL - Ambient Assisted Living

EQF - The European Qualifications Framework



1

Introduction

1. Introduction

This document summarizes the results of task T2.5 "Study of the pathways to HE", which is the last task of WP2 "Blended learning library for the W&F sector" of the ALLVIEW project. This task was scheduled for the 13th month of the project and lasted 6 months. During this period, the partners of the ALLVIEW project carried out the chain of tasks that make up the whole of this deliverable.

The main objective of this task, led by ULUB (University of Ljubljana), was to review learning objectives of Vocational (VET) and Higher (HE) education. On this basis, models for transferring learning contents from the context of VET to HE were developed. More specifically, they were developed for three areas: Circular Economy (CE), Industry 4.0 (I4.0) and Ambient Assisted Living (AAL), as they are the main topics of the Allview project and are among the most important topics in the rapidly changing business environment, which will also have a strong impact on all levels of education, also in the wood and furniture sector, especially in regard to ensuring integration of content and concepts in curricula. We assessed VET and HE knowledge gaps in CE and AAL and identified how to fill these gaps and how modern Industry 4.0 technologies can help us to do so. Moreover, we clarified the classification parameters (e.g., knowledge gaps, expected knowledge/skill levels at different educational levels and their short/long term importance, sources to bridge the gaps) of educational programs at both VET and HE. In addition, comparison between the VET-oriented and the HE-oriented projects was done to find out the possible learning contents and concepts already developed. The ultimate goal was to develop a model showing the current and expected level of knowledge and gaps between levels of education in the wood and furniture sector.

For this purpose, we set a series of tasks that allowed us to draw important conclusions. First, we conducted a knowledge gap analysis. A knowledge gap occurs when there is a significant discrepancy between what the education system provides and what practice/economy/business requires in terms of expertise, skills, and know-how from educated/qualified employees. This task was to find out about the knowledge gap along the whole vertical from VET to HE (in terms of content, concepts, curricula) and the knowledge gap between what the educational systems offer and what the practise/business demands, focusing on the following three areas: Circular Economy (CE), Industry 4.0 (I4.0) and Ambient Assisted Living (AAL). It is very important to align learning content, concepts and curricula along the entire vertical from VET to HE to ensure basic knowledge at the lower levels and advanced knowledge at the higher levels of the education systems. To obtain all these data, we took the following measures: surveying and interviewing teachers from VET and HE in the field of wood and furniture education, interviewing companies, interviewing experts in specific fields (CE, I4.0 and AAL) and collecting data from other projects. Second, we analysed the obtained data using a knowledge gap matrix and developed a model/strategy to bridge the gaps and facilitate the transition from VET to HE, in which we will try to propose ways to fill the identified knowledge gaps. In the model/strategy, vertical transitions were addressed very carefully: what should be achieved at a single educational level (EQF 4, 5, 6...) and how can content/concepts be transferred from a lower educational level to a higher level.

This report is organised as follows. The first section presents the objectives of this paper and a literature review focusing on three areas: Circular Economy (CE), Industry 4.0 (I4.0), and Ambient

Assisted Living (AAL). The analysis of the knowledge gaps, including the data collection methodology and results, is presented in Section 2, while Section 3 presents models and proposed strategies to bridge the identified knowledge gaps in wood and furniture, as well as conclusions.

Literature review

Due to rapid technological development and increasing digitalization, the business environment is changing rapidly, which also has a strong impact on the concept of education. The world is entering a new industrial revolution, so-called Industry 4.0, the term of which was first publicly presented in 2011 at the Hannover fair. This brings greater flexibility and speed, better quality and higher productivity. If companies in wood and furniture sector and others want to take advantage of this, they must systematically invest in equipment, information and communication technologies (ICT), and especially in the education and training of employees (Davies, 2015). Recent research has shown that half of the surveyed companies in the Slovenian wood industry are already implementing the concept of Industry 4.0, as a fundamental concept of digitalization of manufacturing companies, in their operations, while the rest are beginners in terms of digitalization (Kropivšek & Grošelj, 2020).

It is clear that Industry 4.0 is not only a technological revolution but will also significantly change the profiles of employees and their necessary skills in wood processing companies. Educational institutions in the wood sector will also have to respond to this, as they will have to offer different competences and, above all, change the existing concepts and methods of education and support them with new technologies and services (CETEM, 2017). Research from 2018 showed that almost half of the population in the EU still lacks basic digital skills and competences (Kropivšek, 2018). The statistical office of the European Union states that in 2017, 83 % of households in country of EU owned a personal computer. The data from 10 years before that states that only 63 % of EU households owned a personal computer in 2007 (Eurostat). This also indicates that the trend of using digital technologies is increasing. As the digitization of the educational process is such a complex project, it needs to be implemented at several levels. After setting appropriate (strategic) guidelines and goals, special attention should be paid to the didactic and content side of the digitization of the educational process (Damsa et al., 2015). It is crucial that new information technologies and didactic approaches based on them are continuously introduced into the educational process. Therefore, the digitization of the educational process is not only a technological challenge, but above all an organizational project that must ensure the proper selection and effective introduction of ICT in the educational process and the introduction of new didactic approaches using these technologies by increasing the pedagogical digital competencies of teachers (Kropivšek, 2018). The COVID-19 pandemic has also made a significant contribution to the even faster digital transformation of the business and educational environment (Kane et al., 2020). Digitization of most educational activities and their shift to cloud platforms that enable distance learning has become one of the priorities of all educational institutions (Kropivšek et al., 2021).

On the other hand, the European furniture industry faces a variety of economic, regulatory, and environmental challenges. Production growth in emerging markets, improved logistics and lower tariffs in foreign markets are putting increasing pressure on EU-based companies. In the domestic market, increased demand for low-cost products is making it more difficult for companies that focus on durable and high-quality products to compete. In addition, increased raw material, labour and energy costs within the EU are also challenging standard business practices. To address these existing threats, new practices and out-of-the-box thinking are needed to renew the sector and make it more sustainable (Ecores, 2017).

To thoroughly prepare future generations for current topics such as: Circular Economy, Industry 4.0 and Ambient Assisted Living, we need to provide appropriate educational content and, in the future, ensure its integration at all levels of education also in the wood and furniture sector.

Industry 4.0

This new, digital industrial revolution promises greater manufacturing flexibility, customized mass production, increased speed, better quality, and higher productivity. However, to reap these benefits, companies need to invest in equipment, information and communication technologies (ICT) and data analytics, as well as in the integration of data flows throughout the global value chain. The EU supports industrial change through its industrial policy and by funding research and infrastructure. Countries are also promoting national initiatives, however, challenges like training workers and future professionals remain (CSM, 2017). This is the age of artificial intelligence, genome editing, biometrics, renewable energy, 3D printing, autonomous vehicles, Internet of things and Blockchain technology which has limitless possibilities and could become an extensive part of education system (Turcu et al., 2018). Instead of technology being a thing we use, it will be truly embedded in our lives - and our bodies - to make big changes. There is an argument that this is just an extension of the third revolution, but in many ways it can be said that the speed and intent with which emerging technology is changing makes it different from the introduction of computer technology (Khan & Isreb, 2018).

Circular Economy

The circular economy provides a promising way to create more value in the industry by simultaneously addressing resource constraints, consumer benefits, and profitability challenges. However, the transition from a linear to a circular economy requires significant changes at the micro, meso and macro levels, from innovation at the business model and value chain level to the introduction of supporting policies (Ecores, 2017). In the international project E- SPACE they stated, that the circular economy is based on three principles (E-SPACE, 2019):

- Design a system where products / services are produced and delivered without waste and pollution.
- Separate biological materials (suitable for composting, e.g. organic materials); from technical materials (not suitable for composting, e.g. metal and plastic).
- The use of renewable energy sources and the sustainable use of natural resources in the context of the ability to renew itself.

The FURN360 project (Ecores, 2017) report states that various support mechanisms could be promoted to get the furniture and wood industry more involved in the cycle. The European Furniture Industry Federation (EFIC) supports a step-by-step approach to enable a gradual, sustainable, and realistic transition to circular economy principles, balancing environmental sustainability principles with economically sustainable criteria. As most companies in the sector are SMEs, support measures should be adapted to the size and scale of these companies. Educational (awareness of successful business examples, focused training programmes) and economic support (e.g. financial innovative projects, public incentives and technical assistance, development of circular tenders) are key to support the transformation of businesses.

Corporate social responsibility (CSR) towards the environment is regulated by international documents and national legislation. The European Parliament and Council Directive on Environmental Liability with regard to the prevention and remedying of environmental damage is based on the polluter pays principle. The polluter bears all the costs of the prescribed measures to prevent and reduce pollution and environmental risks. The state may prescribe an environmental tax (Butinar et al., 2020). There are also prompts that wants the European Commission to provide more integrated strategies for specific economic sectors. And so, the furniture sector was chosen to exemplify challenges and opportunities regarding the sector's recovery and green transition to a sustainable and circular economy (bioeconomy), its technological transformation, mainly driven by the digitalisation of industrial processes, and the sector's overall target of managing the climate change (EESC, 2022).

Ambient Assisted Living

The age structure of the European population has changed fundamentally, with people living longer than ever before. Longer life expectancy and consistently lower birth rates have meant that our population is getting older. It is predicted that by 2070 more than half of the EU population will be over 65. The ageing population brings many challenges in terms of the quality of life of older people and their careers, and the impact on the labour market. These challenges need to be addressed now if we are to ensure that we can lead healthy, active and independent lives into old age (AAL Programme). The ageing of the population is also a great opportunity. With the right community of experts, the right support and the right technologies, we can develop solutions and products that can change people's lives for the better now and in the future. The term » Ambient Assisted Living« refers to the use of new information and communication technologies (ICT) and the creation of a supportive and inclusive environment that enables older and disabled people to live independently and actively integrate into society for as long as possible (Zdravstveni portal, 2021).

Key issue in our society has become quality of life rather than its lifespan, which is reflected in the health services that individuals need. In recent years, many different types of assistive technologies have appeared on the market, and their development is increasing and interfering with all areas of human activities. However, experts still question the correct choice and effectiveness of assistive technology and its impact on the quality of life of individuals (Ocepek, 2010).

2

Knowledge gaps analysis

2. Knowledge gaps analysis

A knowledge gap occurs when there is a significant disparity between what education system provides and practice/economy/companies demands regarding expertise, skills and know-how of educated/skilled staff. Skills and knowledge gaps are one of the biggest roadblocks to successfully attaining (business) goals at all levels of economy (Wahyuni et al., 2020). Skills and knowledge gaps lead to low performance and to increased costs, while also impacting motivation, engagement and retention of individuals. It is every economy and company highest interest to bridge these gaps. It can be done through different actions: mostly through learning and development. On the other hand, there is also very important to align learning objectives along the whole vertical from VET to HE to assure the basic knowledge on lower levels and advanced knowledge on higher levels of educational systems.

Steps of knowledge gap analysis, based on (QuestionPro, 2021; iMocha, 2021):

1. Assess the starting position as dual process:
 - Analysing the current knowledge provided on different levels of education from VET to HE (regarding contents, concepts, curricula) focusing on fields CE, I4.0 and AAL – to identify gaps within the vertical education system.
 - Analysing current situation in practice/industry.
2. Define the objectives and company / industry needs, and with that related necessary skills and knowledge.
3. Identify the gaps.
4. Prepare to bridge the gaps.

Methodology used:

1. Surveying and interviewing teachers from HE and VET in wood and furniture education: to get an overview of which topics and to what extend from (CE, I4.0 and AAL) are included in wood and furniture education in certain educational levels.
2. Interviewing companies: to find out what competencies companies in wood and furniture sector needs from area of CE, I4.0 and AAL.
3. Interviewing expert of a particular field (CE, I4.0 and AAL): to get the experts' opinion on the importance of topics from each field for students at different levels of education in wood and furniture.
4. Developing Knowledge Gap Matrix showing:
 - The gaps along the different vertical levels of education from VET to HE regarding CE, I4.0 and AAL.
 - The gaps between what education systems are providing and practice/industry is demanding regarding CE, I4.0 and AAL / divided by EQF and/or job positions:
 - The current level of knowledge.

- The expected level of knowledge.
 - The short term (current) and long term (in 5 years) importance of particular knowledge.
5. As a preparation to bridge the gaps, collecting data from other projects is important: analysing their content as an important source for filling the identified knowledge gaps.

Surveying and interviewing teachers

According to the information obtained the curricula are not regularly updated, e.g.: The curricula for higher education in Slovenia in the field of wood and furniture (EQF 6) were last updated in 2014, the curricula for vocational education (EQF 4) were updated in 2006, and the curricula for post-professional vocational education (EQF 5) were last updated 20 years ago, in 2001. Therefore, we surveyed teachers in wood and furniture education programmes to gain detailed insight for each EQF level. 8 countries from Europe have participated in conducting the interviews (Slovenia, Italy, Poland, Germany, France, Belgium, Netherlands, and Spain). Through the questionnaire, we wanted to find out what topics related to the Circular Economy and Ambient Assisted Living are taught and what Industry 4.0 concepts and tools are used in the educational process. We also wanted to find out how important they think these topics are for graduates in wood sector and to what extent it would be useful to include them in the curriculum. Later, in addition to the survey, we conducted interviews because the responses to the survey were not satisfactory.

Methodology

The survey was created in the open-source application "1KA" which provides an online survey service (1KA. 2021). We created 2 separate surveys in every language of partners in Allview project (Slovenian, Dutch, French, German, Italian, Polish and Spanish), one for vocational (VET) and one for higher (HE) education. Questions for VET referred to EQF level 4 and 5 and HE to EQF 6, 7 and 8. Each survey form (Annex A, Annex B) contained 5 main closed-ended questions and some open-ended questions, where respondents could supplement the closed-ended questions and express their opinions. Surveys were sent to wood and furniture vocational and higher education institutions in July 2021. As we were not satisfied with the number of answers, we decided to gather missing data with interviews.

On December of 2021, we began interviewing teachers, principals, deans, etc. who have a holistic view of certain educational programmes at their institution. The goal was to interview at least one person per school in individual country. During the interviews, which lasted approximately 30 minutes and were conducted primarily via videoconference, we used our survey as a guide to obtain comparable responses. The answers to the questions we used to determine which topics from the circular economy, Industry 4.0, and Ambient Assisted Living are included in individual educational program are shown with bar charts. Respondents could choose between three options for these questions: I do not include it, I partially include it, and I fully include the topic in classes that I teach.

Based on the data obtained by interviewing teachers and professors from educational programs related to the W&F sector, we first determined for each country in which educational levels (EQF 4, 5, and 6) certain content is fully included, partially included, and which is not. We followed the

principle of greater importance when: Fully included > Partially included > Not included. For example, if the responses in a particular country showed that a content was fully and partially and not included in certain educational program, we included it in the group of fully included content. In this way, individual learning contents in each country could only be included fully, only partially or not at all. Then we merged results from each country and calculated the proportions of individual content according to the following Equation [1]:

$$\%_{Share} = \frac{\text{Number of answers}}{\text{Number of all answers}} \times 100 \% \quad \dots[1]$$

We then combined content from individual areas (Circular Economy, Industry 4.0, and Ambient Assisted Living) and calculated the proportions from each area to see the big picture (Figure 5).

Results

Charts in Figure 1 and 2 shows differences between EQF levels regarding inclusion of contents from area of CE.

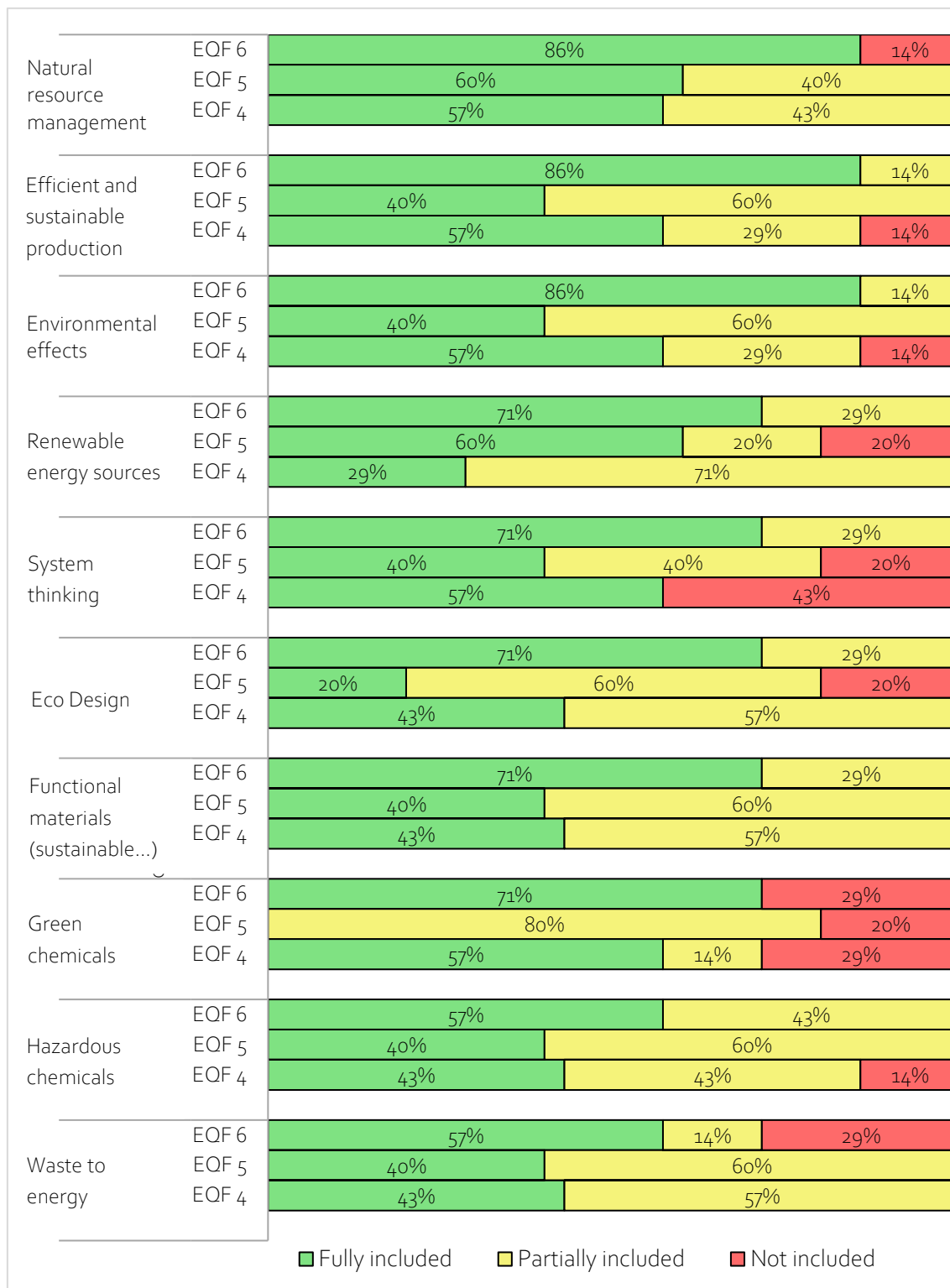


Figure 1: Shares of fully included, partially included and non-included contents from Circular Economy in certain educational levels (n=101)

