Improving Malaysian HE Knowledge Towards a Wood and Furniture Industry 4.0

making 4.0
IN MALAYSIAN WOOD & FURNITURE INDUSTRY

Deliverable 1.2

Report of gaps and needs of the Malaysian HE and Industry in comparison with Europe

Prepared	Verified	Approved
UPCT-UPM	**All**	**All consortium**

Dissemination level: National / International

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1. Introduction

This document reports the results performed in **WP1** "Analysis and comparison of the current HE training offer and furniture and woodworking industry" regarding task **T1.4: "**Compare and identify gaps and needs between Malaysian and European situations". This task has been executed thanks to the results obtained from the work performed in tasks **T1.1**, **T1.2** and **T1.3.** The work done in the former was summarized in outcomes **O1.1** and **O.1.3,** while the two latter were compiled in two internal reports.

In tasks **T1.2** and **T1.3,** UPCT and UPM, together with the support of the whole consortium and associated partners, performed the analysis about the lack, need and request of competences and skills with specific attention to the Key Enabling Technologies (hereinafter, KETs) of Industry 4.0 (hereinafter, I4.0) in the European and Asian Higher Education (HE) and in the wood and furniture sector all over Asia and Europe, as well as the level of implementation in the industry of last technological trends.

The compiled data have been analysed in this report to offer a comprehensive view of the current competences and qualifications in furniture and woodworking training offered by European and Malaysian universities and compare these with European and Malaysian industry requirements. The analysis remarks the similarities and differences between both regions (Malaysia and Europe) are identified as well as the current gaps in Malaysia HE offer and the needs that the manufacturing wood and furniture industry have to cover in following years. Such information is needed to prepare a more contemporary training path (**WP2**) and learning content (**WP3**), incorporating I4.0 assumptions, supporting competitiveness and employment in the sector.

With this work we have achieved **Milestone 1**: "Analysis of collected information". Moreover, this work is also linked to specific project objective **SO1**: "Define how the HE offer for future workers of the Malaysian wood industry could be improved in comparison with the current HE offer and the technologies already implemented in Asia".

The results of this report are critical for the correct implementation of the project, not only because they are directly related with the definition of the Joint Curriculum MAKING4.0, scheduled in **WP2**, but also with the learning outcomes which have to be defined in **WP3**.

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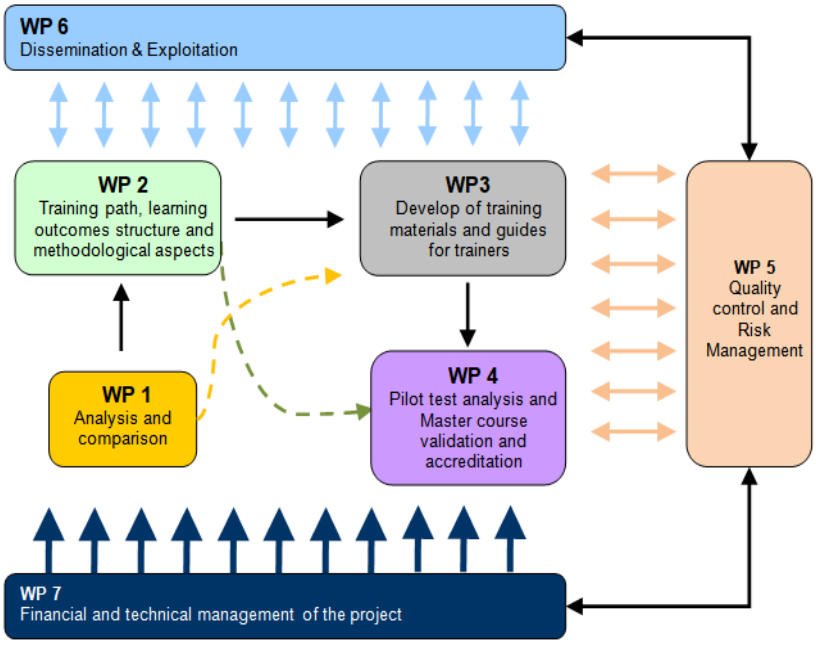

Figure 1 MAKING 4.0 work packages relation

The results of this report will be presented during the 2nd Consortium Meeting, scheduled in Poland in the first week of July 2019. Different events have been scheduled, which will be reported in **O1.4,** ending **WP1.**

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2. Industry 4.0 in Malaysia and EU at a glance

2.1 Malaysia

In the past 40 years, Asia has become one of the world's most important regions for industrial manufacturing. This development started with comparatively simple manufacturing processes. The combination of know-how, speed and a high degree of adaptability is the outstanding characteristic of the successful industries in Asia. But this success can continue only if Asia adapts their manufacturing process, industry, job profiles and skills of workers to the emerging I4.0.

I4.0 means new players and new business models, while others will most probably disappear. The adoption of I4.0 cannot be tackled by companies alone. Therefore, Governments and Universities play an important role at the hour to introduce new skills and competences in I4.0.

Many countries around the world recognize the importance of the transformation of the manufacturing industry to their industrial future state. Hence, they (including a few Asian countries) have launched I4.0 related policies and programme to support the research, development and deployment of I4.0 technologies and processes at their local manufacturers [1].

On this matter, in Malaysia, the Government has launched different strategies to deal with the deep change behind the adoption of Industry 4.0:

- The Malaysia Education Blueprint 2015-2025 [3]
- The National Policy on Industry 4.0, so-called Industry4WRD [2]

In the former, the Ministry of Education in Malaysia proposes major reforms to the whole Malaysian Educational System, but emphasizing the HE in order to accelerate the positive upward trajectory of the system, built on five aspirations: access, quality, equity, unity, and efficiency.