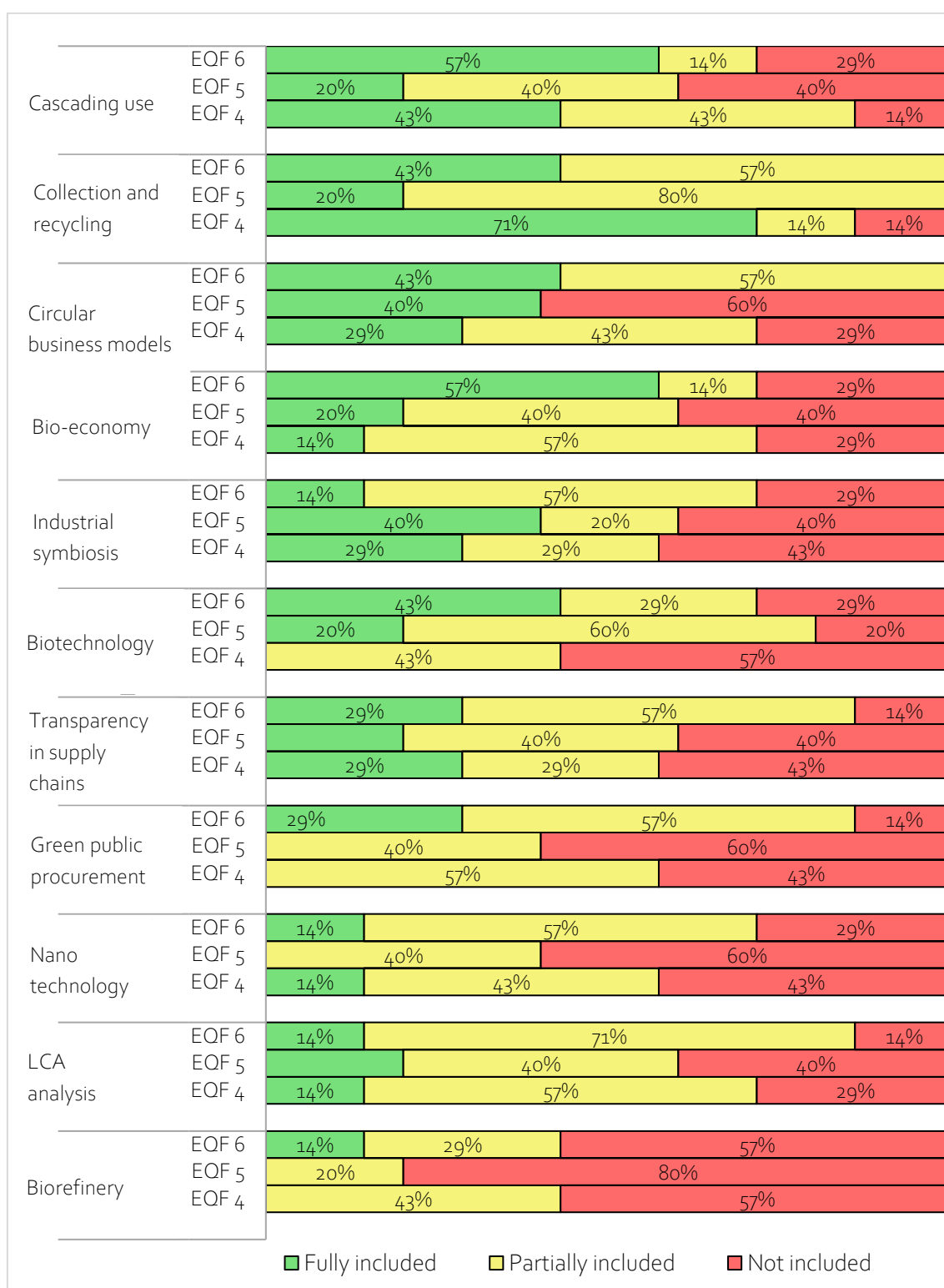


Figure 2: Shares of fully included, partially included and non-included contents from Circular Economy in certain educational levels (n=101)

The chart in Figure 1 and 2 shows that at EQF 6, the most covered content in the circular economy domain are, for example, "Natural Resource Management", "Efficient and Sustainable Production", "Environmental Effects", "Renewable Energy Sources", "Systems Thinking", "Eco Design", etc., but

largely all other topics in this domain are covered at this educational level, the least covered is "Biorefinery". The most taught content at EQF 5 also includes "Natural Resource Management" and "Renewable Energy Sources." The only content that is covered more in EQF 5 than in EQF 6 is "LCA Analysis", but at this stage there is a huge amount of content that is covered even less than in EQF 4. We could even say that circular economy is discussed more in EQF 4 than in EQF 5. Among the most discussed topics in EQF 4 is "Collecting and Recycling", which is covered more than in the two higher levels, but there are also some other contents that are only slightly less discussed than in EQF 6. As in EQF 5 and 6, the content "Biorefinery" is the least covered. One content that is taught significantly less than at the two higher levels is "Biotechnology." In general, in addition to "Biorefinery," the less discussed content at all levels includes, for example, "LCA -analysis", "Nano Technology", "Green public procurement", etc.

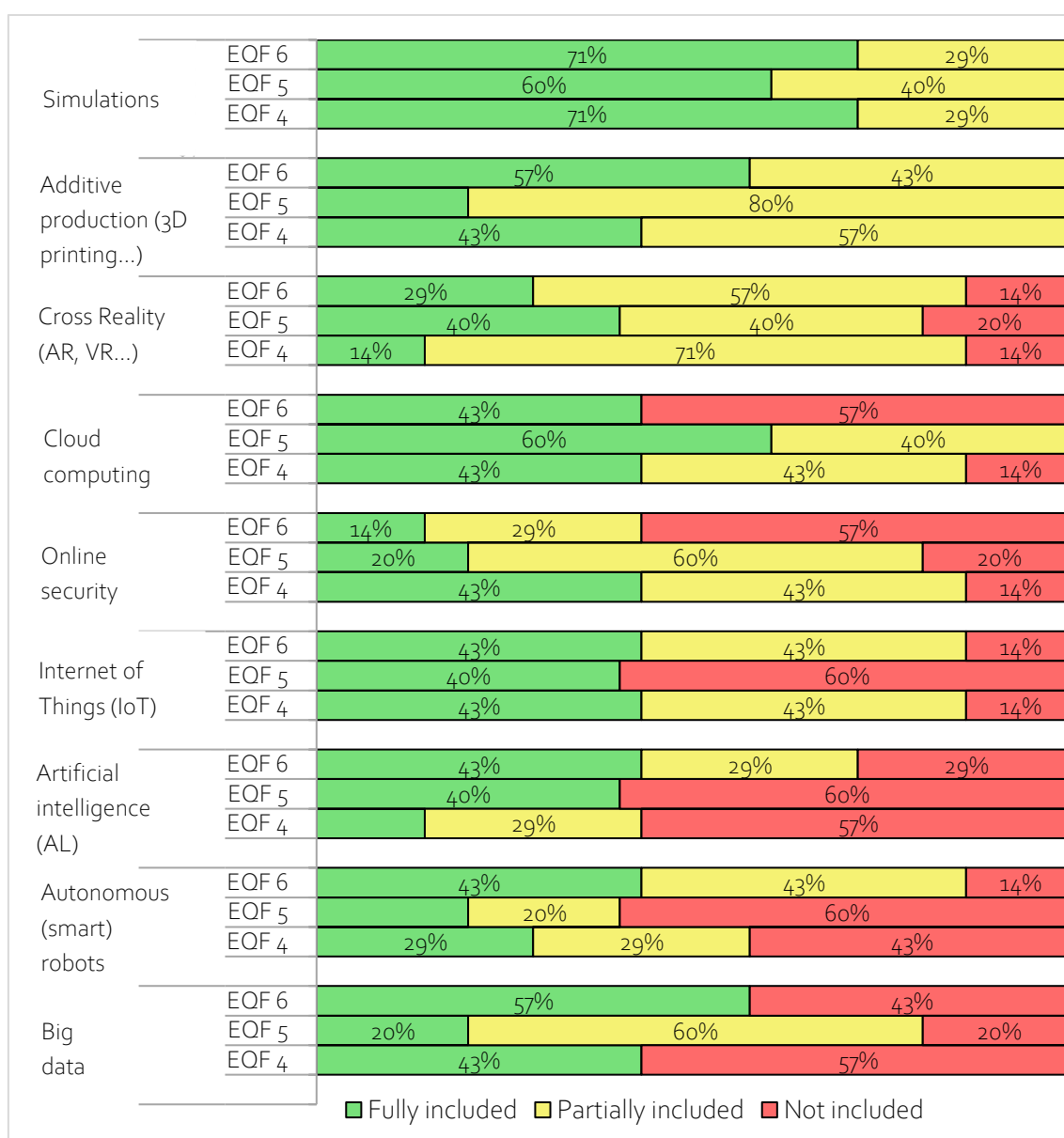


Figure 3: Shares of fully included, partially included and non-included contents from Industry 4.0 in certain educational levels (n=101)

It seems that "Simulations" and "3D printing" are included at least partially in all EQF levels and are also the most frequently covered topics in Industry 4.0. Highly included concepts/tools in EQF 6 are also "Cross reality", "Autonomous Robots" and "IoT". At this level, countries either cover "Cloud Computing" completely or not at all, there is no in-between. The least covered content at EQF 6 is "Online Security", which is covered at EQF 5 and 4 to greater extent and it is beside "IoT" the most discussed Industry 4.0 content at EQF 4. The most discussed contents at EQF 5 are "Simulations" and "Cloud Computing" and the least attention get "Autonomous Robots" and "IoT". At EQF 4 least included concepts are "AL", "Autonomous Robots" and "Big Data".

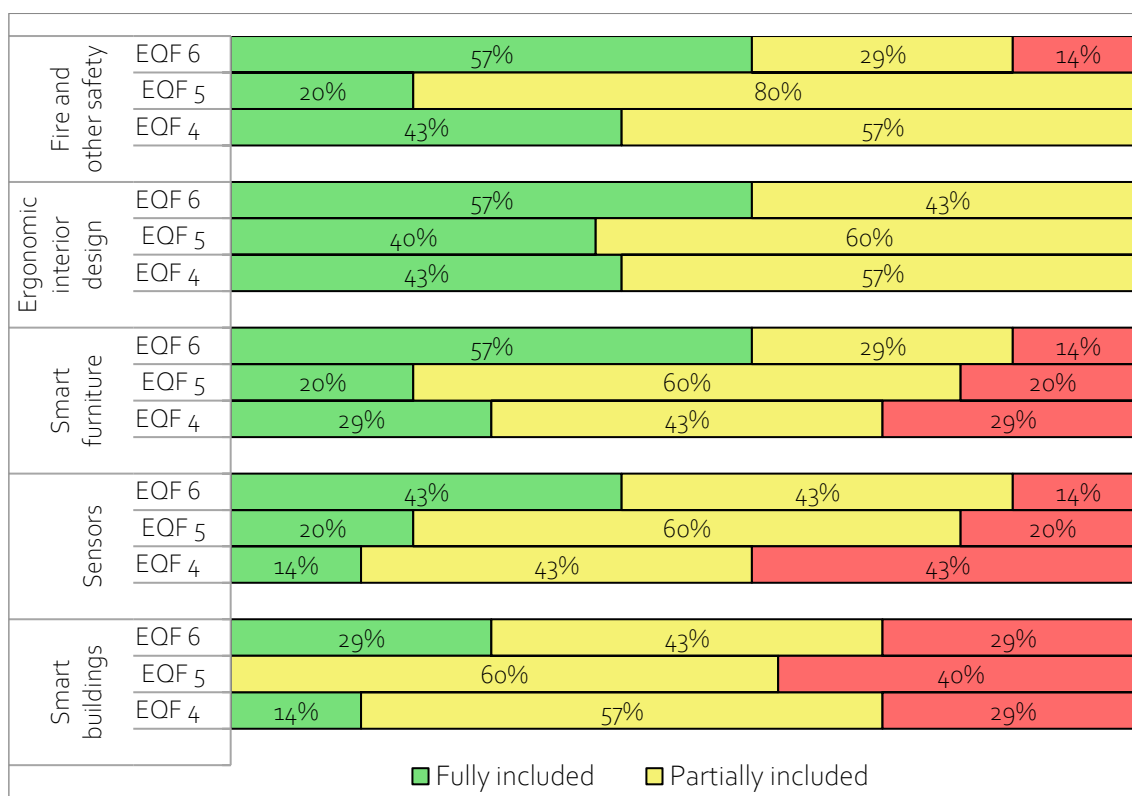


Figure 4: Shares of fully included, partially included and non-included contents from Ambient Assisted Living in certain educational levels (n=101)

The chart in Figure 4 shows that the most included topics in EQF 4 from Ambient Assisted Living are "Fire and Other Safety" and "Ergonomic Interior Design". At EQF 5 these two contents stand out, as they are covered to a lesser extent than at EQF 4. These two topics are also the most included topics in EQF 6, which seems to have highest inclusion of all the topics in AAL. Since EQF 4 have higher inclusion of topics then EQF 5 we do not have a steady increase from the lower to the higher educational levels.

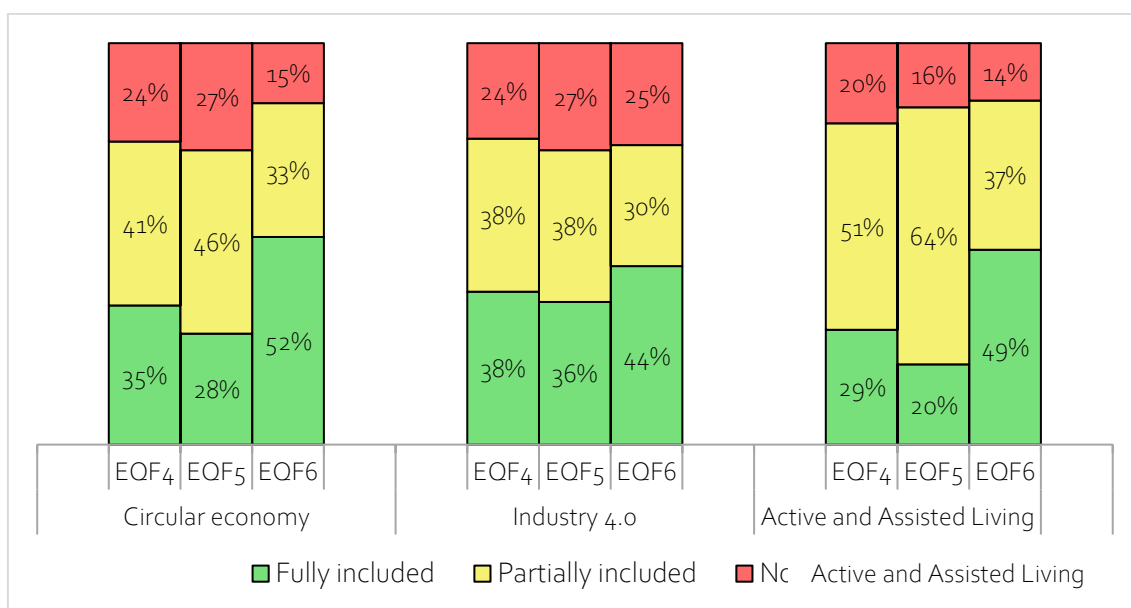


Figure 5: Comparison of the extent to which different fields are included in each educational program (n=101)

The graph in Figure 5 shows the overall picture of the fields and their comparison between the different levels of education. From this we can conclude that the subject areas are most represented at EQF 6, with all three subject areas included in roughly equal proportions (fully included $\pm 8\%$). On EQF 5, Industry 4.0 is the most represented area, however all topics are covered less than on EQF 4, which could mean that at this level they have greater emphasis on content outside of this research. EQF 4 have less coverage than EQF 6 in all areas, but surprisingly large amount of content is covered in Industry 4.0, where we could say that EQF 6 lags behind. Based on that we can assume that EQF 4 follows the trends of Industry 4.0 more than EQF 5 and 6. We can also conclude that all three areas are involved to lesser extend in EQF 5.

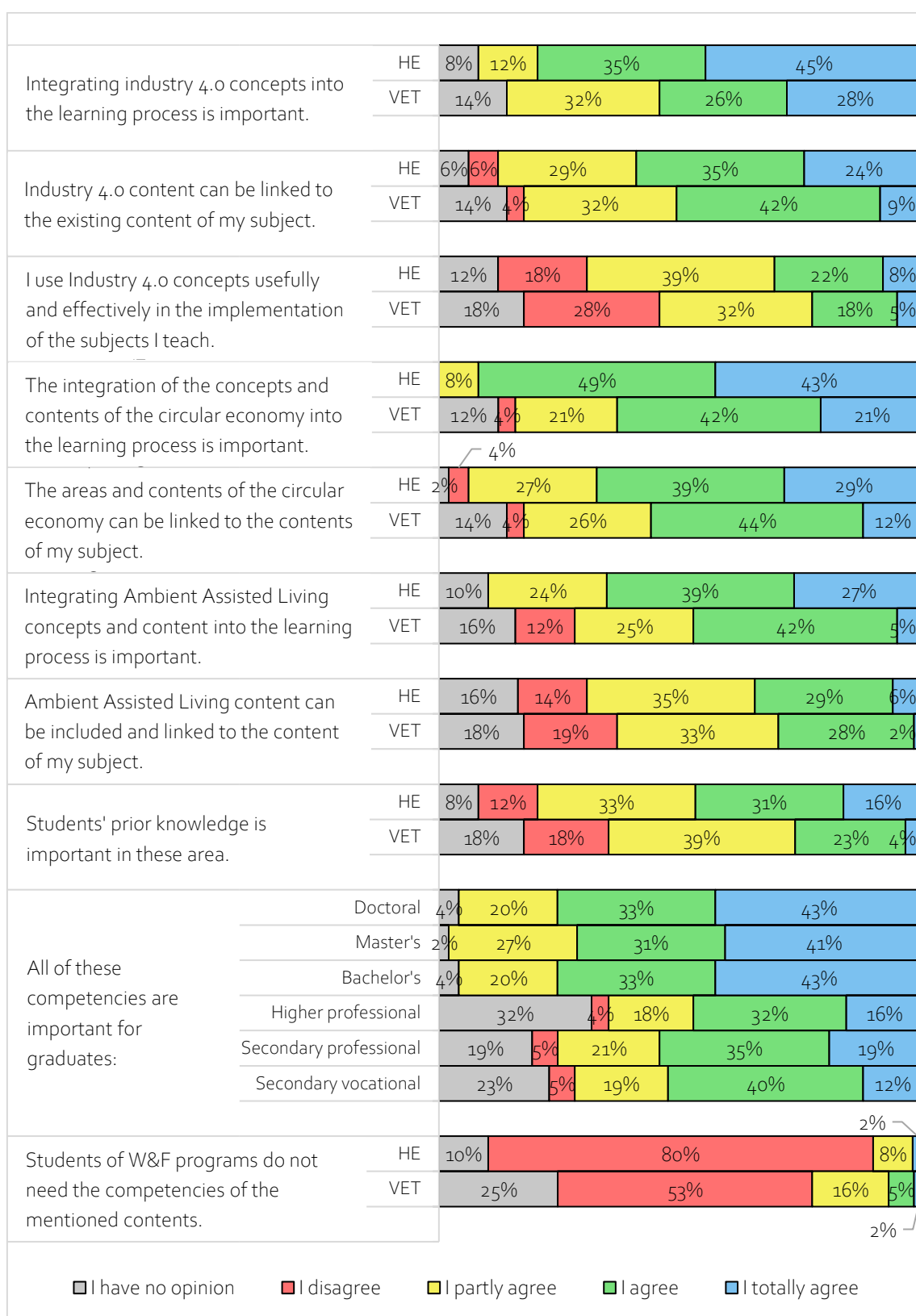


Figure 6: Shares of responses to listed statements of pedagogical staff in VET (n=57) and HE (n=49) educational programs related to W&F (n=105)

From the responses in Figure 6, we can see that both VET and HE teachers think that Industry 4.0, Circular Economy, and Ambient Assisted Living should be integrated into the learning process, but it seems that this is more important for HE. Comparing the three areas, the integration of Industry 4.0 and Circular Economy concepts seems to be equally important, while Ambient Assisted Living seems to be slightly less important, especially for VET. Teachers at both levels overwhelmingly agree that these areas can all be linked to existing content in their subjects, with about 4-6% disagreement for I4.0 and CE and more disagreement on linking ALL (14% for HE and 16% for VET). 18% of teachers on HE says they do not use Industry 4.0 concepts effectively in the classroom, and even more teachers (28%) say this on VET. Teachers at HE says prior knowledge is somewhat more important than teachers at VET, but both groups consider it important to some degree. Teachers at both levels did not express much difference in importance between graduates of HE (EQF 6, 7 and 8) and VET (EQF 4 and 5), but there are differences between these two groups of students. As we have already seen, we can conclude that these topics are important for all W&F graduates and that they are somewhat more important for HE graduates, where they are somewhat easier to integrate.

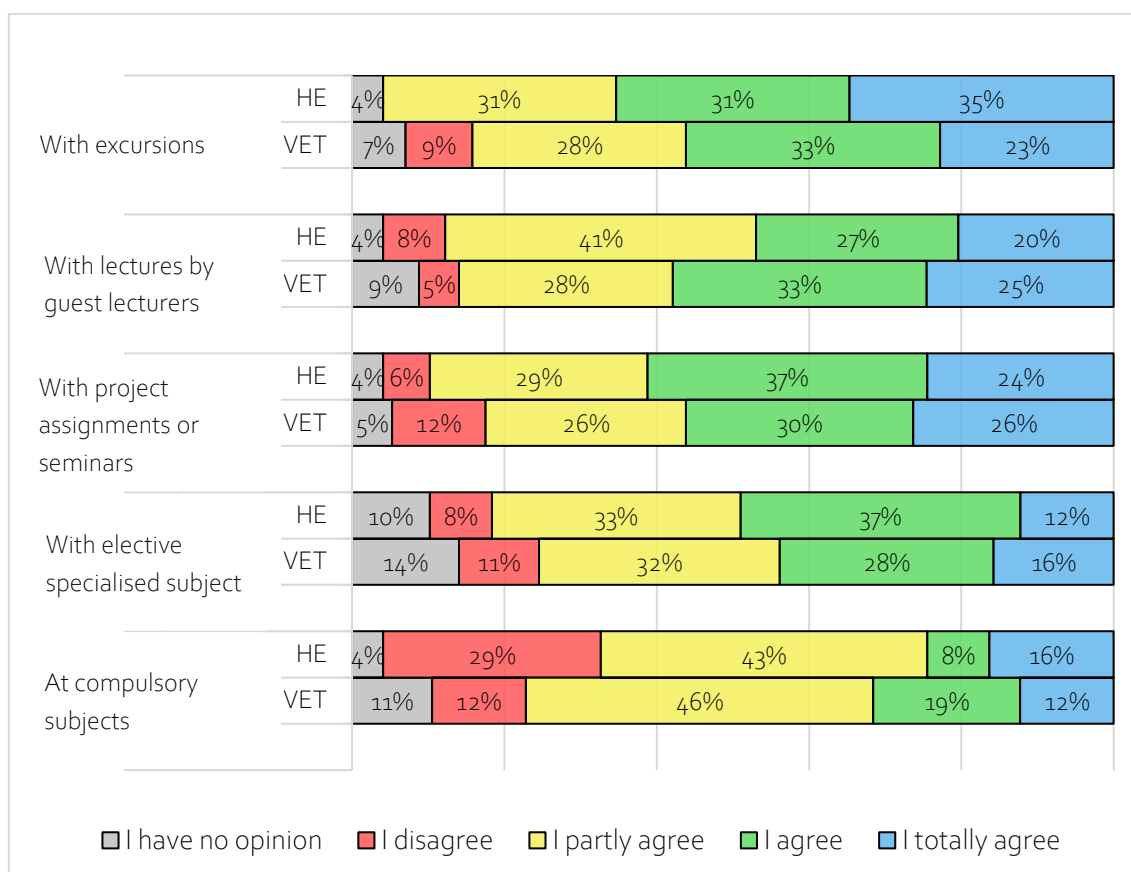


Figure 7: How teachers assess appropriateness of ways for integrating CE, I4.0, and AAL (n=104)

Figure 7 shows teachers' responses to the question of whether it would be appropriate to include the above content in the courses or subjects they teach. There is not much difference between the responses of teachers from VET and HE. All integrations seem to be appropriate, some more than others. Most respondents fully agreed or at least agreed that field trips, project assignments, or seminars and lectures by guest lecturers would be appropriate. Meanwhile, 9% of teachers from

VET disagreed with field trips, none from HE disagreed. The greatest disagreement was "in compulsory subjects", as 29% of teachers from HE disagrees that content from these areas could be integrated into their subjects, and it seems that this is less possible in HE than in VET.

Interviewing companies

Companies needs can be directly considered in the renewal of the curriculum. That is why we started interviewing companies in February 2022. The goal was to find out what competencies companies in the wood and furniture sector need from specific occupations, with a focus on circular economy and Industry 4.0, which Allview also deals with. We also wanted to know if they see any deficits in education, how they think the circular economy and Industry 4.0 will affect their business model, and whether they have already started to adopt these concepts.

Methodology

We interviewed 9 companies from Slovenia, France, Poland, Spain and the Netherlands, all from the wood and furniture sector. 1 of the companies was an engineering firm, the others were manufacturers of furniture - C31, with one also being processor of wood - C16. The participating companies varied in size (number of employees), with most being medium-sized (50-249 employees). The interviews were conducted in the form of live interviews via a video conferencing application and lasted on average about 40 minutes. The questionnaires were emailed to the interviewees in advance so that they could familiarise themselves with the topic of the questions and prepare for the interview. The questionnaire was semi-structured and contained mainly closed-ended and some open-ended questions, but the interviews were conducted in a way that allowed respondents to answer freely. We recorded the interviews so that we could better focus on the respondents' answers and guide the conversation more easily.

Results

First of all, companies in the wood and furniture industry (W&F), indicated in the interview the number of employees. Of the 9 companies, 1 was an engineering firm, the others were manufacturers of furniture - C31, with one also being a wood processor - C16. The participating companies varied in size (number of employees), with most being medium-sized (6 companies), 2 companies were large, and 1 was small. Most of them indicated that they are currently hiring new employees, mainly production workers. As seen in Figure 8, all companies use social media to find employees. The second most common method are personal contacts. The two methods mentioned also prove to be the most effective for them, at least for 56% of the companies. Other methods have not proven useful for most, such as posting jobs on their website is not useful for anyone.

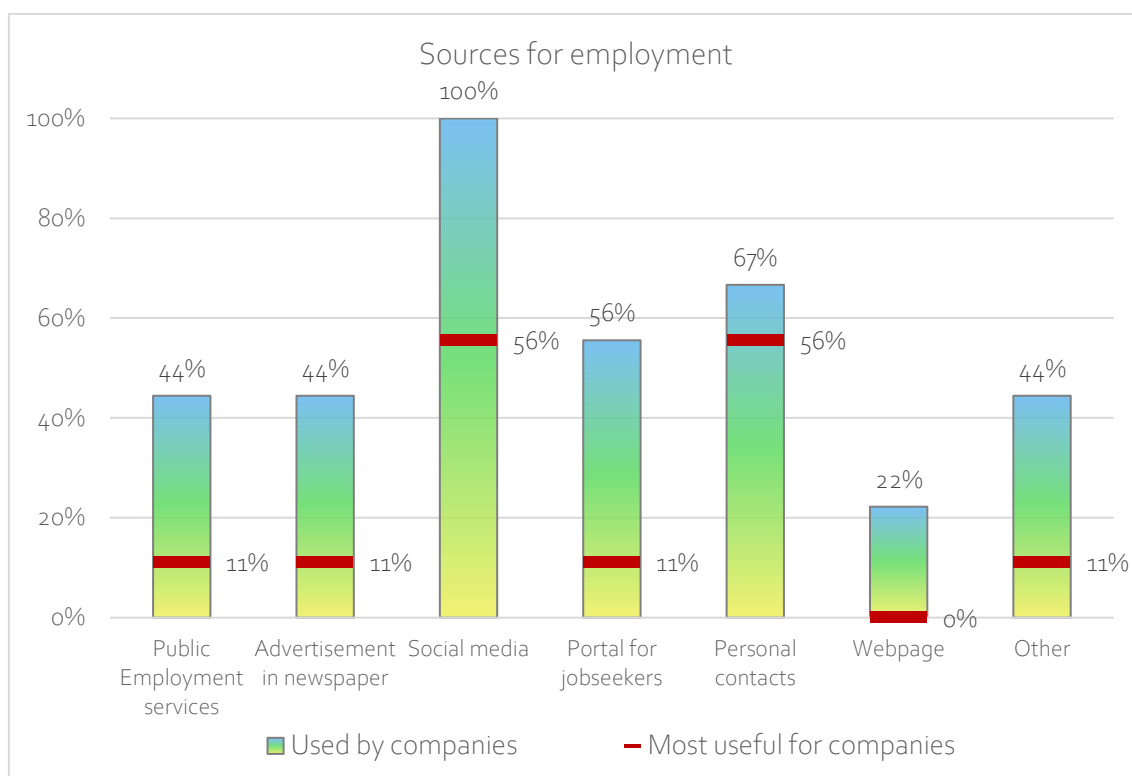


Figure 8: Sources for employment (n=9)

The industry is currently experiencing a shortage of personnel and, as Figure 9 shows, especially of competent personnel. Most companies have difficulty finding competent production workers, and half of them also have trouble finding competent technicians and engineers. Two companies also stated that there is a lack of good managers.

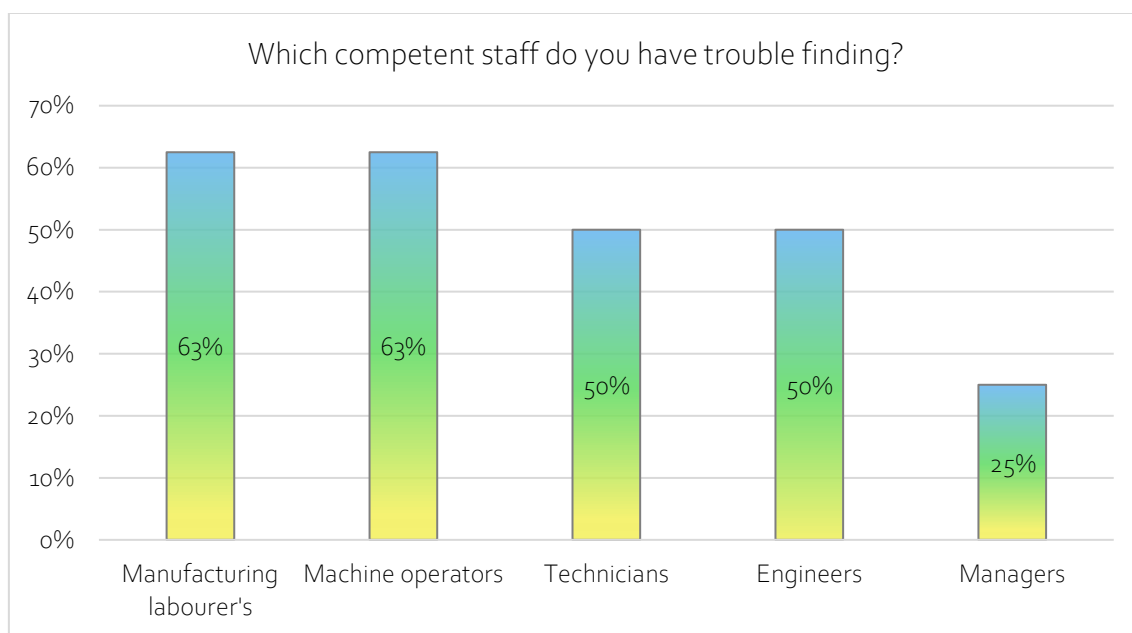


Figure 9: Finding competent staff (n=8)

Companies were asked about the important competencies of their employees. The key terms are compiled in Figure 10. The technical skills that seem to be important for workers in W&F industry depend on the position, but there are some general skills that most should have. For production workers, skills in using machinery and tools and knowledge of wood species seem to be most important. Some companies pointed to the lack of practical skills of newly graduates and suggested that this may be a reason for the lack of practical training in schools. Job-specific skills can largely be learned on the job. Therefore, companies seem to prefer employees with better developed soft skills who are not tied to a specific job. In addition, organisational skills, leadership skills, and critical thinking, teamwork, and collaboration skills are the most commonly cited interpersonal skills employers want. Motivation, accuracy, and the ability to take responsibility are also important. In other comments, one company emphasised that it needs specialised workers. Another company disagreed, telling us that each company has its own specialties at work that need to be learned on the job, but stressed the importance of soft skills and a willingness to learn, change, adapt, and find innovative solutions.



Figure 10: Most important competences employees in W&F should have and they are missing (n=9)

In the next question, we asked them about specific content from the circular economy (CE) that is important for certain occupations (Figure 11). While most agree that waste management and the big picture of CE are important for all professions, all agree that the latter is important for engineers and managers. Most respondents also agree that all of the content listed is important to engineers and managers, and to a lesser extent to technicians, with the exception of biodiversity, which is important only to employees in higher positions. Some of them (33%) believe that knowledge about reuse is important for employees in production and most of them do not believe that regulations and eco design are important for those.

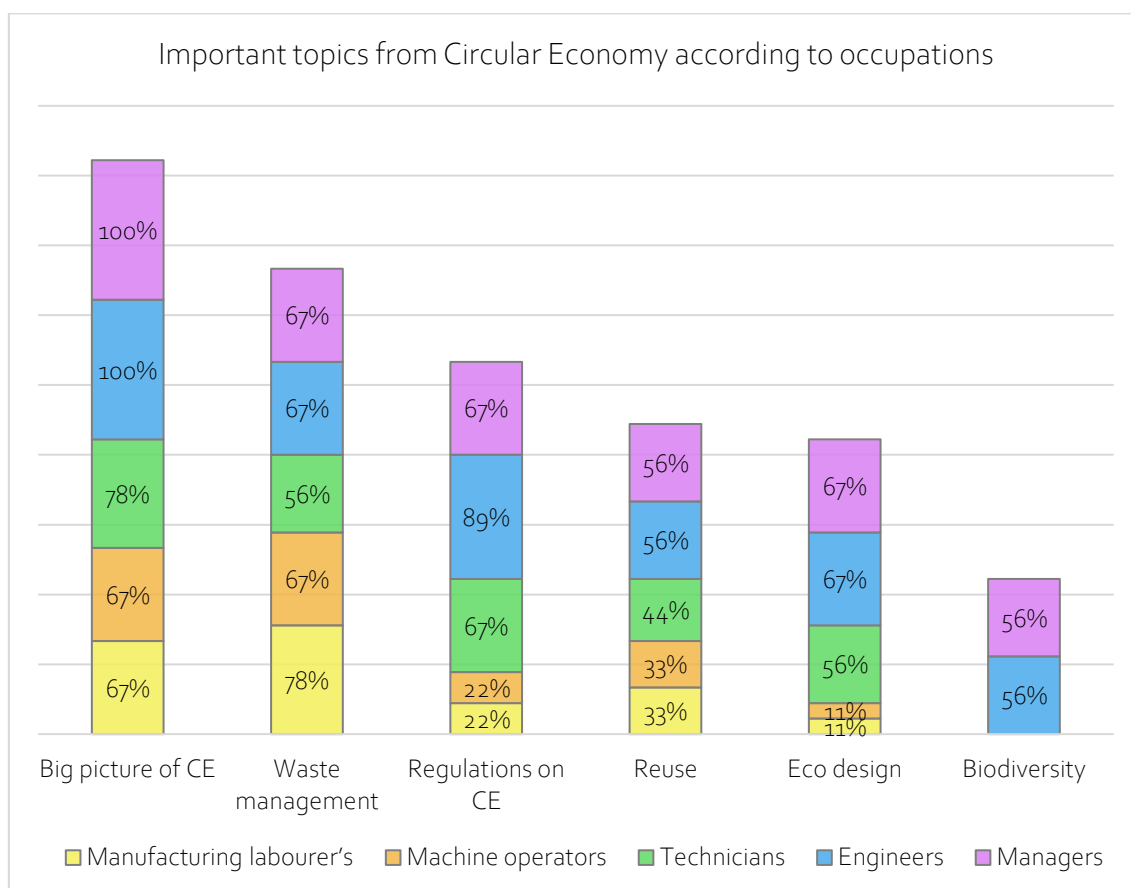


Figure 11: Important topics from Circular Economy according to occupations (n=9)

Figure 12 shows the responses on the use of Industry 4.0 tools and important competencies for employees from this area. The most used concepts/tools from I4.0 are 3D printing and simulations, and even these are used by only 38% of companies. Half of companies would like their employees to have the necessary skills from the latter two. Smart robots and artificial intelligence/machine learning are the least used, with only 1 in 8 companies using them. 38% of companies also want employees with skills from AR / VR and smart robots, which is interesting as smart robots are only used in 1 company. In general, we can say that not even half of the companies in W&F use Industry 4.0 concepts and tools.