In the latter, different shifts are defined, and a set of strategies are point out to adapt Malaysia to I4.0. Focused on education, skills and competences to be prepared as competitiveness workers, the Industry4WRD points out:

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- Shift: to solve the mismatch in the supply and demand of graduates, with employers reporting that graduates lack the requisite knowledge, skills and attitudes.
- Strategy: to enhance the student learning experience by expanding industry collaboration in the design and delivery of programmes.
- Shift: to foster the Quality Technical and Vocational Education and Training (TVET) graduates provided by Universities.
- Strategy: to intensify industry involvement enabling it to lead curriculum design and delivery through new partnership models

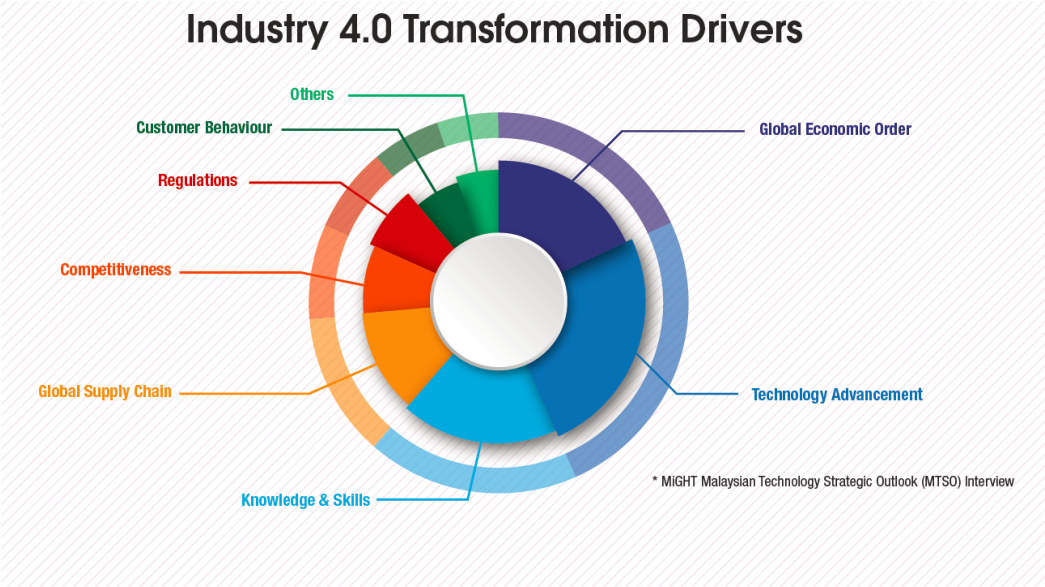

Figure 2 Industry 4.0 transformation drivers detected in Malaysia [2]

Concretely, the Ministry of Education and the Ministry of Human Resources of Malaysia lead two strategies:

- To enhance capabilities of existing workforce through national development programmes specially designed for specific manufacturing sectors and support reskilling and upskilling
- To ensure the availability of future talent by equipping students with the necessary skillsets to work in the Industry 4.0 environment

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Other goals are related to foster the lifelong learning in supporting the professional development of all Malaysians, facilitate the development of innovation ecosystems in selected strategic areas that are critical to the economic growth, and expand their international recognition.

Regarding woodworking and furniture sector, it is needed to remark that it is one of the major contributors to the Malaysian economy, with about 300,000 workers and nearly €4.0bn of exports. The furniture sector has quadrupled its export values since 1995. In 2017 Malaysia was ranked as the 9th World country in furniture exports and 17th in production, regarding the World Furniture Outlook 2017/2018 published by Csil [4]. Thus, the Ministry of Plantation Industries and Commodities in collaboration with the Malaysian Timber Industry Board (MTIB) launched the National Timber Industry Policy 2009-2020 (NATIP) [5]. The NATIP established the innovation and technology, and the human capital development, among others, as main challenges of the industry. It is estimated that at least 9.810 workers will need to be trained annually, 3.450 only in the furniture sector and 3.600 in the panel production.

The NATIP pointed that there is a need to strengthen the competence and knowledge to embrace cutting edge technologies and higher value-added manufacturing activities and highlights in the page 86 that “a number of universities and polytechnics including UPM, UiTM, USM and UMS provide management level training for the timber industry. The graduates from these institutions, however, either do not seek employment in the timber industry or do not have the skills required by the timber industry. Hence, there is a need for these institutions to review their training syllabus to match the requirements of the industry.