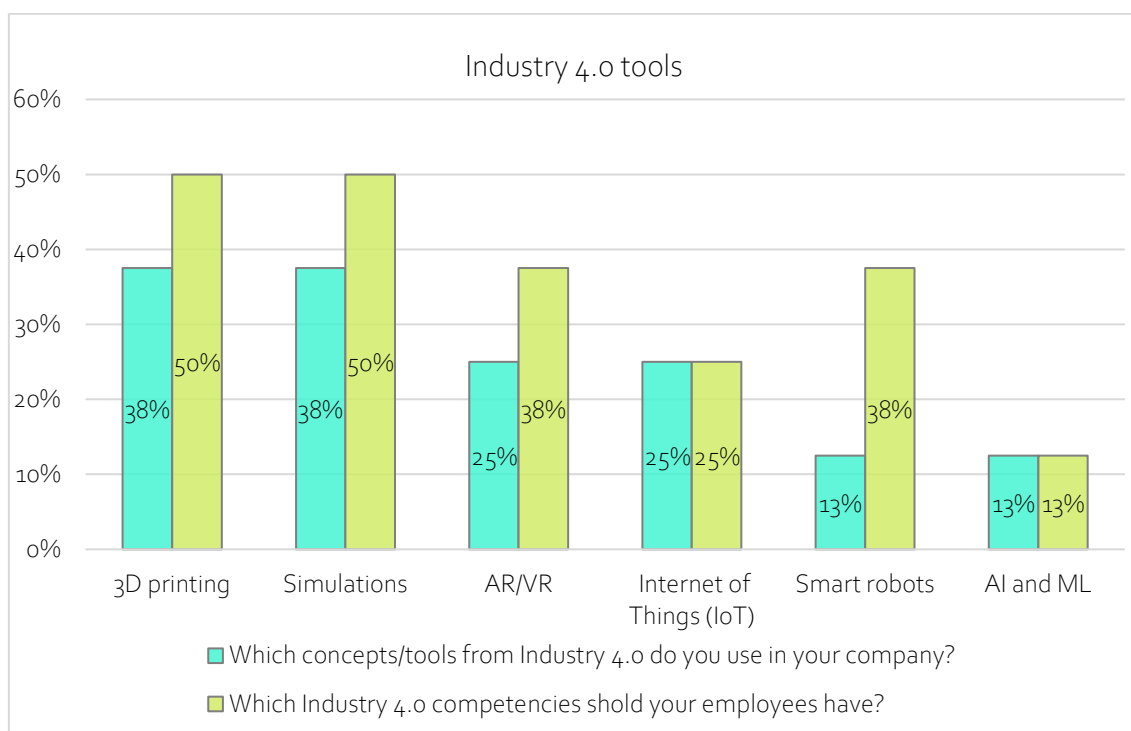


Figure 12: Used Industry 4.0 tools and important competencies for employees (n=8)

Companies believe that Industry 4.0 will have more impact on them in 5 years than the circular economy (Figure 13). And that the circular economy will be more important in 10 years, when Industry 4.0 will no longer be as influential. This could be because companies are currently ill-prepared for the adoption of industry 4.0, as seen in Figure 12, and feel under pressure.

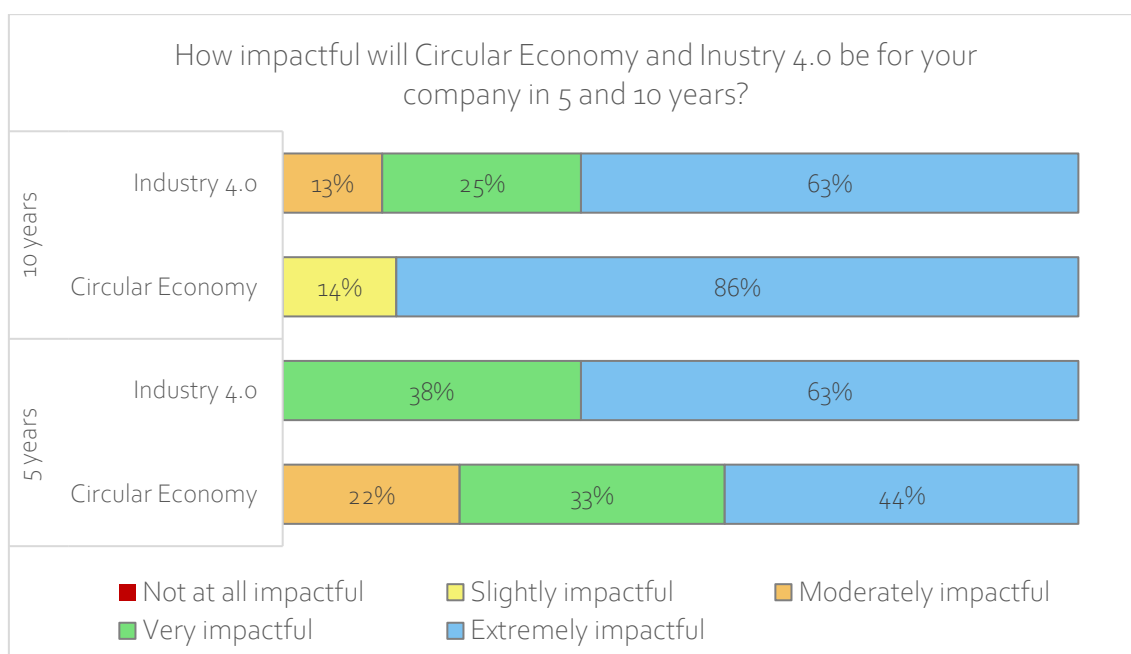


Figure 13: How impactful will Circular Economy and Industry 4.0 be for your company in 5 and 10 years (n=9)?

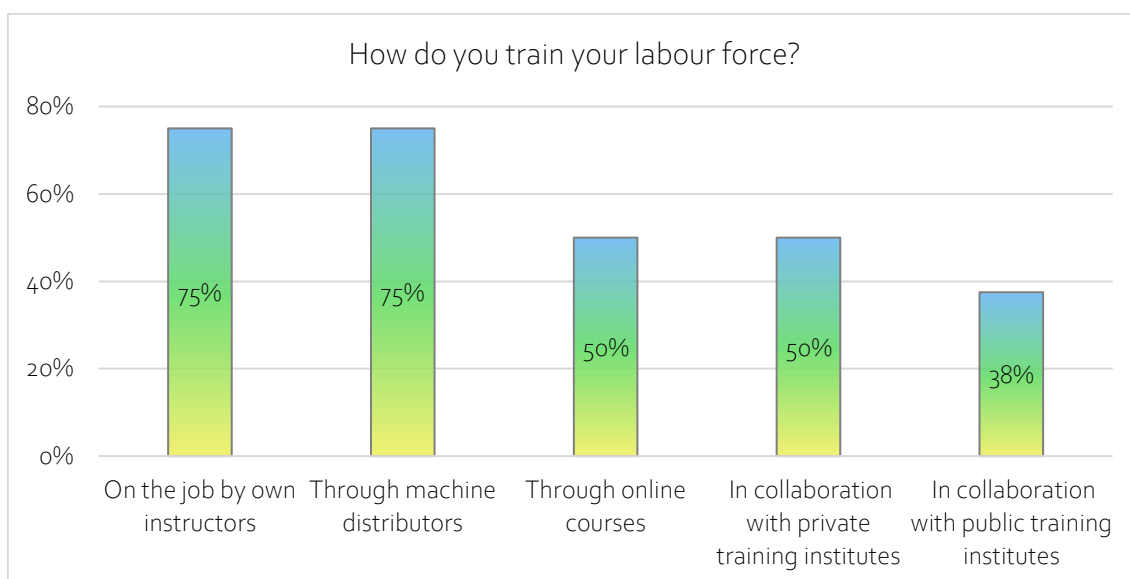


Figure 14: Training labour force (n=8)

Figure 14 shows that 75% of companies train their employees through in-house instruction/peer-to-peer and through machine dealers. This training is likely mostly related to specific tasks or the use of new machinery. Only half of the companies train their employees through online courses and in cooperation with private training institutes. Even less companies (38%) train their employees in collaboration with public training institutes, with whom they collaborate a lot, as we see in Figure 15. 89% of companies collaborate with students in the form of internships and more than half of them conduct company visits for students. 44% of the companies also participate in student project work. Dual training, which has been talked about a lot lately, is not yet very common, which could also be a reason for the mention in the additional comment that students need more practical training in companies to gain real-life experience. Out of the 9 companies, only 2 are presenting themselves at schools.

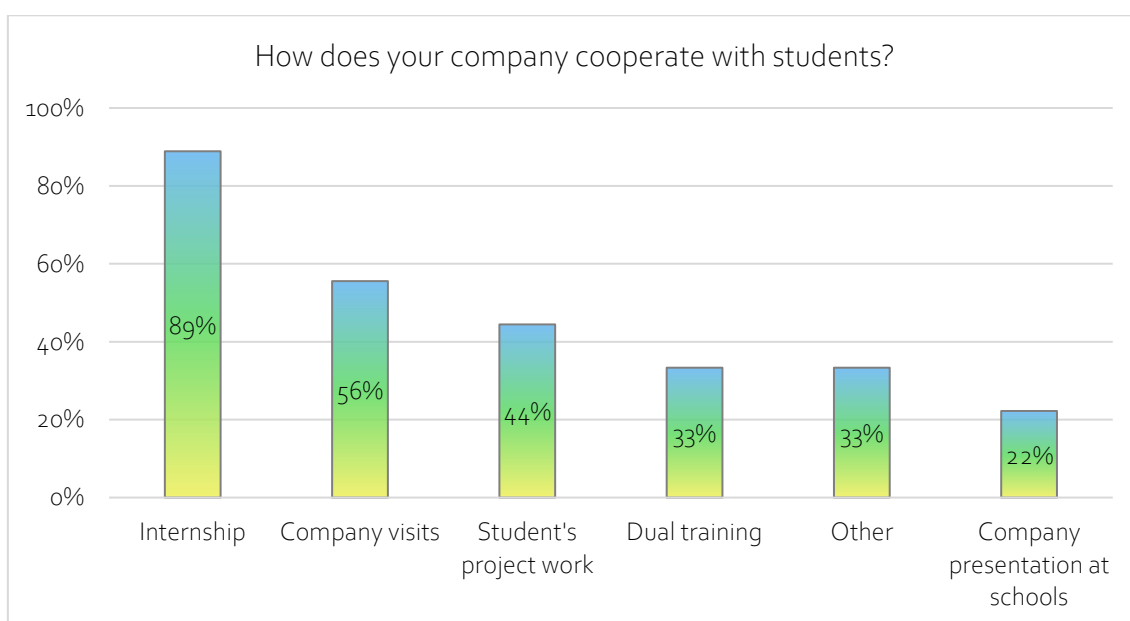


Figure 15: Cooperation with students (n=9)

In the last question, the companies expressed their satisfaction with the cooperation with public educational institutions, which is shown in Figure 16. 1 out of 9 companies (11%) is completely satisfied with the current state of cooperation and one company is only slightly satisfied. Most companies answered that they are moderately satisfied, 22% indicated that they are very satisfied and 22% that they are not at all satisfied, both companies from Spain. Given the small sample in each country, we cannot comment on this, but in general there is room for improvement. From these responses, we can also conclude that companies would like and are willing to collaborate more with educational institutions, as some also emphasised in additional comments. It was also suggested that companies should be involved in curriculum design.

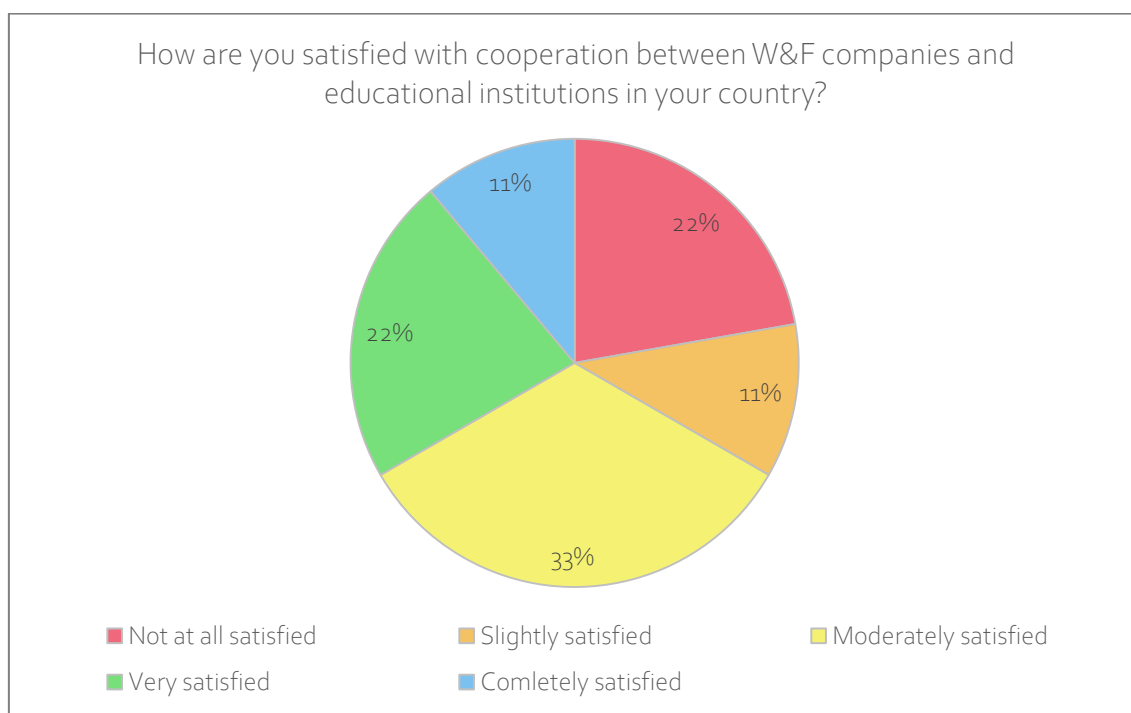


Figure 16: Satisfaction with cooperation with educational institutions (n=9)

Interviewing experts

The main purpose of the interviews was to gain insight into how experts in the circular economy and Industry 4.0 understand these concepts, what role these concepts play in W&F companies and in W&F related educational programs, with a focus on student and staff competencies. We also wanted to know how important the topics from these two areas are for students at different levels of education. All questions were open-ended, as we wanted the interviewees to think for themselves and in this way obtain new information that we had not even thought of or that could not be found in the literature. The goal of the analysis is to get an overview of different opinions, possible relationships and based on the interpretation of the data to define hypotheses or lay the groundwork for further research.

Methodology

Interviews were conducted from April to the end of June 2022 in the form of live interviews via a video conferencing application, lasting on average about 35 minutes per topic. The questionnaires were emailed to the interviewees in advance so that they could familiarise themselves with the topic of the questions and prepare for the interview. The interviews were recorded, and transcripts were subsequently prepared. From the transcripts, we transferred the interviews into a table in which the interview was divided into three levels: Text, Message, and Code. In analysing the responses, we considered the code level. In cases where we used direct quotes from interviewees, we quoted them from the transcripts. The interview was divided into two sets of questions, one related to the circular economy with 11 questions and the other to Industry 4.0 with 12 questions. A total of 9 experts participated in the interviews. Some experts answered both sets, while others who are mainly experts in one area answered only one, resulting in 6 conducted interviews from each area. The interviewed experts were project managers, professors, cluster representatives, etc. from Slovenia, Spain, and Belgium. The results of the interviews are presented in the order of the answers, and the common findings for both sets of questions are summarized at the end.

Results

Interpretations of experts' responses concerning Circular Economy:

1. How do you understand the concept of Circular Economy?

One of the interviewees said »it's a pretty complex thing,« but in general everyone agreed that the concept is about preventing the depletion of the Earth's limited material resources by reducing the consumption of natural goods, with closing resource loops »the ideal model would be Zero Waste.« One of the interviewees stated that we need to limit the use of resources according to the 9R principles, and he emphasised that we need to produce durable products that should remain in the loop as long as possible »so that the materials remain useful (i.e., in use),« which others also mentioned in the context of eco-design. Most also explained that industrial symbioses play an important role with »more communication, less competition« and one said that we also need to pay attention to energy use.

2. Do you think companies in wood and furniture sector from EU and your country are ecologically aware? To what degree, do they meet certain standards? Which standards of Circular Economy are significant in this context?

Most of the respondents believe that the ecological awareness of companies in the wood and furniture industry is very low (Table 1), as one responded said »they do not consider it important and have other priorities at the moment.« The one who believes that most companies are ecologically aware says »they address CE from the wrong end, i.e., R9 (recycling), instead of starting from R1.« Nevertheless, many of them say that companies are in a transitional stage, that awareness is growing, and the EU is working hard on it, but the current system is still linear and not adapted.

Table 1: Do you think companies in wood and furniture sector from EU and your country are ecologically aware?

Answer	n
Companies in W&F industry are ecological aware.	1
Companies in W&F industry are not ecological aware.	4

To question "which standards of Circular Economy are significant in this context?" 2 respondents answered that »circular economy is not based on a single standard« and that the most common standards introduced in this context are the series of standards ISO 14.000. One of the respondents also pointed out the use of eco-labels (FSC and PEFC), but another emphasised that »you cannot achieve a comprehensive circular economy with the standard of a green label alone« and that »they only meet the standards required to sell in the main markets.« One respondent said »we need simple and smart rules for the circular economy.«

3. How are companies in wood and furniture sector ecologically aware comparing to other sectors?

Two of the respondents believe that environmental awareness is greater in other, more advanced sectors. They reasoned that »other sectors have greater financial strength« and that »the W&F sector is traditional and understands everything related to CE from a fairly old approach that focuses exclusively on waste recycling.« One respondent compared the industry to the production sector, for which the thinks W&F is more progressive. Another respondent, who believes that W&F companies are ecologically aware compared to other sectors, stated »W&F companies often think that they are very ecologically aware which ultimately leads them to underutilize their potential to further reduce their environmental footprint,« which was also pointed out by another respondent, saying: »the classic corporate response is that we are green because we use wood, which is often not the case.« Two respondents did not compare the sectors, as one said: »each sector has its own peculiarities and it is difficult to compare them.« One interviewee emphasized that CE is at the focus of an important new EU policy program aimed at pursuing environmentally sustainable production and consumption, and another said: »the European Commission has defined the wood and furniture industry as a pilot sector for the introduction of the circular economy.«

4. Is there any specific company in wood and furniture or other sector that is example of best practice? Could you please describe some of them? Is there any specific country that stands out in this area?

As examples of best practice of companies in wood and furniture sector respondents point out 9 companies from different EU countries:

- From Slovenia: Donar, Alples, MSora, Melu doors, Podgorje, Stilles;
- From Spain: FAMA, Solteco;
- From Germany: Traceless.

We must take into account that most respondents were from Slovenia, that is why we have the more best practices from there. One responded didn't point out any company, but he did direct us to the best practice databases on woodcircus.eu, zenodo.eu and cradletocradle.org.

The situation in Europe is not uniform, the Scandinavian countries such as Finland, Sweden and Norway were cited as examples of good practices by 3 respondents. One responded pointed out the Netherlands as one of the leading countries in the circular economy »as they have an ambitious project of being a country based on the circular economy 100 % by 2050« and Germany as a leader in waste management.

5. What are the biggest obstacles for companies in wood and furniture sector in adoption of circular economy concepts and why?