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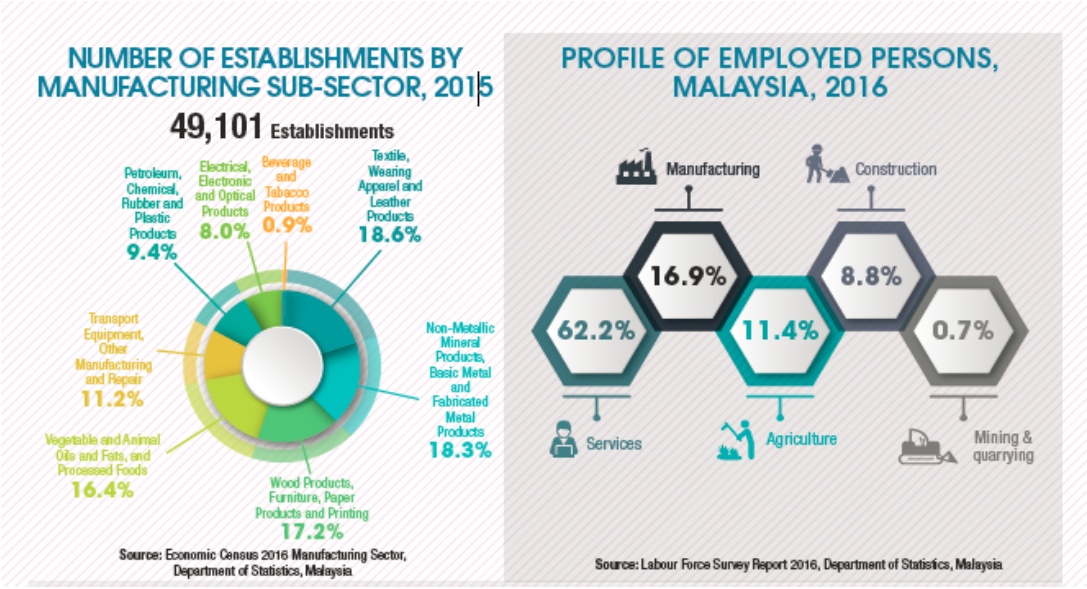

Figure 3 Manufacturing sector analysis, performed by Department of Statistics, Malaysia [2]

Similarly, the Academy of Sciences Malaysia in its Mega Science 3.0 report dedicated to the furniture industry sector [6], highlights that "changes in education and training are required to equip the future workforce with new skills required in the future"

Moreover, the white paper "Is Malaysia ready for industry4.0?" [7] points out that human resources are one of the most important challenges in the manufacturing sector for upgrade it.

As such, it is imperative for Malaysia to transform itself at an accelerated pace and embrace I4.0 as a critical cornerstone to propel and sustain its future manufacturing competitiveness. Indystry4WRD remarks that Malaysia has to pay specifically attention to four overarching goals:

- Drive continuous growth in manufacturing GDP
- Increase national productivity
- Create higher skill employment opportunities
- Raise innovation capabilities and competitiveness

The conclusions of the National Policy in Malaysia are that a qualified and skilled workforce is indispensable for the introduction and adoption of I4.0. The technical

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knowledge required is high, and will be primarily recruited from the STEM (science, technology, engineering and mathematics) subjects. However, for some years the number of STEM graduates in Malaysia has fallen below expectations. Therefore, there is an urgent need to create a skilled and diverse workforce, with high salary, both by upskilling the existing labour pool and by attracting and developing future talent in the manufacturing sector. Particular attention also needs to be given to reskilling and upskilling lesser-skilled workers to other sectors and activities.

In this way, a set of actions are enumerated:

- To create an I4.0 Talent Competency & Technology Mentoring programmes to drive broader workforce development initiatives in line with specific sector requirements
- To establish Skills Certification programmes in I4.0 areas
- To develop tailored training courses for the reskilling of transitioning employees
- **To enhance classroom modules for intensive upskilling programmes by using augmented or virtual reality (AR/VR)**
- To enable the availability of data on I4.0 talent and labour pools for the Government, academia and industry (in order to chart future action plans)
- To boost support for TVET and STEM education programmes, in part by increasing funding for vocational education and training programmes
- To integrate theory and practical I4.0 applications into tertiary education curricula, including structuring industry placement opportunities
- To promote manufacturing as a preferred option for high-skilled jobs to overcome public perception and attract both skilled labour and university graduates
- To enhance and increase the capacity and capability of educators, trainers and instructors in the manufacturing-related education sectors

Most of the actions mentioned above will be addressed in the MAKING 4.0 project, through the development of an innovative Master degree for engineers of furniture smart factories that will modernize HE degrees, by focusing on the ICTs skills needed to increase competitiveness of the wood and furniture industry of Malaysia.

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2.2 Europe

The I4.0 was created and enhanced by Germany in 2010, using the concept as a strategy to improve competitiveness in business production, hardly knocked by those emerging countries with low labour costs. The goal was to offer an innovative industry close to the customers, with customized and turnkey products and solutions and minimizing production and service times [8].

Later, the European Commission (EC) launched different strategies to promote the industrial change, funding in research and infrastructures. Moreover, some of its member countries are working on I4.0 national initiatives, such as "Industria Conectada 4.0" in Spain [9], or "Factory of the Future, (FoF)" in France and Italy [10].

The EC is also driving the deployments of I4.0 in different sectors through the European Technology Platforms (ETPs). This is composed of forums of industry stakeholders, recognized by the EC, which are formed to support the development of innovation agendas and technology roadmaps for several sectors, at national and EU levels. Manufuture, the ETP dedicated to improve the competitiveness of European manufacturing, launched the European Factories of the Future Association (EFFRA), a Public-Private Partnership (PPP) of industrial associations which regularly publishes strategic technology roadmaps that form the basis for research and technology development call topics [11].

Regarding skills and competences of future workers, in 2015 the Association of German Engineers (VDI) and the American Society of Mechanical Engineers (ASME) published the skills and competencies recommended for the qualified worker for the I4.0 [12]. These are summarized in Table I, and are classified with an established priority in "Must", "Should" and "Could"; and, in turn, in technical qualifications and personal skills. In [13] it is also highlighted that the lack of digital skills of employees is one of the challenges to be addressed in the adoption of I4.0.

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	Must...	Should...	Could...
	...be included in the skillset of the skilled labor of the future.		
Technical Q&S	IT knowledge and abilities	Knowledge Management	Computer programming/coding abilities
	Data and information processing and analytics	Interdisciplinary / generic knowledge about technologies and organizations	Specialized knowledge about technologies
	Statistical knowledge	Specialized knowledge of manufacturing activties and processes	Awareness for ergonomics
	Organizational and processual understanding	Awareness for IT security and data protection	Understanding of legal affairs
	Ability to interact with modern interfaces (human-machine / human-robot)		
Personal Q&S	Self- and time management	Trust in new technologies	
	Adaptability and ability to change	Mindset for continuous improvement and lifelong learning	
	Team working abilities		
	Social skills		
	Communication skills		

Figure 4 Qualifications and skills of workers in the factory of the future [13]

There is no doubt that he fast integration of ICTs in all sectors of industry in EU promoted by the adoption of I4.0 is changing the way the European people work, and the skills and competencies required to the workers. ICTs are leading the current economy and the previsions of EC reveal that the future will lead to a fully digitized world, with human capital highly qualified in digital skills. In fact, in Europe the demand of workers with multidisciplinary knowledge and ICT profile increases year by year, while the workers with the required ICT profile is dramatically decreasing. The lack of basic knowledge of ICTs is present in over 30% of EU workers. The EC also predicts alarming data, such as in 2020 the number of uncovered ICT profiles could reach 800,000 positions. There is no doubt that a need for training in ICTs to cover the current and future demand exists, and the adoption of I4.0 will generate the need for specific and qualified training on KET. The change must include challenges such as training workers, updating manager skills and adapting the curricula of VET and HE studies related to ICTs, to create the future workers with the skills required in I4.0.

Some European Projects like IN4WOOD [14], 3D+VET [15] or IMFUTURE 16], funded by the Erasmus + Program of UE, aims to bring this fourth revolution to the specific sector of the wood and furniture industry by developing training courses or training

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materials to support this industrial sector and their manufacturers to understand, deploy and use I4.0 enabling technologies in their own businesses, transforming traditional factories into smart factories, that is, improving the competitiveness of their enterprises. All EU partners of MAKING 4.0 are involved in one of more of these projects.

Other European initiatives are PROVET 4.0 [17], an strategic alliance of three entities focused on the electronics and metalworking industry or SO-SMART [18] and HIGHTECH EUROPE [19], where the goals are not to develop a training course or learning materials of I4.0, but to identify and evaluate those available and future ICT tools to link needs and knowledge, as well as to design knowledge transfer schemes.

European efforts in the adoption of I4.0 and the modernisation of curriculum in VET and HE degrees are not only focused on European countries, but also on other Regions. EC promotes actions in other Regions, like Asia, being a priority in the Erasmus+ call Capacity Building in Higher Education. An example of this support is the MAKING 4.0 project.

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3. Analysis of Malaysian Industry and HE

This section summarizes the results obtained from Task **T1.2**, where the MAKING 4.0 consortium analyses the situation of industry 4.0 skills, knowledge and competences in the Asian HE students, HE program degrees, and in the wood / furniture / habitat industry.

The goal of this analysis is to report the lacking, needed and requested competences and skills with specific attention to the KETs of I4.0 in the Asian HE and in the wood and furniture sector all over Asia, as well as the level of implementation in the industry of last technological trends.

Task **T1.2** has been performed thanks to those results obtained in task **T1.1**, reported in **O1.1**: "Questionnaires or other tools to gather information" and **O1.2**: First contact in situ with Malaysian situation.

This work is also linked to specific project objective **SO1**: Define how the HE offer for future workers of the Malaysian wood industry could be improved in comparison with the current HE offer and the technologies already implemented in Asia. Moreover, this work fulfils the indicator numbers defined in the MAKING 4.0 project:

	Target	Gathered
Responses from Asian industry	60	65
Responses from Asian HE institutions	20	21

Table 1 Indicator numbers in WP1 of MAKING 4.0 project

3.1 Methodology for analysing the results

Task T1.1 was aimed at defining the methodology and tools for gathering information from Malaysian and European targets: students/teachers in HE and industry. During the Kick-off-Meeting, all partners and MTIB representing the sector experts agreed on working in the framework of two types of questionnaires:

- Survey for entrepreneurs/managers/CEOs of wood and furniture manufacturers
- Survey for students/researchers/teachers in HE

MAKING 4.0 Consortium agreed with the use of the same survey for all students/teachers for Europe and Malaysia, distinguishing the responses for the analysis in T1.2 and T1.3

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through a specific question about the country of respondent. The same agreement was reached for the survey to design for industry in Europe and Malaysia.

As O1.1 reported, Google form was used as survey platform for launching the questionnaires and gathering responses. Google Forms permits to collect online survey responses easily. Moreover, Google Forms offers the possibility to automatically export the results to .xls files or to Google Sheets for online access and sharing.

Responses in both surveys have been exported to two .xls files to be managed with Excel tool (Microsoft Office). Both files have been managed with the same procedure: responses have been filtered by country, to divide responses from continents: responses from countries in Asia and from countries in Europe. Filtered responses have been stored in two Excel sheets in the same .xls file. Those data collected comes from other continents have been omitted for the analysis.

Data from both continents have been reviewed in depth for avoiding inconsistences or misleading responses. Those incomplete responses have been removed for the analysis.