According to the respondents, there seem to be several obstacles. Most of them pointed out that high initial investments are required and therefore there is a lack of them. One of the respondents stated that »It happens that companies find it difficult or impossible to close the loop themselves« and that there is currently no government support for creating a loop infrastructure, which was said by several respondents and seems to be one of the biggest obstacles. One respondent said: »moving from a linear to a circular production model means a disruptive change in the production chain of companies in the sector« and another pointed out »there could be companies that would exist just to close the loops.« Two respondents also pointed out that »there is a big know-how/competence gap.« One of the interviewees believes that it is difficult for companies to replace the current high-quality materials without sacrificing product quality because there are not many options. The problem is also in the minds of management, »we have to understand that this principle is coming, and we have to think circularly, there will be no choice. « It was also pointed out that »we need a continuous supply of large quantities of biomass at extremely low cos« and that »in some cases quantity and homogeneity do not meet the conditions.«

6. What are the benefits for companies if they become more circular?

For this question, we focused primarily on the benefits to companies. From the answers given by the respondents, it appears that the circular economy has a cost for the companies and that they can benefit economically from it if they know how to sell it as an added value »by including the specificities of the production processes in the price of the product, i.e. using the circular economy as a selling point.« The market seems to become more favourable over time because »the segment of customers demanding ecological products will grow as young people enter the market« and two of the interviewees believe that it gains companies acceptance in the market, »which would

increase profits in terms of sales.« Two respondents pointed out that this will require companies to network, which is good because »it will allow them to better understand their business partners, broaden their horizons, think outside the box, and allow for more innovation through greater openness« and »reach new markets and customer segments in both B2B and B2C.« Another economic benefit pointed out by two interviewees is that they can save some capital because »all savings in raw materials and waste lead to cost savings.«

7. How should companies become more circular and approach to the transformation of their business model (any existing support systems, governance). How does digitalization help circular economy?

Respondents stated that »it is important to start analysing the production process« and that »it is necessary to evaluate their resource flows, supply chains, and business models« because »the transformation of the production model must be gradual« with »a clear plan and an individual approach to what we need to do.« One respondent emphasised that »we need to take action in the areas that stand out for greater impact« and two respondents said that we need to »define what brings us added value.«

One respondent believes there are several experts who can help companies become more circular. Another pointed out that »without incentives, legal obligations, or demand from the construction sector or other customers, the potential for the wide-scale cascading of solid wood is very limited.« Three respondents stated that »the supportive environment at the government level is not fully developed, nor is legislation« and that they do not see support systems that would encourage circular economy activities, so it is not systematically supported.

All respondents (n=5) who answered the question about the benefits of digitization for the circular economy agreed that »increased digitization has the potential to enable the transition to a circular economy« and, as one of the respondents put it, »can have a positive impact on other things, not just the circular economy, if you do it right.« Most of them see digitalization as key to the circular economy.

8. What level (basic, in-depth, advanced) and which circular economy competences should employees in wood and furniture sector have and how do they differ according to occupation?

The answers of the three respondents were quite similar. They believe that competencies should increase with the level of education and position in the company. They suggest that production employees should have basic knowledge »to know what a circular economy is, what a company does and why change is necessary,« technicians and middle managers should have more advanced knowledge »to know a little more about technologies, materials and designs that enable the transition to a circular economy,« and higher level employees (department managers, production managers, directors...) should have as advanced knowledge as possible, »they should have in-depth strategic knowledge to know the big picture, materials and trends.« The answers of the other respondents vary. One proposes a more modular approach, i.e., a more talent-oriented training leading to mixed profiles such as 'circular carpenter', but on the other hand, he agrees with the above that the level of knowledge (basic or advanced) and competences (practical or theoretical)

depends very much on the position in the company. In addition, two of the interviewees believe that »it is not so much that you master a particular technology, but that you are aware of the possibilities« and that »it makes sense for companies to bring in external specialists in terms of specific knowledge, especially in small companies that cannot afford their own specialists.«

9. Which competences from area of Circular economy are currently important for newly graduates and how do they differ according to EQF level? Do you think there are gaps between levels of education, which?

One respondent believes that current curricula have become very microscopic and technology oriented. He therefore stresses the importance of mastering a system approach, system thinking, and strategic, long-term thinking: »I think we have completely abandoned these skills and thinking outside the box.« He adds that this may be more important for higher levels of education than for production workers. Another interviewee has a similar opinion »normative competencies, which are skills related to the vision and values needed to support the transition to a circular economy model, and general interdisciplinary competencies, which could refer to cross-cutting knowledge needed to support each profession,« besides he also points out technical skills, for which he says »are specific to each profession.« Competencies that are important for undergraduate students (EQF 6) were listed by another respondent, »each student should understand the specifics of the wood processing industry and have technical knowledge (materials, technologies, techniques leading to the circular economy). Most importantly, he or she should understand how we can transition to the circular economy at the strategic level (organizational knowledge), e.g., through knowledge of circular business models.« The same respondent defined the competencies for VET students similarly, »but not at such a sophisticated level, but rather in terms of understanding CE and the technical domain.« Another respondent listed important competencies for the technical professions »the competencies that focus more on eco-design, use of new technologies, and life cycle analysis« and pointed out that business models are important for those in management. The last respondent took a broader view, pointing out that we need an interdisciplinary approach, which was also emphasized by another respondent above.

10. Which competences from area of Circular economy will be important for newly graduates in 5 and 10 years? How will it affect labour market?

None of the respondents defined and separated the 5- and 10-year milestones, but all shared their opinion more generally 'the near future'. Two respondents felt that the circular economy will be necessary within 5-10 years. One said that it was hard to say with the current dynamics of things, but »if we continue with the linear economy, capabilities for rotational and circular use will be a necessity,« the second pointed out that »within 5-10 years, environmental awareness will continue to have a privileged place within the circular economy, as it is one of the most fundamental competencies of the model.« He then enumerated some specific competencies, which include many soft skills: »recognizing opportunities and creativity will be other key competencies to continue innovating and adapting to the market in the environmental sector. Profiles with great initiative and willingness, as well as creatives in the technical field, will likely be most in demand for jobs related to the circular economy.« Another respondent gave a similar answer, saying, »the jobs

of the future will require mostly creativity and innovative thinking, and less technical knowledge, as machines will do the work.« He pointed out that wood-related jobs should not specialize in one segment but should have a broader view »Wood-related jobs are not expected to be experts in all areas themselves« because it will no longer be a matter of having everything in your head, as information is and will always be available »the key is knowing how to find information, extract it, and use it properly.« Two respondents did not answer this question and the last one pointed out some specific skills: »skills related to new business models, full life cycle analysis, developing strategies for industrial symbiosis, and taking advantage of new technological trends will be needed.«

We cannot ignore some other comments from participants. One pointed out that curricula are updated too infrequently, as he believes »curricula should be updated with new content at least every two school years because things change very quickly.« In his opinion, companies expect graduates to know about the latest things, »but they need to be able to apply the knowledge and be prepared to use it.« Other interviewee pointed out different problem: »society needs to be prepared for change, because it's not just about production, it's about consumption, lifestyle, value systems, etc., and we are not prepared for that as a society, but it varies from country to country.«

11. How to ensure lifelong learning of employees and what approach for this field would you suggest?

Respondents indicate that lifelong learning is important to companies. One believes that »continuous learning is the only way to avoid becoming obsolete,« and he points out that »we live in a world of constant change and change is part of the global dynamic.« This brings us to the response of another interviewee who believes that much depends on management, »who should not see this as a waste of time and money« and he also points out that »employees must be willing to be trained.« He advises planning such training in advance and explaining to employees why it is necessary. Another respondent adds that »the accumulation of such competencies could be included in the promotion system to provide a small material incentive.«

One respondent answered that »major combined efforts between education providers and company frontrunners in CE need to be part of the solution so that both corporate experience and the latest R&D insights can be incorporated directly into lifelong learning programmes.« He believes that »the most competitive education systems, especially at the VET level, are those that cooperate most with the private sector to minimise skills gaps.«

The last respondent lists offerings that would »in addition to traditional training, rely on innovative teaching models through learning platforms, the development of boot camps where workers from different companies can share their knowledge with different experts.«

Interpretations of experts' responses concerning Industry 4.0:

12. How do you understand the concept(s) of Industry 4.0?

All respondents understand the concept of Industry 4.0 as one in which every task and process is supported by Informational Technologies (IT). One of the interviewees adds, »The main goal is to ensure inclusion and simplify processes, making them faster, with fewer errors and delays, and available from anywhere at any time.«

One respondent gives his own view of Industry 4.0 from a company perspective »Industry 4.0 enables companies to do several things to make them more competitive: On the one hand, they can reduce costs by using technology; on the other hand, it allows them to have more information about customers' behaviour, to have access to more information in the final analysis, and thus to offer a value proposition that better meets their needs; and technology also allows them to change the way products are offered to customers so they can consume them differently and with other complementary services.«

13. Would adoption of these technology and concepts make companies overall more competitive?

The answers to the question above are presented in Table 2. We have divided them into two categories: those who believe that Industry 4.0 makes companies more competitive, and those who believe that Industry 4.0 does not in itself guarantee competitiveness.

Table 2: Would adoption of Industry 4.0 technology and concepts make companies overall more competitive?

Answer	n
Industry 4.0 make companies more competitive	4
Industry 4.0 by itself does not yet guarantee competitiveness	2

4 respondents agreed that Industry 4.0 increases the competitiveness of companies. Examples of their arguments are as follows:

- »It also affects the way business is done, how to connect with the market and customers, how to integrate and expand the entire supply chain globally and without borders.«
- »Industry 4.0 enables companies to do several things that make them more competitive: On the one hand, by using technology, they can reduce costs; on the other hand, it allows them to get more information about customers' behaviour, ultimately having access to more information and thus being able to offer a value proposition that better meets their needs; and technology also allows them to change the way products are offered to customers so that they can consume them differently and with other complementary services.«

2 respondents believe that Industry 4.0 alone does not guarantee competitiveness yet. They cited the following reasons:

- »An important role is played by the business environment, which needs to be equipped and prepared. There is also a problem with the skills of the employees. If the products are not very sophisticated technologically, have low added value and do not offer economies of scale, then the cost of digitalize business processes may be too high. In this case, the competitiveness of the company may even decrease.«
- »We must not forcefully digitalize outdated systems because we will only make things worse. That's why we must develop a strategy and first define what we want to achieve

with digitalization and what benefits it has for the customer. Only then can we start with digitalization of processes, for which we need time, a strategy, and a changed business model.«

14. How do you think companies in wood and furniture sector could be more competitive by applying Industry 4.0?

2 respondents indicated what could make the wood and furniture sector more competitive through the application of Industry 4.0, by:

- Innovative business models.
- AI in decision making using Big Data.
- AI in some core operations in the so-called smart factory.
- Limitless use and security of data through cloud computing.
- IoT - in production and products.
- AR/VR in marketing, HR development and in production.
- Digital twins in the development (and simulation) of wood products.
- From driverless transport to smart containers.
- Smart warehousing, smart shelves to human and information exchange in all possible logistic chains and contexts = smart SCM.
- Mainly ERP-like solutions.

The other 4 respondents believe that the competitiveness of companies does not depend on Industry 4.0 alone. As reasons they cite:

»In many companies, there is a large knowledge/competence gap at all employee levels (and also a technology gap). Therefore, first and foremost, a 'strategy check-up' should be carried out to assess the individual opportunities and needs of each company. The second step should be to decide which direction to take, then train/hire staff and acquire the necessary infrastructure. There is no one-size-fits-all approach to Industry 4.0.«

»Companies can be more competitive if all their business processes are digitalized, networked and unified. They need to know how to use the data they collect to analyse their production and predict how it will develop in the future. Individual processes, purchasing, production and personnel must be networked, which is possible through digitalization. This is how we get rid of 'manual labour'. Artificial intelligence can and must be used to predict how machines and customers will behave in the next five years.«

»To become more competitive, they need to innovate, both in terms of technology and organisation, and in terms of the value proposition they provide to their customers.

»Technology also allows companies to handle more complex scenarios in production with the same resources, so a higher level of personalization can be achieved, which is also very positive for consumers.«

15. Is there any specific company in wood and furniture or other sector that is example of best practice? Could you please describe some of them? Is there any specific country that stands out in this area?

As examples of best practice of companies in wood and furniture sector respondents point out 4 companies from different EU countries:

- Ikea from Sweden
- Veriset Kuchen from Switzerland
- Nolte from Germany
- Fama Sofas from Spain

One respondent didn't give an example, while one interviewee highlighted Germany as a country that stands out in this area.

16. Do you think companies in the EU are competitive compared to companies globally (US, Japan, China...)?

Three respondents think that EU companies are more competitive than non-EU companies while one respondent disagrees with this statement. 2 respondents think that EU companies are more competitive in the EU market itself than in the world market.

In general, some improvements need to be made in the wood and furniture industry to become globally competitive.

Table 3: Do you think companies in the EU are competitive compared to companies globally (US, Japan, China...)?

Answer	n
Yes, they are competitive globally	3
No, they are not competitive globally	1
Other	2

17. What are the advantages of digitalization and what are its benefits for the companies?

According to respondents' answers, the following advantages and benefits for companies are:

- Better and faster decision making with AI and Big Data.
- Innovative business models.
- Smart factory - based on a smart loop of (all) business processes and the development of IoT products.
- Limitless use and security of data through cloud computing.

- Digitalized marketing, HR development and production with AR/VR.
- The development (and simulation) of wood products using digital twins.
- Smart Logistics and smart SCM.
- BIM - Building Information modelling.
- Digitalization enables faster work.
- Availability of more information for decision making.
- Expansion of the company's ability to develop processes or tasks that would be unthinkable without technology.
- Access to cost-effective technologies.
- Opening of new markets.
- Promotes a culture of innovation within the company.
- Improves the efficiency of processes in organisations.
- Helps promote collaborative work and internal communication.
- Improved communication with customers.
- Access to new business opportunities.
- Extends the life of the company.
- Reduces costs.
- Facilitates the recruitment of qualified staff.
- Satisfied employees.

18. Are wood and furniture companies (note company size) prepared for adoption of all industry 4.0 technologies and concepts (digital index), which? What are the biggest obstacles?

Respondents' answers are summarised in the following statements (see table below).

Most respondents agree that larger size of companies is a factor that strongly influences the degree of digitalization.

The biggest obstacles to the introduction of Industry 4.0 technologies are the provision of digital infrastructure, the preparation of digital strategies, insufficient support from the state and high hardware maintenance costs.

Table 4: Are wood and furniture companies (note company size) prepared for adoption of all industry 4.0 technologies?

Answer	n
Larger companies are better prepared than small ones.	3

In general, companies are opened to incorporate new technologies into their system	2
It depends on size of the company and integration into a broader business system	1

19. Which digital technologies are more important for business success and why?

Respondents considered the following competences as more important for business success:

- Innovative business models.
- AI in decision making with the help of Big Data.
- AI in some core operations in the so-called smart factory.
- Limitless use and security of data through cloud computing.
- IoT - in production and products.
- AR /VR in marketing, HR development and in production.
- Digital twins in the development (and simulation) of wood products.
- Smart SCM.
- BIM - Building Information Modelling and management.
- ERPs, B2C and B2b platforms.
- CRM-like customer management systems.
- 3D printing.

20. Who should company address to help them implement digital transformation (support systems available, governance...)?

The following entities were mentioned by respondents:

- Government (digital transformation tenders).
- Support systems (digital innovation hub).
- Public and private infrastructure centres.
- Qualified and experienced personnel.

21. What level (basic, in-depth, advanced) and which Industry 4.0 competences should employees in wood and furniture sector have and how do they differ according to occupation?

The opinions of the respondents on this subject differ. For this reason, the answers are scattered. For example, one respondent said, "When companies want to implement Industry 4.0, they often turn to external service providers."

At the lower education level basic knowledge is required. Production employees need to have instrumental or technical skills related to the use of certain tools, while middle and senior management should have advanced skills. One respondent believes that: "Office workers and

middle managers need to develop their digital skills for data and information processing because of the type of work they usually do. As well as the higher profiles of the company, which will also require these types of skills.

One respondent identifies 3 categories of important competences/skills employees should have:

- Digital information processing skills: Communication, creativity, implementation, evaluation, integration, organization and access to information, and identification of information needs.
- Instrumental digital skills: the use of equipment, specific software, network resources, programming, and these types of skills.
- Transversal competences: teamwork, adaptability to change, organization and planning, management/leadership skills, initiative, self-learning, or problem-solving skills.

22. Which competences from area of Industry 4.0 are currently important for newly graduates and how do they differ according to EQF level? Do you think there are gaps between levels of education, which?

For new graduates, »digital and process skills are important«, replied one respondent. Another adds, "»...the most necessary competences would be digital skills to process information, followed by transversal competences.«

One respondent says, »you have to know how to search, find, and properly use data. It's not necessary to have specific skills, but you have to know that certain tools exist, what the benefits are, and how to best use them for your business when the time comes.«

No one addressed the question: "Are there gaps between education levels? " Only one gives his view on how to fill the competency gaps: »The Industry 4.0 competency gaps should be filled by graduates of courses related to Industry 4.0. In addition, the establishment of modular and thus flexible 'trade-related' and classical wood/furniture VET/HE study programmes would allow for more talent-oriented training (higher productivity) and lead to mixed profiles such as 'IT-carpenters', 'sales carpenters', 'circular carpenter', etc. These would have better interface skills with other disciplines and could therefore cover competency gaps in I4.0, CE, AAL, etc. Such interface skills are very often missing and often have to be trained 'on the job' in the companies.«

23. Which competences from area of Industry 4.0 will be important for newly graduates in 5 and 10 years? How will it affect labour market?

Respondents have different views on the importance of Industry 4.0 competences in the future. In general, respondents believe that ICT skills will increase significantly.

Two respondents point out "digital information processing skills" as important competences for new graduates, while one believes that »woodworking professions should focus more on creativity, logic and thinking skills.«

Three respondents did not answer this question.

24. How to ensure lifelong learning of employees and what approach for this field (Industry 4.0) would you suggest?

2 respondents did not answer this question. Among those who answered this question, it is interesting to note that 3 respondents believe that the company management plays an important role in this issue. Management must create the conditions for such training to take place and provide resources for it. Also »the trainings should be planned in advance and employees should be informed in detail.«

One respondent replied, »... major combined efforts between training providers and companies that are pioneers in Industry 4.0 need to be part of the solution here, so that both company experience and the latest R&D insights can be incorporated directly into lifelong learning programmes.«

One respondent answered simply: »Continuous, planned, personalised and very close training.«

Knowledge Gap Matrix

In this phase, we collected the results obtained from surveying/interviewing teachers, which can be found in chapter above 'Surveying and interviewing teachers', where teachers evaluated in which educational levels (EQF 4, 5, and 6) certain content is fully included, partially included, and which is not. In this chapter we interpreted those results as the level of knowledge of students at different educational levels (EQF4, 5 and 6) in relation to the wood sector. In this way, we obtain the current level of knowledge and can identify the strengths and weaknesses of each educational level, which helps us identify gaps within and between educational levels. In addition, we interviewed new group of professors who teach courses related to the wood sector in HE ($\geq$ EQF 6), so we also obtained the current expected knowledge level and the expected knowledge level of students in 5 years at each level. Some professors (n=8) also participated in the Analytic Hierarchy Process (AHP) of the importance of each area (CE, I4.0 and AAL) at the present time and in 5 years for all students in wood-related courses.