Once the filter task has been performed, data were ready for the analysis. To do this, UPCT has followed the recommendations of the report "developing and running an establishment skills survey", by the European Centre for the Development of Vocational Training (CEDEFOP) [20]. This report guides in the task of Data analysis for this type of surveys (see Figure 5).

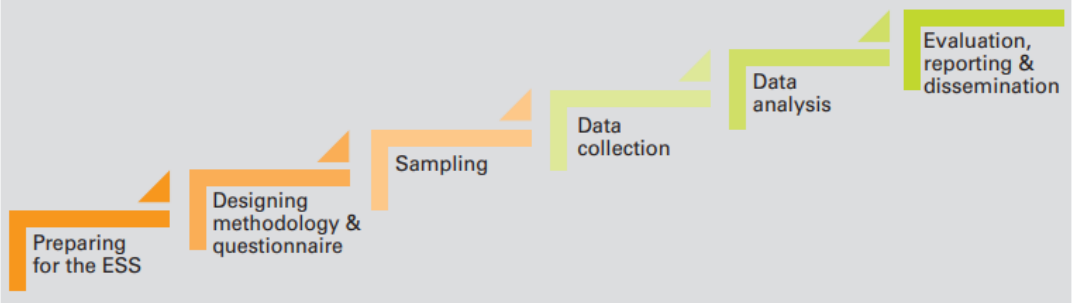

Figure 5 Steps in the development and implementation of an establishment skills survey [20]

Data have been managed to plot representative graphs that permit to get in depth in the responses and report first conclusions. Next two sections provide a complete analysis of the results obtained from both surveys in Europe.

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3.2 Analysis of responses from HE students and teachers

3.2.1 Country and Institution of respondents

131 responses were collected from 5 different Asian countries: Malaysia, Indonesia, Vietnam, Thailand and Philippines. The highest percentage of respondents corresponds to those Asian countries with partners participating in MAKING 4.0 project: Malaysia (95%-125 responses), Philippines (2%-2 responses), Thailand (1%-2 responses), Indonesia (1%-1 response) and Vietnam (1%-1 response) (see Figure 6).

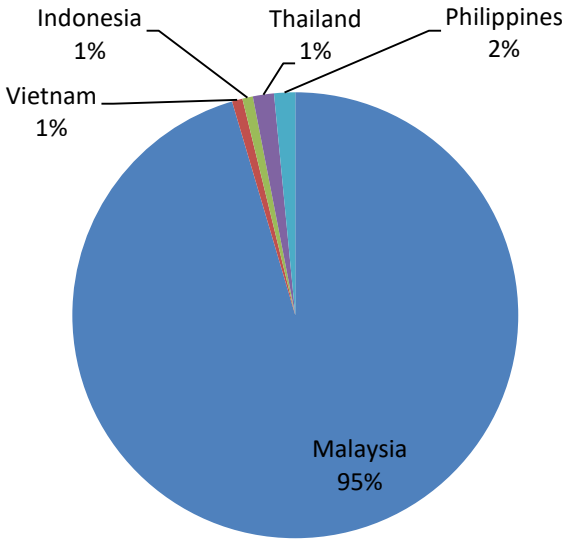

Figure 6 Distribution of responses from countries

Responses were from 19 Asian HE institutions and 2 VET schools (Malaysia). Annex I summarizes the number of responses per institution and country. The analysis of those responses from countries in the MAKING 4.0 consortium show that HE partners from Asian (UPM, USM, UKM and UiTM) made a big effort for receiving responses in their countries, getting more success in their own institutions, as Figure 7 shows.

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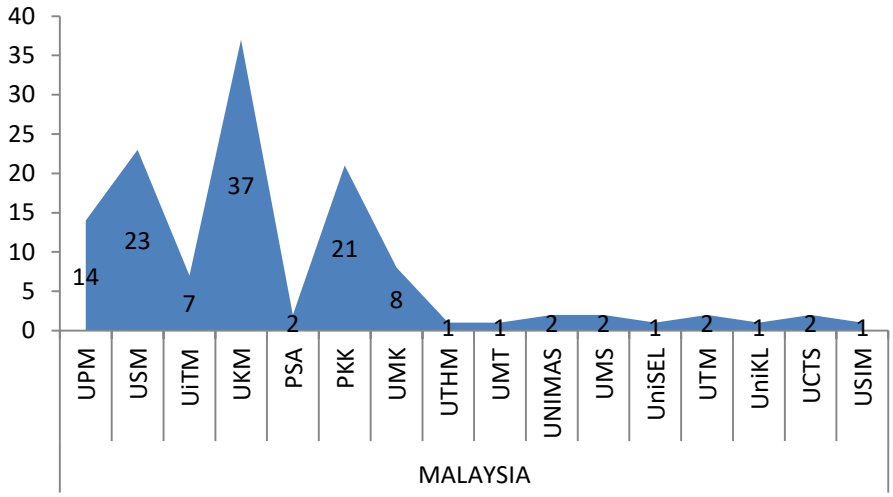

Figure 7 Responses of HE institutions placed in Malaysia in MAKING 4.0 consortium

The number of responses from other Asian countries was lower than the previous one, reaching four countries, five HE institutions and six responses (see Figure 8).

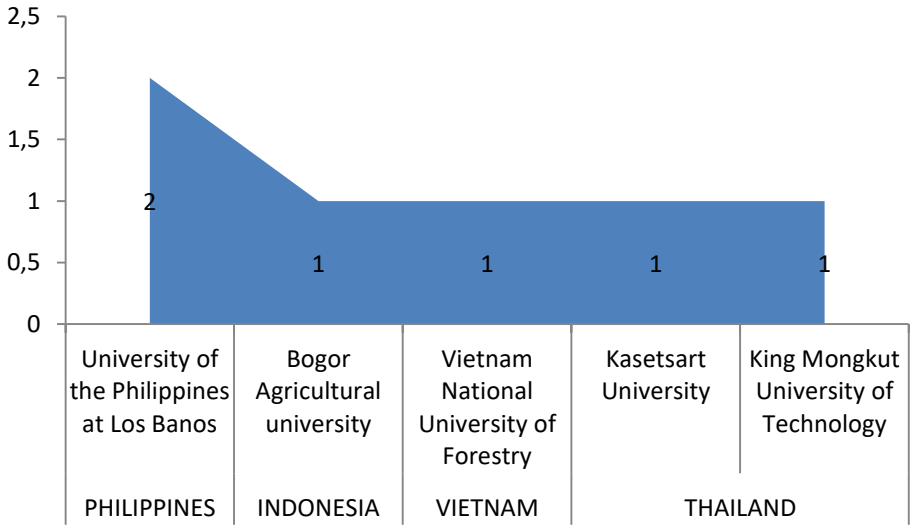

Figure 8 Responses of HE institutions placed in Asian countries out of MAKING 4.0 consortium

3.2.2 Education level and specialization of respondents

Respondents were asked by their education level. Results plotted in Figure 9 show that most of them are mainly of Bachelor's degree (89%), Master's degree (15%) and Ph.D. level (3%). Only 24% of respondents have Diploma/equivalent. The way to ask the

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question does not permit to know if the responder is already graded in the level marked, or is running for that.

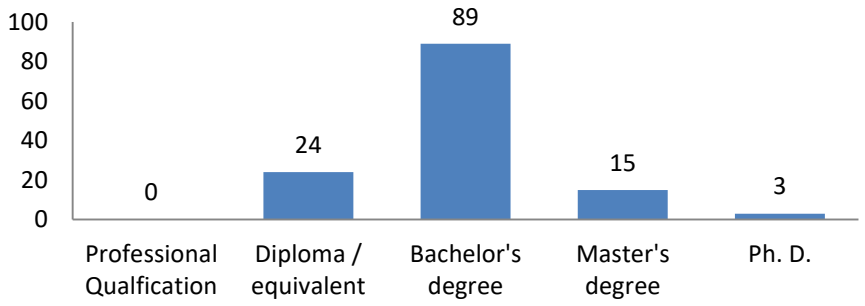

Figure 9 Education level of respondents

The program specialization or field of expertise of the respondents was found to be very diverse. Figure 10 shows that respondents indicated twelve different specialities. In Figure 11 has been shortened into three topics: forestry, wood science, furniture, wood engineering, architecture, material and management, comprises 93.89% of responses and science and environment, comprise 3.82% of respondents. Other multimedia, education and shariah (religious study) fields make up 2.29% of respondents.