Methodology

1. The original data from the teachers' responses were converted into proficiency levels using a 10-point scale (Figure 17). The results represent the 'current level' of competence, which can be seen in the matrix in Figure 20, which also shows the 'expected level' of competence and the 'expected level in 5 years'. The expected level now and in 5 years was determined by professors teaching courses at HE, in courses related to the wood sector. They rated the expected level of proficiency by the same 10-point scale. The matrix in Figure 20 shows the average rating of 10 professors. In both matrices, we separated different EQF levels and/or by occupation positions. *Note that the current level represents the average of the countries participating in the study, i.e., some countries are below and some are above the 'current level' shown.*

Not included	Partially included	Fully included	Skill/Knowledge Level of proficiency (SL)	
0	≤ 10	≥ 90		= Expert level
≤ 10	≤ 20	≥ 80		= Advanced 2
≤ 20	≥ 0	≥ 70		= Advanced 1
≤ 30	≥ 0	≥ 60		= Upper Intermediate 2
≤ 40	≥ 0	≥ 50		= Upper Intermediate 1
≤ 50	≥ 0	≥ 40		= Intermediate 2
≤ 60	≥ 0	≥ 20		= Intermediate 1
≤ 70	≥ 0	> 0		= Basic 2
≤ 80	≥ 0	≥ 0		= Basic 1
≤ 100	≥ 0	≥ 0		= No knowledge

Figure 17: Transformation rules for conversion of original data to level of proficiency and scale

2. The second matrix in Figure 23 shows gaps calculated based on the data in the matrix in Figure 20. We calculated the difference between the expected proficiency level and the current proficiency level and weighted the difference according to the importance of the topics for the W&F sector from the results of the AHP analysis (Equation 2).

$$\text{Knowledge gap} = (\text{expected level} - \text{current level}) * W_{AHP} \quad \dots[2]$$

For the Analytic Hierarchy Process (AHP) Microsoft Excel software template (Goepel, 2013) was used for evaluation, which also calculated the level of consensus. AHP is a method to analyse complex decisions, in our case by comparing and ranking the importance of certain areas (CE, I4.0 and AAL) for the wood and furniture sector. With the following comparison we want to find out how important each area is for students in study programmes related to the wood and furniture sector now and in 5 years. For importance, the ratio scale from 1 to 9 was used, where 1 express that the compared fields are equally important and 9 that one area is extremely more important than the other (Figure 18). Participants repeated the comparison twice, once for importance now and once for importance in 5 years. The results are summarised in Figure 21 and Figure 22.

Industry 4.0									Circular economy								
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Industry 4.0									Ambiend and Assisted Living								
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Circular economy									Ambiend and Assisted Living								
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	

Figure 18: Template for importance evaluation (AHP)

We graphically represented the results of our calculations using an 11-point scale (Figure 19), with different shades of red indicating the size of the gap (i.e., less knowledge than expected), different shades of orange indicating the negative gap (i.e., current knowledge is higher than expected), and white indicating there is no gap.

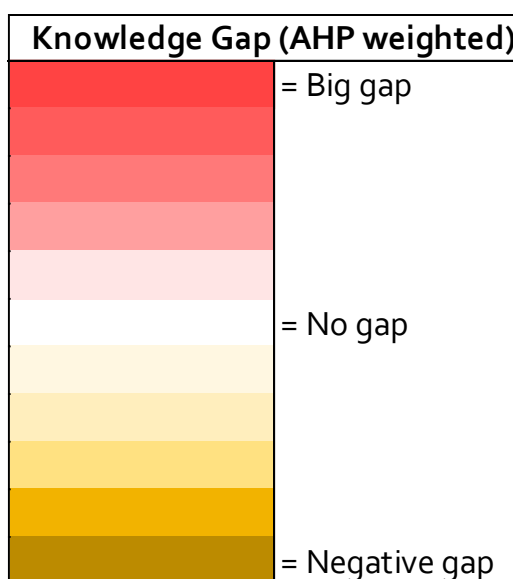


Figure 19: Knowledge/competency gap scale

Results

In Figure 20, we see that there is not much difference between the current and expected knowledge levels in EQF 4, as the current knowledge level is consistent with the professors' assessment. We also see that the current knowledge level is well developed vertically (from EQF 4 to EQF 6), which is positive. The topic 'Collection and recycling' is one of the topics that has the highest level in EQF 4 compared to EQF 5 and 6, which is not necessarily bad. The current level in EQF 5 is lower for most topics based on the professor's expectations. Same for EQF 6, which does not meet all current expectations, especially in the area of Industry 4.0. In general no level of education does not meet the expectations in 5 years at the moment, with some exceptions. We can conclude that in 5 years more knowledge from these three areas is expected from graduates at all EQF levels.

	Higher production staff and technicians			Production engineers			Engineers and middle management		
	Secondary vocational education (EQF 4)			Higher professional education (EQF 5)			Bachelor's Degree (EQF 6)		
	Current level	Expected level now	Expected level in 5 years	Current level	Expected level now	Expected level in 5 years	Current level	Expected level now	Expected level in 5 years
Eco Design									
Cascading use									
Natural resource management									
Renewable energy sources									
Efficient and sustainable production									
Environmental effects									
Circular business models									
Industrial symbiosis									
Biotechnology									
Systemic thinking									
Waste to energy									
Biorefinery									
Green chemicals									
Bio economy									
Functional materials (sustainable composites, advanced materials)									
LCA analysis									
Collection and recycling									
Transparency in supply chains									
Hazardous chemicals									
Green public procurement									
Nano technology									
Cross Reality (VR, AR, MR)									
Cloud computing									
Online security									
Internet of things - IoT									
Simulations									
Autonomous (smart) robots									
Big data									
Additive production - 3D, 4D printing									
Artificial intelligence									
Smart buildings									
Smart furniture									
Ergonomic interior design									
Sensors									
Fire and other safety									

Figure 20: Level of proficiency

The results of the Analytic Hierarchy Process (AHP) show that professors of higher education believe that I4.0 is the most important of the three topics for the W&F sector, followed by CE and AAL. The latter does not seem to be crucial at the moment. The level of agreement was 74.2%, indicating a high level of agreement among the participants (Figure 21).

n=	3	Number of criteria	Scale:	Linear												
N=	8	Number of Participants	Consensus:	74,2%												
Objective	Importance of topics for wood and furniture sector today															
Table	<table><tr><th>Criterion</th><th>Weights</th><th>Rk</th></tr><tr><td>1 Industr 4.0</td><td>56,2%</td><td>1</td></tr><tr><td>2 Circular economy</td><td>30,4%</td><td>2</td></tr><tr><td>3 Ambiid and Assisted Living</td><td>13,4%</td><td>3</td></tr></table>				Criterion	Weights	Rk	1 Industr 4.0	56,2%	1	2 Circular economy	30,4%	2	3 Ambiid and Assisted Living	13,4%	3
Criterion	Weights	Rk														
1 Industr 4.0	56,2%	1														
2 Circular economy	30,4%	2														
3 Ambiid and Assisted Living	13,4%	3														

Figure 21: AHP - Importance comparison of topics for wood and furniture sector today (n=8)

Figure 22 shows the importance in 5 years when the turnaround occurred. In 5 years, the same participants believe that CE will be the most important of the three topics for the W&F sector, followed by I4.0 and AAL. The latter also seems to be gaining strongly in importance. The level of consensus at this topic is lower (64.7%), but this is not bad considering that forecasting the future is difficult. Similar results were expressed by the companies that believe I4.0 will be important sooner than CE (Figure 13). Thus, we can assume that the concepts of Industry 4.0 need to be established first so that they can help integrate CE and support AAL. The latter was also expressed by the experts in the 'Interviewing experts' chapter, who also said that Industry 4.0 is key to the transition to a circular economy.

n=	3	Number of criteria	Scale:	Linear												
N=	8	Number of Participants	Consensus:	64,7%												
Objective	Importance of topics for wood and furniture sector in 5 years															
Table	<table><tr><th>Criterion</th><th>Weights</th><th>Rk</th></tr><tr><td>1 Industr 4.0</td><td>29,5%</td><td>2</td></tr><tr><td>2 Circular economy</td><td>49,3%</td><td>1</td></tr><tr><td>3 Ambiid and Assisted Living</td><td>21,2%</td><td>3</td></tr></table>				Criterion	Weights	Rk	1 Industr 4.0	29,5%	2	2 Circular economy	49,3%	1	3 Ambiid and Assisted Living	21,2%	3
Criterion	Weights	Rk														
1 Industr 4.0	29,5%	2														
2 Circular economy	49,3%	1														
3 Ambiid and Assisted Living	21,2%	3														

Figure 22: AHP - Importance comparison of topics for wood and furniture sector in 5 years (n=8)

In Figure 23, we see that EQF 4 has only minor gaps in terms of current expected knowledge, with the exception of some topics (renewable energy sources, green public procurement, cross reality and online security). At this level there are also few negative gaps, which mean that their level of knowledge is higher than expected, e.g., at 'simulations' and 'green chemicals' the difference is quite significant. Considering the importance of areas, EQF 5 and EQF 6 do not reach the expected level of knowledge in most of the topics. We have to accept that topics studied in this research are not the only important topics. EQF 5 have largest gaps off the three levels of education. The largest current knowledge gaps at EQF 6 are in area of I4.0 and some topics at CE. These gaps should be addressed immediately and can be easily filled with learning content of various projects (e.g., Essence, FURN360, Making4.0, In4Wood, Ditrama, Allview, etc.) and MOOCs, as rapid direct incorporation into curricula can be challenging. The expected level in 5 years (in 2027) is much higher than the current level, reflecting the large gaps in the figure below. Nevertheless, we would

not call this a gap, but rather room for improvement, as this is the level expected of students in W&F-related courses given the importance of the fields in the future. These topics should be added to curricula in 5 years to expand knowledge across the vertical and fill the gaps. However, it is important to remember that these are not the only important and expected competencies that students should have. Therefore, inclusion in the curriculum should be based on additional research comparing the importance of these areas to all other competencies expected at each level of education and in each program of study. In this research, we averaged the current level of knowledge from studied countries, which means that some countries that participated in this study have lower levels of knowledge and lag behind from our average. For a more accurate definition, further research should be conducted at the country level and separately for each study program, as there are several study programs related to the W&F sector within the same EQF level that also have gaps within the individual country.

	Higher production staff and technicians		Production engineers		Engineers and middle management	
	Secondary vocational education (EQF 4)		Higher professional education (EQF 5)		Bachelor's Degree (EQF 6)	
	Current knowledge gap - AHP weighted	Room for improvement - AHP weighted	Current knowledge gap - AHP weighted	Room for improvement - AHP weighted	Current knowledge gap - AHP weighted	Room for improvement - AHP weighted
Eco Design						
Cascading use						
Natural resource management						
Renewable energy sources						
Efficient and sustainable production						
Environmental effects						
Circular business models						
Industrial symbiosis						
Biotechnology						
Systemic thinking						
Waste to energy						
Biorefinery						
Green chemicals						
Bio economy						
Functional materials (sustainable composites, advanced materials)						
LCA analysis						
Collection and recycling						
Transparency in supply chains						
Hazardous chemicals						
Green public procurement						
Nano technology						
Cross Reality (VR, AR, MR)						
Cloud computing						
Online security						
Internet of things - IoT						
Simulations						
Autonomous (smart) robots						
Big data						
Additive production - 3D, 4D printing						
Artificial intelligence						
Smart buildings						
Smart furniture						
Ergonomic interior design						
Sensors						
Fire and other safety						

Figure 23: Knowledge/competency gap and room for improvement in 5 years

Data collection from different projects

We collected information of other EU projects with similar topics as Allview, to see what their objectives were. We focused on project which developed learning units, since these projects can fill potential knowledge gaps, if they are open source. For this step, Allview partners who have participated in similar projects, such as: FURN360, IN4WOOD, MAKING4.0, ESSENSE, etc. and are familiar with their content in detail have participated. We collected information about 8 projects which developed open-source training contents on same topics as Allview (Table 5) and can help us fill the gaps (Figure 24 and 25). Within different tasks (Task 2.1 and 2.2), Allview partners did a review and collected existing educational content on these topics in more detail, which is presented in Deliverables 2.1 and 2.2 and the associated database (<https://allview.eu/downloads/>).

Table 5: Projects with opensource content

	Topic	EQF level	Duration of learning modules	Is content open source?
FURN360	Circular Economy	4	75h	Yes
IN4WOOD	Industry 4.0	5	90h	Yes
MAKING4.0	Circular Economy	4	80h	Yes
ESSENSE	Industry 4.0	5	80h	Yes
DITRAMA	Ambient Assisted Living	6	110h	Yes
	Industry 4.0	4 & 5	70h	Yes
SHELDON	Ambient Assisted Living	/	/	Yes
PHARAON	Ambient Assisted Living	/	/	/
WOOD CIRCUS	Circular Economy	4 & 5	/	/

3

The model

3. The model

Circular Economy (CE), Industry 4.0 (I4.0) and Ambient Assisted Living (AAL) are the most important topics in the (rapidly changing) business environment, focusing on the environmental issues, the aging population problem and the technological background to develop appropriate solutions to these challenges. These topics are also very important for the wood and furniture sector. Consequently, current and especially future employees in the wood industry should have a certain level of knowledge and skills for certain job positions. All of this has a strong impact on the concept of education at all levels in the wood and furniture sector, including lifelong learning. With this in mind, we developed a model for transferring learning content and concepts from the context of vocational (VET) to higher (HE) education for the above-mentioned topics. The model then served as a basis for proposing appropriate transfer strategies as a possible pathway from VET to HE, considering the respective requirements and structures. In doing so, we clarified some classification parameters of each unit at both VET and HE. We calculated knowledge gaps within a single level of education, but also between different levels according to their short- and long-term importance, companies' expectations about their employees' skills according to the certain job positions, and experts' predictions about the development of each topic (CE, I4.0 and AAL) in the near future. We also analyzed the (possible) ways to bridge the gaps, including the definition of the available sources (learning material from other VET and the HE -oriented projects, learning material developed within the Allview project, changes in the curriculum and publicly available MOOCs).

From the data we obtained by interviewing companies, we can conclude that, in addition to more highly developed soft skills, companies expect graduates to have skills in sustainable economy, responsibility, digital skills, and social media management; the latter mainly because companies rely primarily on social media to find employees. As for CE, companies expect all employees to have knowledge of waste management and the big picture view, students in EQF 5 and 6 study programs must have knowledge from all topics of CE, while in EQF 4 reuse, recycling and eco-design are important. Use of Industry 4.0 concepts and tools in W&F companies is quite low, but most of them want to improve the situation, so they need employees with skills in: 3D printing and simulations, AR / VR, smart robots, and (less) IoT. Companies believe that right now Industry 4.0 will have more impact on them than Circular Economy, and that Circular Economy will be more important in the near future, when Industry 4.0 will not be as influential. Current employees in companies are mostly trained through internal training/peer-to-peer and through machine dealers, less through online courses and in collaboration with private training institutes. The biggest problem is that companies rarely train their employees in collaboration with public educational institutions. Although they are quite satisfied with the current level of cooperation (depends on the country), companies are willing to cooperate more and believe that they should be involved in curriculum design. They cooperate with students mainly through internships and company visits, but do not participate enough in students' project work and dual training. There is still room for improvement.

From the interviews with the CE experts, we can conclude that the ecological awareness of the companies in the wood and furniture industry in the EU is low, mainly due to the low financial strength and limited understanding of the modern concepts of CE, which are not only about waste

recycling. There are significant differences between countries in the EU, but all have the intention to address certain CE topics. They believe that the biggest obstacles for companies are: high initial investment, no government support for creating a circular/loop infrastructure, and a large know-how/competence gap, especially in management. The next obstacle is also low digital index of companies, while increased digitalization has the potential to help the transition to a circular economy; we can say that digitalization is the key to the circular economy. Experts believe that competences should increase with the level of education and position in the company. They suggest a modular approach and more talent-oriented training, leading to mixed profiles such as 'circular carpenter', which is not so much about mastering a specific skill, but about being aware of the possibilities (especially in small companies that cannot afford their own specialists). In terms of EQF levels, experts believe that a lower level of knowledge (basic knowledge) is important in EQF 4 and 5, in terms of understanding CE and the technical aspects. The competences should focus more on eco-design, the use of new technologies and life cycle analysis. In EQF 6, it is of great importance to master a system approach, system and strategic thinking, and to understand the transition to the circular economy at a strategic level - the creation of circular business models. Experts also believe that within 5-10 years there will be a need for a circular economy that includes creativity and innovative thinking, skills related to new business models, full life cycle analysis, and the development of industrial symbiosis strategies. They explained that curricula are too rarely updated to follow the rapidly changing world. Experts point out that the only way to avoid becoming obsolete is lifelong learning.

I4.0 experts believe that there is no major difference between companies' digital index in EU countries, but there are clear plans and actions. EU companies in the wood and furniture industry are somehow globally competitive, but the main obstacles are high investments (larger companies are better prepared than small ones), provision of digital infrastructure, lack of preparation of digital strategies, insufficient government support and high hardware maintenance costs. Smaller and traditional companies could not even benefit from adopting I4.0 concepts and tools. The most important foundation for the digital transformation of companies, in addition to digital transformation tenders and government support systems, are qualified and experienced employees. Their core competencies should be related to innovative business models, AI in decision making using Big Data, digital security, IoT, AR / VR, BIM - Building Information Modeling and Management, ERPs, B2C and B2b platforms and 3D printing. At lower EQF education levels (EQF 4 and 5), more general knowledge and instrumental or technical skills related to the use of certain tools are required; at EQF 6 level, advanced skills are expected: digital skills for data and information processing (integration, communication...), instrumental digital skills (technical use of equipment, specific software, network resources, programming); organizational competences to support technology. In general, modular and thus flexible wood/furniture VET/HE study programs would allow more talent-oriented training (higher productivity) and lead to mixed profiles such as 'IT carpenters', 'sales carpenters', 'circular carpenters', etc. These would have better interface skills with other disciplines and could therefore fill competence gaps in I4.0, CE, AAL, etc. Such interface skills are very often missing and often have to be trained 'on the job' in the companies. We need to keep in mind that specialized personnel may not be best suited for smaller companies that cannot afford specialists. As for lifelong learning, management must create the conditions for such training to take place, have a plan, and provide the necessary resources. They suggest that lifelong learning

programmes should incorporate the latest R&D findings and close collaboration between education providers and company frontrunners in CE, I4.0, etc. However, possible new directions for lifelong learning include innovative teaching models through learning platforms and the development of boot camps where workers from different companies can share their knowledge with different experts.

Based on the comprehensive analysis of the obtained data, we have developed a model for the integration of learning content, concepts and curricula at all levels of education in the wood and furniture sector now and in 5 years (Figure 24 and 25). In the model, the focus is on the strategy to bridge the identified knowledge gaps in the wood and furniture sector and to facilitate the transition from VET to HE, carefully considering vertical transitions. At the same time, a certain level of knowledge/competence should be achieved at each level of education (EQF 4, 5, 6...) due to the occupation-specific requirements in the sector. On the other hand, the content and concepts at the lower educational levels (EQF 4 and 5) should be suitable for an easy transition to the higher levels (EQF 6).