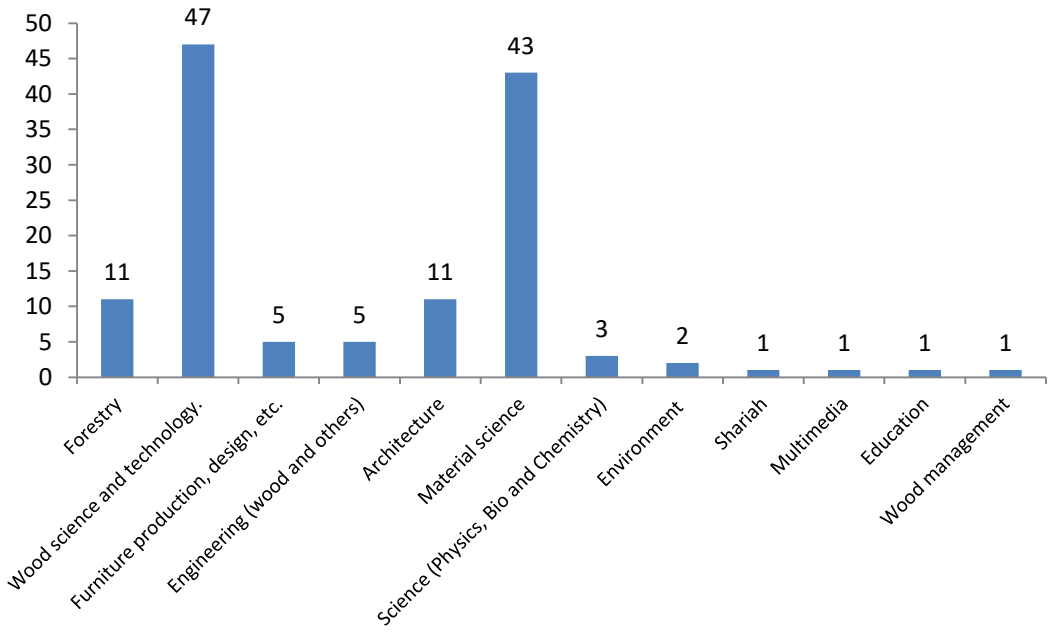

Figure 10 Program specialization of respondents

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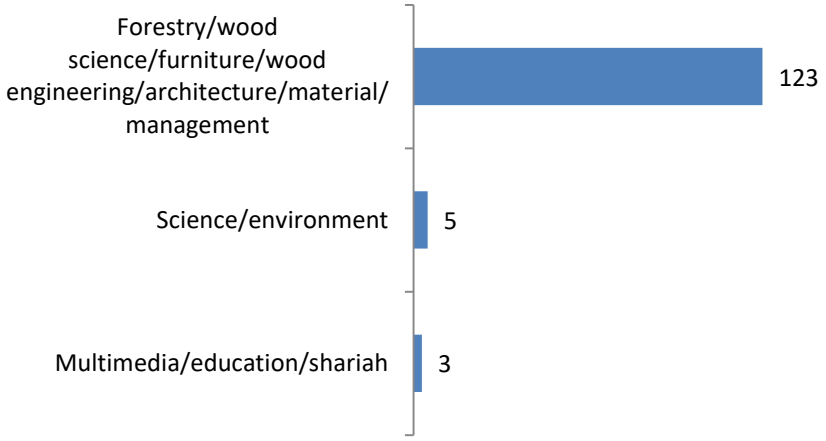

Figure 11 Summary of program specialization of respondents

3.2.3 Employment interests and knowledge about KET of I4.0

Respondents were asked about their interest in seeking employment in the wood/ furniture/ habitat industry when they complete their studies. Results (Figure 12) show that only 80% of respondents are interested in this field sector.

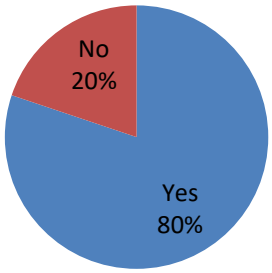

Figure 12 Responses to interest of seeking employment in Wood/furniture/habitat industry

Surprisingly, these results analysed in depth show (Figure 13) that 17.89% of respondents in a program specialization of forestry, wood science, furniture, wood engineering, architecture, etc., are not interested in seeking employment in that sector. The reasons of that may vary, but most probably come from the fact that most of respondents are running

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for a HE degree, and employ in wood and furniture industry are typically known by the high percentage of low qualification jobs.

However, 80% of respondents with a program specialization focused on science and environment or similar field are interested on that. This result could reflect the fact that the field of expertise in sciences is transversal to all industrial sectors, and students in this field are open to job vacancies where they can apply their knowledge.

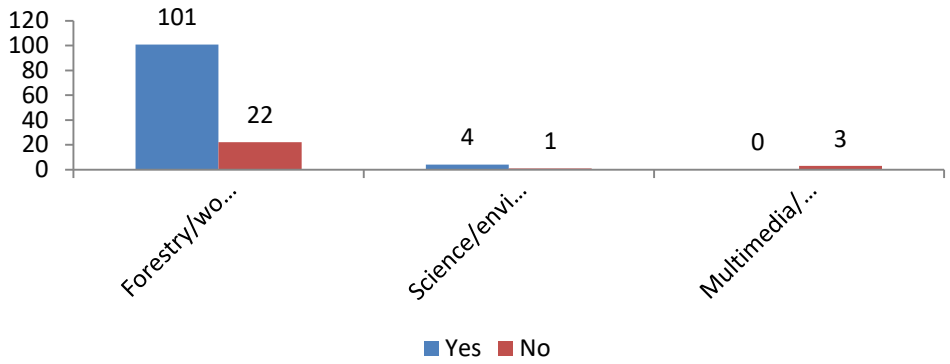

Figure 13 Responses to interest of seeking employment in Wood/furniture/habitat industry distinguishing among field of expertise

Respondents were asked if they think automation and mechanization is important to the wood / furniture / habitat industry. There is no doubt that the vast majority of respondents think that automation is mandatory in this industrial sector, 98% (see Figure 14). This feeling is shared by the society in general.

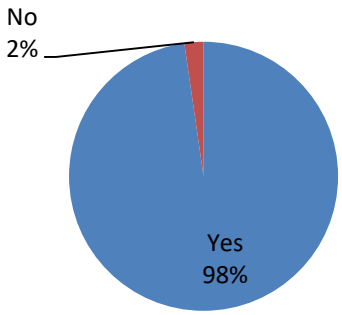

Figure 14 . Responses to question about if automation and mechanization is important to the wood / furniture / habitat industry

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Although most of them are conscious about the need of transforming industry to the digital evolution through automation and mechanization, a 57% of respondents are not aware of which technologies are used in the industry presently, as results in Figure 15 shows.

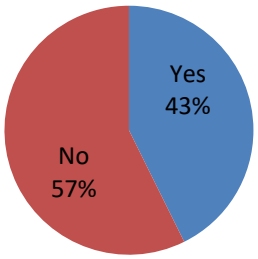

Figure 15 Responses to question about if respondents are aware of automation technologies used in the industry presently

These results are analysed in depth to know if the field of expertise in their program specialization affects to their knowledge in that. Results were plotted in Figure 16, showing that the area of expertise has not influence, a priori. In fact, negative responses in the program specialization of forestry, wood science, furniture, wood engineering, architecture, etc., have a result (in percentage) than those in the field of science and environment, 56.91% and 40% respectively.