The model in Figure 24 shows knowledge gaps within and across educational levels in all three areas (CE, I4.0 and AAL) examined in this study. The colour of the graphs shows the size of the knowledge gap in a given area within each EQF level also seen in Figure 23: the larger it is, the more resources we need to close it. This gap is mainly influenced by industry expectations, to which educational institutions must adapt. EQF 6 should also work with companies to shape industry development through scientific and professional research and innovation to equip graduates with the latest relevant competencies. Another important cause of the gap is the global/local development of the economic environment, policy and technology, to which companies and educational institutions must respond. For example, the development of modern information technology affects the implementation of the educational process, which can be made more efficient and also increases students' motivation to learn (Goropečnik, 2021). A gap also occurs between EQF levels as they follow trends and update content at different pace. If we want to achieve a certain level of knowledge at EQF 6, good foundations must be laid at lower levels, especially at EQF 4. This fact, as well as the industry and the broader environment, was considered when setting the expected level of knowledge in our research. In the short term, it is difficult to provide missing knowledge through curriculum renewal, so other sources should be used. Several projects focus on the development of learning content, many of which (also Allview) developed learning material for CE, I4.0 and AAL and are freely available (open source). It is no coincidence that there are more VET projects, because at this level sound foundation for HE needs to be provided. Source for additional knowledge can also be freely available MOOCs offered by many providers. Since these contents are quite scattered, we created an overview in Allview as part of Tasks 2.1 and 2.2. We expect the smart platform developed in WP1 to be an important contributor to this integration, especially as a place where W&F companies can find training for their employees, as it becomes increasingly clear how important lifelong learning is. Through collaboration between companies and education providers, Continuing Professional Development (CPD) can be more flexible in meeting the needs of SMEs than formal education programmes, where it is difficult to keep up with the current pace of change.

The role of companies is not only to (co-)create the demand for knowledge and to be the main 'consumer' of knowledge, but also to participate in the educational process. Such as with dual learning, where they should not only comply with EQF 4, but also create conditions for all levels of education. They can also make an important contribution to the design of the curriculum, in particular by contributing their valuable experience.

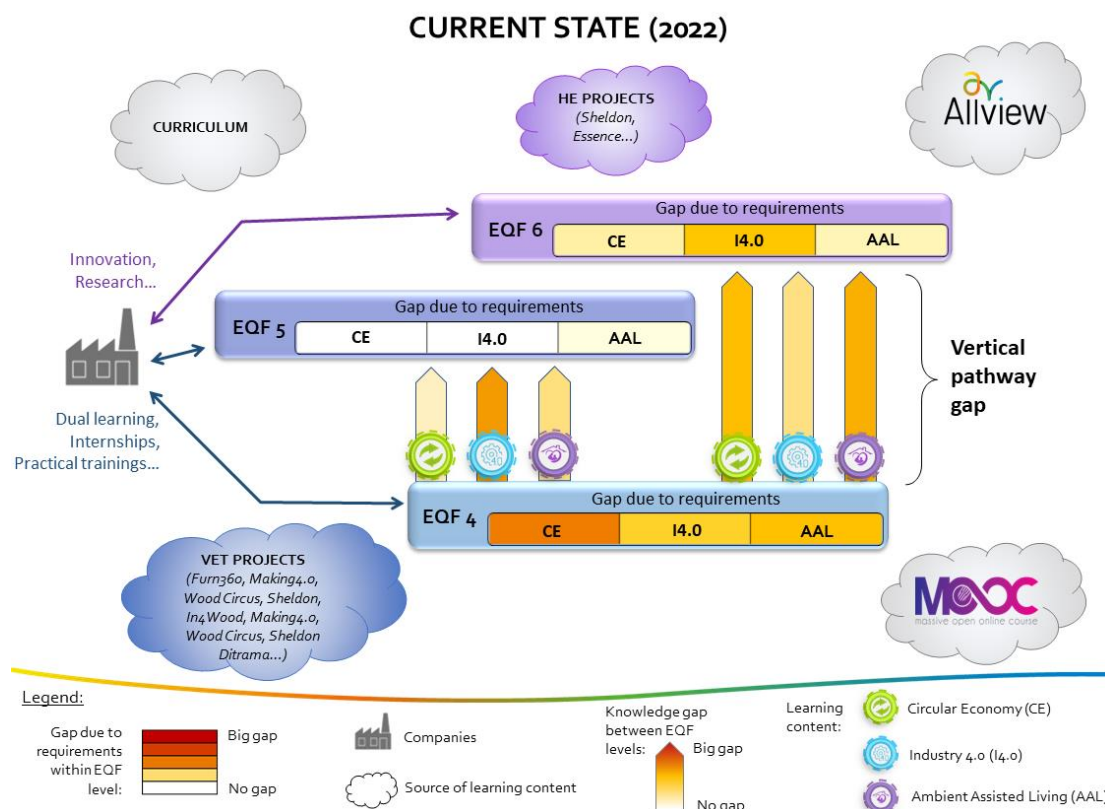


Figure 24: Model for integrating learning content, concepts, and curricula at all levels of education in the wood and furniture sector – current state (2022)

5 years from now, in 2027 (Figure 25), we can see that the knowledge gaps within EQF levels will increase if the knowledge level remains the same, as experts expect graduates to have more knowledge from these areas by then (CE, I4.0 and AAL). The gaps between the different EQF levels will also increase, which is good up to a point, as knowledge needs to be updated from lower to higher level of education. In particular, the topics on CE will become more important in the coming years. Because the focus needs to be on curriculum change at all levels of education, we need to start deliberately renewing the curriculum now so that we have it updated and ready in 5 years. The main source of expertise will probably continue to be (following the example of "open science") so-called "open learning materials" (projects, MOOCs...), where individuals can effectively acquire such knowledge. The digital literacy of employees and students is necessary, as well as technological equipment. It should also be noted that there can be differences between EU countries, so each country adapts the planning and implementation of change to its own situation, strategy is key. We must not forget the competences of teachers who need to be able to teach new contents. We believe that MOOCs and learning content from projects could play an important role here. This concerns especially the teachers of VET, as we believe that HE teachers should be ahead

of the current state of the economy and companies already. At the very least, we believe that collaboration between VET and HE is crucial, e.g., working together on projects where knowledge can be transferred in both directions.

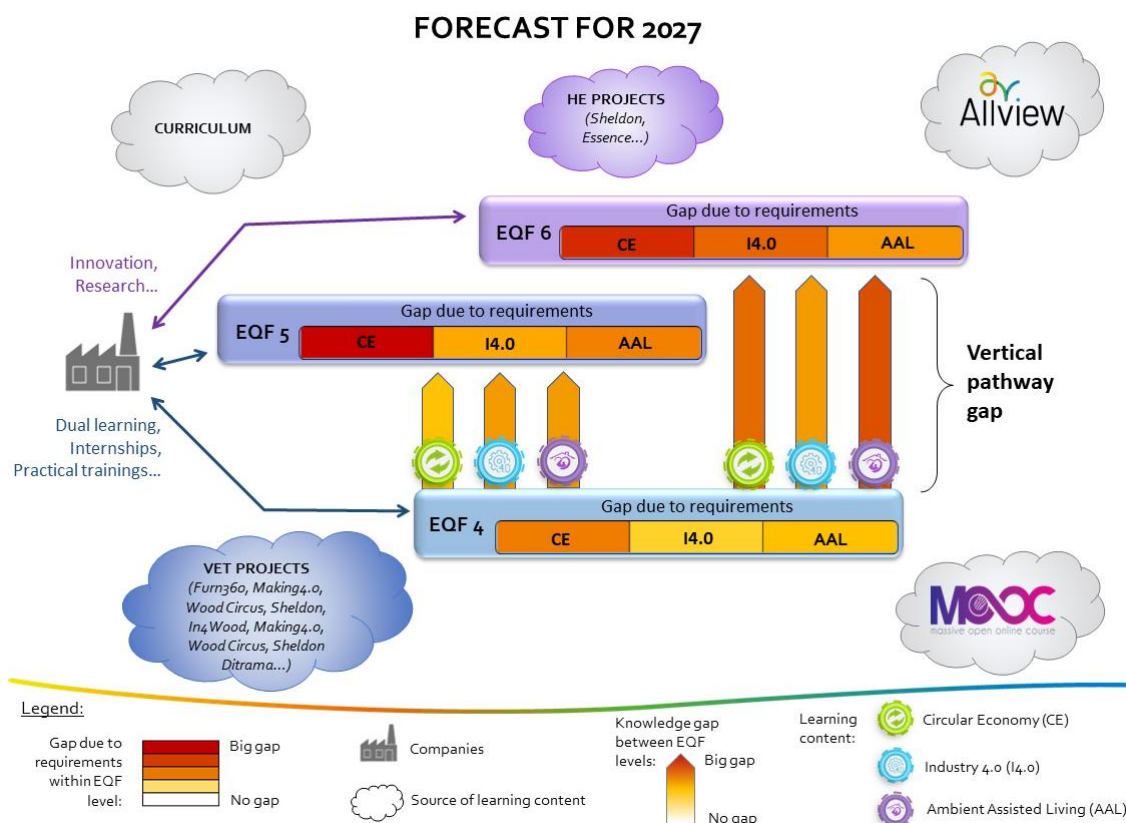


Figure 25: Model for integrating learning content, concepts, and curricula at all levels of education in the wood and furniture sector – in 5-years' time (2027)

The above model represents the dynamics of a constantly changing process that, as we have already said, differs in certain values between countries/companies/institutions and therefore the strategies and responses to the situation can be different. This is especially true for national frameworks of formal education and the offerings of specific open learning courses. However, there are also many commonalities between the countries involved in the project. The most important thing that needs to be done at the EU level is to establish guidelines for the integration of modern/trendy content into formal education frameworks. EQF 5 is a particularly urgent issue, as the research has shown competences (in our case: CE, I4.0 and AAL) are not significantly upgraded from EQF 4 to EQF 5. This could mean that the EQF puts more emphasis on other competencies (soft skills, etc.), which is not necessarily a bad thing. The fact is that EQF 5 graduates are mainly practice-oriented professionals who do not have a direct opportunity for further formal education, as they are not properly placed in the vertical of education but are somewhere on the fringe and do not have much more in-depth content compared to EQF 4.

Our research focused mainly on CE, I4.0 and AAL, which does not mean that other competencies are not relevant for students in W&F related courses. For optimal curriculum renewal, all competencies should be considered and compared, as this is the only way to determine the realistic importance of the topics. The current level of knowledge identified in our study is the average of

the participating EU countries, which means that some countries are above and some below the average. We were unable to highlight any country in particular due to insufficient numbers of participants in each country. Further research should be conducted at the country level and based on the individual educational programs in the country, as programs within the same EQF level do not offer the same competencies (for good reason). Finally, our results can serve as a basis for further research and the requirements and opinions of companies and experts can be directly considered. The expected level of knowledge of graduates of certain education levels can serve as a reference point for each program in the W&F sector to see whether it meets the "requirements".

4

Conclusions

4. Conclusions

We can conclude that the current expectations regarding the level of knowledge on the topics CE, I4.0 and AAL are met in EQF 4 and no major changes are needed as the level of knowledge on some topics exceeds the current expectations and needs. The largest knowledge gaps were found in EQF 5, especially in the topics CE and AAL, and in EQF 6 the current knowledge requirements are not met, especially in the topics from I4.0, as the expectations for these graduates are high. If the level of knowledge remains the same, the gaps will increase in the near future (in 5 years...) at all levels of education, as these topics seem to become more important and more knowledge is expected from all graduates. The knowledge gaps will increase especially in CE, as companies and experts consider this area to be particularly important in the near future.

The importance of each area for further economic, political and technological development is also closely related to skills gaps. Both companies and experts considered certain skills more important than others and emphasized that competent personnel and sufficient government funding are important for the successful introduction of new concepts in companies' operations. Vocational education (EQF 4 and 5) requires ensuring general knowledge and technical skills related to the use of tools/machinery, and higher education (EQF 6) requires more advanced skills in all respects other than the basics. One of the possible solutions is to develop modular and thus flexible wood/furniture VET /HE degree programs that would allow for more talent-oriented training and lead to mixed profiles such as 'IT -carpenters', 'sales carpenters', 'circular carpenter', etc. These would have better interface skills with other disciplines and could therefore fill competence gaps in I4.0, CE, AAL. Such interface skills are very often missing and often have to be trained 'on the job' in the companies. On the other hand, smaller companies cannot afford specialists and these skills can be acquired through open-source training (MOOCs and content developed by projects).

Company management must create the conditions, have a plan and provide resources for lifelong learning to take place. Lifelong learning should incorporate the latest R&D insights and include collaboration between education providers and companies that are pioneers in I4.0 and CE. Companies are willing to collaborate more with educational institutions and should be involved in curriculum design. They work with students mainly through internships and student visits, but do not participate enough in student project work and dual training. There is room for improvement here.

Knowledge gaps both within and between educational levels are shown in the model for integrating learning content, concepts and curricula at all educational levels in the wood and furniture sector. The main sources to fill the current gaps are mainly freely available (open source) learning materials developed under other content-oriented EU projects and other freely available MOOCs. This learning content is usually in English and not available in all EU languages, which can be a barrier. To close the gaps in the long term, we need to update curricula at all levels of education.

The current state of knowledge from CE, I4.0 and AAL shows that the existing curricula at each educational level (EQF 4, 5 and 6) have different knowledge gaps. The identified current knowledge level is the average of the participating EU countries, which means that some countries are above and some are below the average. We were not able to highlight any country in particular due to

insufficient numbers of participants in each country. However, the differences between countries make it necessary for each country to adapt the planning and implementation of changes to its own situation.

As our research focused mainly on CE, I4.o and AAL, it does not mean that other competencies are not relevant for students in W&F-related courses. For optimal curriculum renewal, all competencies should be considered and compared, as this is the only way to determine the realistic relevance of the topics for a given profession. The curriculum between EU countries for the same profession at the same EQF level should be as uniform as possible. A common basis should be found for this, but further research on updating the curriculum should be carried out at country level and focus on the requirements of the sectors in that country.

An important part of upgrading curricula with new content is to educate teachers, and MOOCs and learning content-oriented EU projects could play an important role in this. At the very least, collaboration between VET and HE is crucial, such as joint work on projects where knowledge can be transferred in both directions.

In addition to MOOCs and learning content from other specialised projects, the Allview project (Tasks 2.3, 2.4 and WP3) is a major contributor to the learning content of CE, I4.o and AAL, which is also translated into several languages (Slovenian, Dutch, Italian, Spanish, German, Polish and French) and is available on the ALLVIEW training platform. However, the main contribution of the Allview project will be the smart platform developed in WP1, which will serve as a portal to make this scattered learning content accessible in one place.

The model for integrating all levels of education considers the dynamics of change and provides for local characteristics in countries and their specific responses (e.g., developing national frameworks for formal education and providing open learning courses in native languages). Joint activities at the EU level are also envisaged (e.g. the creation of guidelines for the integration of modern/trendy content in formal education frameworks, solutions to the EQF 5 problem, government support for companies and educational institutions, etc.).

5

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6. Annex

Annex A: Survey questionnaire for teachers in vocational education (VET)

Introduction

ALLVIEW is an amazing European project that gathers 22 partners from 8 different countries, to create a European platform that will encourage all actors dedicated to training in the wood and furniture sector to work together. With this survey we explore to what extent in vocational and higher education in wood and furniture sector learners acquire competences in the field of Industry 4.0, circular economy and in the field of active and assisted living and prepare a strategy to integrate these contents at specific training levels.

The survey is not anonymous, as it is important for the research to link the mentioned concepts to specific topic conducted at the Higher and Vocational education.

Your participation is critical to the survey, so I really urge you to complete it. The survey will not take you much time. Thank you very much for your cooperation.

Meaning of terms:

* Industry 4.0 - According to the World Economic Forum which coined the phrase, it is one of "cyber-physical systems" – that is, the merging of the capabilities of both human and machine. This is the era of artificial intelligence, genome editing, biometrics, renewable energy, 3D printing, autonomous vehicles, the Internet of Things and augmented, virtual and mixed reality (XR). Instead of technology being the thing we use that changes us, it will now be truly embedded in our lives and bodies.

* Circular economy - It is based on the concept of a positive material cycle, which focuses on the reuse, repair and recycling of existing materials and products. With the working concept of "closing the loop", we can turn one industry's waste into another's material source, reducing the amount of waste sent to landfills or to be incinerated. Conceptualizing and thinking in terms of the circular economy starts at the very beginning of the product life cycle; smart product design and selection of production processes that can help save resources and enable efficient waste management while creating new business opportunities.

* Active and Assisted Living' - It refers to the use of new technologies (ICT), to create a supportive and inclusive environment that enables older and disabled people to live independently and actively integrate into society.

Sources of the terms:

<https://www.digitalpulse.pwc.com.au/fourth-industrial-revolution-guide/>

<https://celkrog.si/kljucni-pojmi/krožno-gospodarstvo/?lang=en>

<https://www.aal-europe.eu/about/>

Q1 Hard reminder

Name and surname

Q2 Soft reminder

E-mail

Q3 Soft reminder

What subjects do you teach in wood and furniture study programs?

Q4

[Soft reminder](#)

What content and to what extent do you teach about the topic of circular economy in your subjects in the individual wood and furniture study programs?

1: I am not including it. 2: I am including it partially 3: I am fully including it

	Secondary vocational education (EQF 4)			Secondary professional education (EQF 4)			Higher professional education (EQF 5)		
	1	2	3	1	2	3	1	2	3
Eco Design	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cascading use	☐	☐	☐	☐	☐	☐	☐	☐	☐
Natural resource management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Renewable energy sources	☐	☐	☐	☐	☐	☐	☐	☐	☐
Efficient and sustainable production	☐	☐	☐	☐	☐	☐	☐	☐	☐
Environmental effects	☐	☐	☐	☐	☐	☐	☐	☐	☐
Circular business models	☐	☐	☐	☐	☐	☐	☐	☐	☐
Industrial symbiosis	☐	☐	☐	☐	☐	☐	☐	☐	☐
Biotechnology	☐	☐	☐	☐	☐	☐	☐	☐	☐
Systemic thinking	☐	☐	☐	☐	☐	☐	☐	☐	☐
Waste to energy	☐	☐	☐	☐	☐	☐	☐	☐	☐
Biorefinery	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green chemicals	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bioeconomy	☐	☐	☐	☐	☐	☐	☐	☐	☐
Functional materials (sustainable composites, advanced materials)	☐	☐	☐	☐	☐	☐	☐	☐	☐
LCA analysis	☐	☐	☐	☐	☐	☐	☐	☐	☐
Collection and recycling	☐	☐	☐	☐	☐	☐	☐	☐	☐
Transparency in supply chains	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hazardous chemicals	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green public procurement	☐	☐	☐	☐	☐	☐	☐	☐	☐
Nano technology	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q8

If the above question does not specify any content from the field of circular economy that you are teaching, please write it here.

It can also be any other content that is directly or indirectly related to this topic.

Enter the text

Q9 [Soft reminder](#)

Which industry 4.0 concepts do you use or deal with in the implementation of pedagogical processes?

1: I have nothing to do with the concept 2: I use the concept minimally 3: I use the concept often.

	Secondary vocational education (EQF 4)			Secondary professional education (EQF 4)			Higher professional education (EQF 5)		
	1	2	3	1	2	3	1	2	3
Cross Reality (VR, AR, MR)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cloud computing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Online security	☐	☐	☐	☐	☐	☐	☐	☐	☐
Internet of things - IoT	☐	☐	☐	☐	☐	☐	☐	☐	☐
Simulations	☐	☐	☐	☐	☐	☐	☐	☐	☐
Autonomous (smart) robots	☐	☐	☐	☐	☐	☐	☐	☐	☐
Big data	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additive production - 3D, 4D printing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Artificial intelligence	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q13

If the above question does not specify any Industry 4.0 concept you are using, please write it here.

These may also be other concepts that are directly or indirectly related to this topic.

Enter the text

Q14 [Soft reminder](#)

What content from the field of Active and Assisted Living do you teach in your subjects in individual wood and furniture study programs?

1: I am not including it. 2: I am including it partially 3: I am fully including it

	Secondary vocational education (EQF 4)			Secondary professional education (EQF 4)			Higher professional education (EQF 5)		
	1	2	3	1	2	3	1	2	3
Smart buildings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Smart furniture	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ergonomic interior design	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sensors	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fire and other safety	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q18

If the above question does not specify any content from Active and Assisted Living topic that you are teaching, please write it here.

A

This can be any content that helps create a safe living environment that allows a person to remain independent and socially active for as long as possible.

Enter the text

Q19

Soft reminder

Please evaluate the following statements.

	I have no opinion	I disagree	I partly agree	I agree	I totally agree
Integrating industry 4.0 concepts into the learning process is important.	☐	☐	☐	☐	☐
Industry 4.0 content can be linked to the existing content of my subjects.	☐	☐	☐	☐	☐
I use Industry 4.0 concepts usefully and effectively in the implementation of the subjects I teach.	☐	☐	☐	☐	☐
The integration of the concepts and contents of the circular economy into the learning process is important.	☐	☐	☐	☐	☐
The areas and contents of the circular economy can be linked to the contents of my subjects.	☐	☐	☐	☐	☐
Integrating Active and Assisted Living concepts and content into the learning process is important.	☐	☐	☐	☐	☐
Active and Assisted Living content can be included and linked to the content of my subjects.	☐	☐	☐	☐	☐
All of these competencies are important for students in Secondary vocational education.	☐	☐	☐	☐	☐
All of these competencies are important for students in Secondary professional education.	☐	☐	☐	☐	☐
All of these competencies are important for students in Higher professional education.	☐	☐	☐	☐	☐
Students of wood and furniture programs do not need the competencies of the mentioned contents.	☐	☐	☐	☐	☐

Q20

Soft reminder

What would be the appropriateness of including the mentioned contents in study programs or in the subjects you teach?

	Inappropriate	Less appropriate	Appropriate	More appropriate	Very appropriate
At regular subjects	☐	☐	☐	☐	☐
With elective specialised subjects	☐	☐	☐	☐	☐
With project assignments or seminars	☐	☐	☐	☐	☐
With lectures by guest lecturers	☐	☐	☐	☐	☐
With excursions	☐	☐	☐	☐	☐

Q21

Would you include the mentioned contents in any other way that is not listed above?

Enter the text

Q22

Please indicate if you have any comments, suggestions or opinions on the above topics / questions.

Enter the text

Thank you page

Thank you

You have finished the survey. Thank you.

Annex B: Survey questionnaire for teachers in higher education (HE)

Introduction

ALLVIEW is an amazing European project that gathers 22 partners from 8 different countries, to create a European platform that will encourage all actors dedicated to training in the wood and furniture sector to work together. With this survey we explore to what extent in vocational and higher education in wood and furniture sector learners acquire competences in the field of Industry 4.0, circular economy and in the field of active and assisted living and prepare a strategy to integrate these contents at specific training levels.

The survey is not anonymous, as it is important for the research to link the mentioned concepts to specific topic conducted at the Higher and Vocational education.

Your participation is critical to the survey, so I really urge you to complete it. The survey will not take you much time. Thank you very much for your cooperation.

Meaning of terms:

* Industry 4.0 - According to the World Economic Forum which coined the phrase, it is one of "cyber-physical systems" – that is, the merging of the capabilities of both human and machine. This is the era of artificial intelligence, genome editing, biometrics, renewable energy, 3D printing, autonomous vehicles, the Internet of Things and augmented, virtual and mixed reality (XR). Instead of technology being the thing we use that changes us, it will now be truly embedded in our lives and bodies.

* Circular economy - It is based on the concept of a positive material cycle, which focuses on the reuse, repair and recycling of existing materials and products. With the working concept of "closing the loop", we can turn one industry's waste into another's material source, reducing the amount of waste sent to landfills or to be incinerated. Conceptualizing and thinking in terms of the circular economy starts at the very beginning of the product life cycle; smart product design and selection of production processes that can help save resources and enable efficient waste management while creating new business opportunities.

* Active and Assisted Living' - It refers to the use of new technologies (ICT), to create a supportive and inclusive environment that enables older and disabled people to live independently and actively integrate into society.

Sources:

<https://www.digitalpulse.pwc.com.au/fourth-industrial-revolution-guide/>

<https://celkrog.si/kljucni-pojmi/krožno-gospodarstvo/?lang=en>

<https://www.aal-europe.eu/about/>

Q1

Hard reminder

Name and surname

Enter the text

Q2

Hard reminder

E-mail

Enter the text

Q3

Hard reminder

What subjects do you teach in wood and furniture study programs?

Enter the text

Q4

Hard reminder

What content and to what extent do you teach about the topic of circular economy in your subjects in the individual wood and furniture study programs?

1: I am not including it. 2: I am including it partially. 3: I am fully including it

	Bachelor's Degree (EQF 6)			Master's Degree (EQF 7)			Doctorate Degree (EQF 8)		
	1	2	3	1	2	3	1	2	3
Eco Design	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cascading use	☐	☐	☐	☐	☐	☐	☐	☐	☐
Natural resource management	☐	☐	☐	☐	☐	☐	☐	☐	☐
Renewable energy sources	☐	☐	☐	☐	☐	☐	☐	☐	☐
Efficient and sustainable production	☐	☐	☐	☐	☐	☐	☐	☐	☐
Environmental effects	☐	☐	☐	☐	☐	☐	☐	☐	☐
Circular business models	☐	☐	☐	☐	☐	☐	☐	☐	☐
Industrial symbiosis	☐	☐	☐	☐	☐	☐	☐	☐	☐
Biotechnology	☐	☐	☐	☐	☐	☐	☐	☐	☐
Systemic thinking	☐	☐	☐	☐	☐	☐	☐	☐	☐
Waste to energy	☐	☐	☐	☐	☐	☐	☐	☐	☐
Biorefinery	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green chemicals	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bioeconomy	☐	☐	☐	☐	☐	☐	☐	☐	☐
Functional materials (sustainable composites, advanced materials)	☐	☐	☐	☐	☐	☐	☐	☐	☐
LCA analysis	☐	☐	☐	☐	☐	☐	☐	☐	☐
Collection and recycling	☐	☐	☐	☐	☐	☐	☐	☐	☐
Transparency in supply chains	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hazardous chemicals	☐	☐	☐	☐	☐	☐	☐	☐	☐
Green public procurement	☐	☐	☐	☐	☐	☐	☐	☐	☐
Nano technology	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q8

If the above question does not specify any content from the field of circular economy you are dealing with, please write it here.

It can also be any other content that is directly or indirectly related to this topic.

Enter the text

Q9

Hard reminder

Which industry 4.0 concepts do you use or deal with in the implementation of pedagogical processes?

1: I have nothing to do with the concept 2: I use the concept minimally 3: I use the concept often.

	Bachelor's Degree (EQF 6)			Master's Degree (EQF 7)			Doctorate Degree (EQF 8)		
	1	2	3	1	2	3	1	2	3
Cross Reality (VR, AR, MR)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cloud computing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Online security	☐	☐	☐	☐	☐	☐	☐	☐	☐
Internet of things - IoT	☐	☐	☐	☐	☐	☐	☐	☐	☐
Simulations	☐	☐	☐	☐	☐	☐	☐	☐	☐
Autonomous (smart) robots	☐	☐	☐	☐	☐	☐	☐	☐	☐
Big data	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additive production - 3D, 4D printing	☐	☐	☐	☐	☐	☐	☐	☐	☐
Artificial intelligence	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q13

If the above question does not specify any Industry 4.0 concept you are using, please write it here.

These may also be other concepts that are directly or indirectly related to this topic.

Enter the text

Q14

Hard reminder

What content from the field of Active and Assisted Living do you teach in your subjects in individual wood and furniture study programs?

1: I am not including it. 2: I am including it partially 3: I am fully including it

	Bachelor's Degree (EQF 6)			Master's Degree (EQF 7)			Doctorate Degree (EQF 8)		
	1	2	3	1	2	3	1	2	3
Smart buildings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Smart furniture	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ergonomic interior design	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sensors	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fire and other safety	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q18

If the above question does not specify any content from Active and Assisted Living topic that you are teaching, please write it here.

This can be any content that helps create a safe living environment that allows a person to remain independent and socially active for as long as possible.

Enter the text

Q19

Hard reminder

Please evaluate the following statements.

	I have no opinion	I disagree	I partly agree	I agree	I totally agree
Integrating industry 4.0 concepts into the learning process is important.	☐	☐	☐	☐	☐
Industry 4.0 content can be linked to the existing content of my subjects.	☐	☐	☐	☐	☐
I use Industry 4.0 concepts usefully and effectively in the implementation of the subjects I teach.	☐	☐	☐	☐	☐
The integration of the concepts and contents of the circular economy into the learning process is important.	☐	☐	☐	☐	☐
The areas and contents of the circular economy can be linked to the contents of my subjects.	☐	☐	☐	☐	☐
Integrating Active and Assisted Living concepts and content into the learning process is important.	☐	☐	☐	☐	☐
Active and Assisted Living content can be included and linked to the content of my subjects.	☐	☐	☐	☐	☐
Students' prior knowledge is important in these areas.	☐	☐	☐	☐	☐
All of these competencies are important for Bachelor's graduates.	☐	☐	☐	☐	☐
All of these competencies are important for Master's graduates.	☐	☐	☐	☐	☐
All of these competencies are important for Doctoral graduates.	☐	☐	☐	☐	☐
Students of wood and furniture programs do not need the competencies of the mentioned contents.	☐	☐	☐	☐	☐

Q20

Hard reminder

What would be the appropriateness of including the mentioned contents in study programs or in the subjects you teach?

	Inappropriate	Less appropriate	Appropriate	More appropriate	Very appropriate
At regular subjects	☐	☐	☐	☐	☐
With elective specialised subjects	☐	☐	☐	☐	☐
With project assignments or seminars	☐	☐	☐	☐	☐
With lectures by guest lecturers	☐	☐	☐	☐	☐
With excursions	☐	☐	☐	☐	☐

Q21

Would you include the mentioned contents in any other way that is not listed above?

Enter the text

Q22

Please indicate if you have any comments, suggestions or opinions on the above topics / questions.

Enter the text

Thank you page

Thank you

You have finished the survey. Thank you.

Annex C: Interview questionnaire for companies in wood and furniture (W&F) sector

Name of the company:			
Activity of the company:	C16 – process of wood (manufacture of wood and products of wood and cork)	C31 - manufacture of furniture	Other
Size of the company (number of employees):	Micro (1 - 9)	Medium (50 - 249)	
	Small (10 - 49)	Large (250 ≤)	
e-mail of contact person:			

1. Approximately how many employees does your company have by main occupations?

Main occupations	Number of employees
Manufacturing labourer's	
Machine operators	
Technicians	
Engineers	
Managers	
Others:	

2. Are you planning to employ new staff from the field of wood and furniture educational background in the next 6 months?

- Yes
- No

- If »Yes«, which occupation?

Main occupation	Approximate number of new employees in the next 6 months
Manufacturing labourer's	
Machine operators	
Technicians	
Engineers	
Managers	
Others:	

- If »No«, are you planning to employ from any other field of education, which one?

3. What sources do you use when looking for new employees?

- Public Employment services
- Advertisement in newspapers (+ local, regional, national?)
- Social media (+ which one: LinkedIn, Facebook, Instagram, Twitter...?)
- Portal for jobseekers (+ which one)
- Personal contacts
- Other: _____

- Which one is the most useful for your company?

- Public Employment services
- Advertisement in newspapers (+ local, regional, national?)
- Social media (+ which one: LinkedIn, Facebook, Instagram, Twitter...?)
- Portal for jobseekers (+ which one)
- Personal contacts
- Other: _____

4. Do you have trouble finding competent staff for your company?

- Yes
- No

- If »Yes«, indicate for which staff:

- Manufacturing labourer's
- Machine operators
- Technicians
- Engineers
- Managers
- Other: _____

5. What are 3-5 most important occupational competences (skills, knowledge, attitudes...) new employee in your company should have?

- 1.
- 2.
- 3.
- 4.
- 5.

6. What occupational competences (skills, knowledge, attitudes...) newly graduates from the field of wood and furniture education on the labour market and current employees in your company are missing?

Main occupation	Missing competences	
	Newly graduates on the labour market	Current employees in your company
Manufacturing labourer's		
Machine operators		
Technicians		
Engineers		
Managers		
Others:		
Others:		

7. Do you think it is important, that your employees have competences from area of Circular Economy?

- Yes, all employees
- Yes, but just some employees
- No

- Is there any specific topic from this area that you think it is important for certain occupations?

Topics of Circular Economy					
	Manufacturing labourer's	Machine operators	Technicians	Engineers	Managers
Waste management					
Biodiversity					
Big picture of Circular Economy,					
Eco design					

Regulations on CE					
Reuse (take back programs for furniture, mattresses...)					
Other					

8. How impactful do you think area of Circular Economy and Industry 4.0 will be 5, 10 years from now for your company? Please rate the importance in the next 5 and 10 years.

Indicate on the scale from 1 to 5:

- 1- Not at all impactful
- 2- Slightly Impactful
- 3- Moderately Impactful
- 4- Very Impactful
- 5- Extremely Impactful

	Number of years from now									
	5 years from now					10 years from now				
Importance	1	2	3	4	5	1	2	3	4	5
Circular economy										
Industry 4.0										

9. Which concepts / tools from Industry 4.0 do you use in your company?

Industry 4.0 concepts and tools	Which concepts / tools from Industry 4.0 do you use in your company?
AR / VR	
3D printing	
Simulations	
Internet of things and Industrial Internet of Things (IoT, IIoT)	
Smart robots / Cobots	
Artificial intelligence / Machine learning	

10. Do you think it is important, that your employees have competences from area of Industry 4.0?

- Yes
- No

- If »Yes«, which one?

Industry 4.0 concepts and tools	Which concepts / tools from Industry 4.0 are important for your employees now and in the future?
AR / VR	
3D printing	
Simulations	
Internet of things and Industrial Internet of Things (IoT, IIoT)	
Smart robots / Cobots	
Artificial intelligence / Machine learning	
Other:	

11. Would you encourage your employees to learn about Circular economy and Industry 4.0?

- Yes, all of them.
- Yes, but only some of them. Which one? (Manufacturing labourer's, Machine operators, Technicians, Engineers, Managers)?
- No

- How do you train your labour force?

- On the job by own instructors
- Through machine distributors/manufacturers
- In collaboration with private training institutes
- In collaboration with public training institutes (PES, schools...)
- Through online courses
- Other: _____

12. Do you think cooperation between companies and educational institutions in the wood and furniture sector is satisfying enough in your country?

	Cooperation between companies and educational institutions
Not at all satisfied	
Slightly satisfied	
Moderately satisfied	
Very satisfied	
Completely satisfied	

13. Does your company cooperate with students?

- Yes
- No

- If »Yes«, how does your company cooperate with students (multiple answers)?

- Student's project work
- Internships
- Dual training
- Company visits
- Presentation of the company at the schools / educational institutes
- Other: _____

14. Do you have any suggestions how to improve labour force trainings?

15. Any other suggestions, comments...

Annex D: Interview questionnaire for experts in fields of industry 4.0 (I4.0)

Theme 1: Industry 4.0 – For experts in the field who are also lecturers

- 1.1. How do you understand the concept(s) of Industry 4.0?
- 1.2. Would adoption of these technology and concepts make companies overall more competitive?
- 1.3. How do you think companies in wood and furniture sector could be more competitive by applying Industry 4.0?
- 1.4. Is there any specific company in wood and furniture or other sector that is example of best practice? Could you please describe some of them? Is there any specific country that stands out in this area?
- 1.5. Do you think companies in EU are competitive compared to companies globally (US, Japan, China...)? What about production companies, like wood and furniture companies?
- 1.6. What are the advantages of digitalization and what are its benefits for the companies?
- 1.7. Are wood and furniture companies (note company size) prepared for adoption of all industry 4.0 technologies and concepts (digital index), which? What are the biggest obstacles?
- 1.8. Which digital technologies are more important for business success and why?
- 1.9. Who should company address to help them implement digital transformation (support systems available, governance...)?
- 1.10. What level (basic, in-depth, advanced) and which Industry 4.0 competences should employees in wood and furniture sector have and how do they differ according to occupation?
- 1.11. Which competences from area of Industry 4.0 are currently important for newly graduates and how do they differ according to EQF level? Do you think there are gaps between levels of education, which?
- 2.1. Which competences from area of Industry 4.0 will be important for newly graduates in 5 and 10 years? How will it affect labour market?
- 1.12. How to ensure lifelong learning of employees and what approach for this field (Industry 4.0) would you suggest?

Annex E: Interview questionnaire for experts in fields of circular economy (CE)

Theme 2: Circular Economy – For experts on the field

- 2.1. How do you understand the concept of Circular Economy?
- 2.2. Do you think companies in wood and furniture sector from EU and your country are ecologically aware? To what degree, do they meet certain standards? Which standards of Circular Economy are significant in this context?
- 2.3. How are companies in wood and furniture sector ecologically aware comparing to other sectors?
- 2.4. Is there any specific company in wood and furniture or other sector that is example of best practice? Could you please describe some of them? Is there any specific country that stands out in this area?
- 2.5. What are the biggest obstacles for companies in wood and furniture sector in adoption of circular economy concepts and why?
- 2.6. What are the benefits for companies if they become more circular?
- 2.7. How should companies become more circular and approach to transformation of their business model (any existing support systems, governance). How does digitalization help circular economy?
- 2.8. What level (basic, in-depth, advanced) and which circular economy competences should employees in wood and furniture sector have and how do they differ according to occupation?
- 2.9. Which competences from area of Circular economy are currently important for newly graduates and how do they differ according to EQF level? Do you think there are gaps between levels of education, which?
- 2.10. Which competences from area of Circular economy will be important for newly graduates in 5 and 10 years? How will it affect labour market?
- 2.11. How to ensure lifelong learning of employees and what approach for this field would you suggest?

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Co-funded by the
Erasmus+ Programme
of the European Union