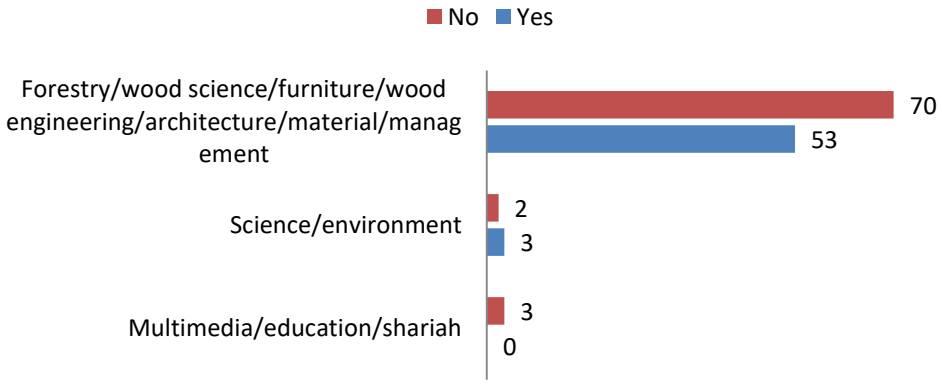

Figure 16 Responses to question about if respondents are aware of automation technologies used in the industry presently, filtered by program specialization of respondents

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It is quite surprising that those respondents in the field of science and environment have no knowledge about how to apply automation technologies in the industry. We have studied in depth the results of this set of responses, and we have found that program specialization of forestry, wood science, furniture, wood engineering, architecture, etc., have a result 88.57% of negative responses (62 from 70) come from people with Diploma/equivalent or Bachelor's degree. As we stated in section 3.1, we cannot confirm the respondents have been graded with that level of education or they are running for that. Hence, it is not unreasonable to think that those respondents have not enough knowledge about automation and new technologies if they are running the first courses of a bachelor's degree. Anyway, the lack of knowledge detected in this question could be given by other factors, not measured in this survey, such us: HE programs with obsolete contents [21], contents in subjects with low examples of application in industry, respondents with no experience in industry, etc. Those 43% of respondents that said yes to the question above (see Figure 15), were also asked to respond about what technologies they are familiar with. The results are plotted in Figure 17, and analysed following the learning branches followed in IN4WOOD project [8,14]: Digital and physic world hybridising, Telecommunication and data and Management systems. These are summarized in Table 2.

As it can be seen, there are two KET that are the most familiar for respondents: CNC (32.14%) and Robotics (23.21%). This result seems obvious because both technologies are being integrated in our daily life. On the other hand, Robotics is known by 23.21% of respondents. Although 3D-printing is a quite new technology, it is not included in most of HE degree programs. From these respondents, 63.63% of them are from field of expertise in wood/furniture, which seems normal because it is the KET most used in those sectors. The previous KET are five of the ten catalogued in the Digital and physic world hybridising. The remainder have less interest for respondents, reaching 8.93% Automatic Sprayer and 3D-printing and virtual reality (VR), augmented reality (AR) and Surface Mount Technology only 1.79% respectively. These last results seem coherent because these are emerging new technologies, missing in almost all HE degree programs. In Telecommunication and Data, 1.79% are found most of KET, which is big data, ICT and cloud computing. These values show that people are user of telecommunication networks

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and the use of digital information, but they are not familiar with those technologies involved on that from the technical point of view.

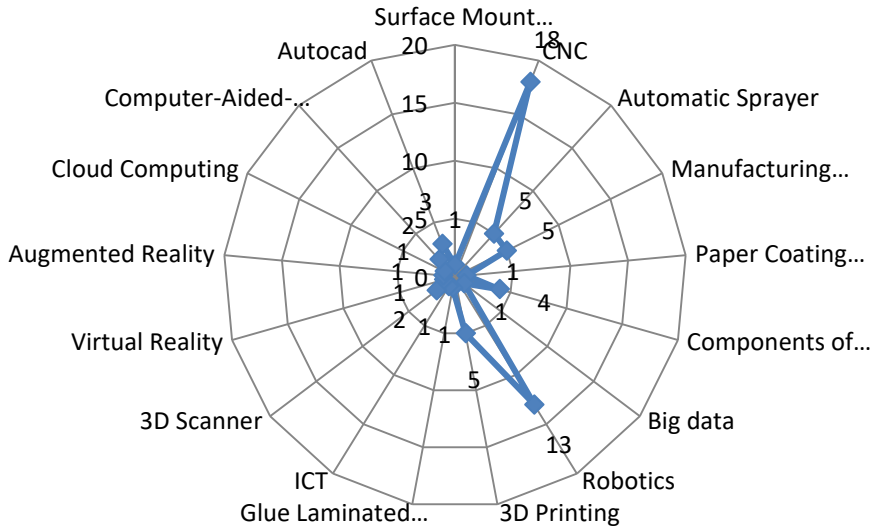

Figure 17 Technologies in which respondents are familiar with

Industry 4.0 technologies	KET	Who knows
Digital and physic world hybridising	Virtual Reality	1.79%
	Augmented Reality	1.79%
	3D Printing	8.93%
	3D Scanner	3.57%
	CNC	32.14%
	Robotics	23.21%
	Automatic Sprayer	8.93%
	Computer-Aided-Design (CAM)	3.57%
	Autocad	5.36%
	Surface Mount Technology	1.79%
Telecommunication and data	Big data	1.79%
	ICT	1.79%
	Cloud Computing	1.79%
Management Systems	Glue Laminated Timber	1.79%
	Components of vehicle/airplane	7.14%
	Paper Coating Technology	1.79%
	Manufacturing automotive	8.93%

Table 2 Summary of Asian responses by KET in which respondents are familiar with

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Finally, all KET in Management system classification, have a rate lower than 10%. This result could come from the fact that these technologies are not usually taught in conventional HE degrees, but in specialized courses.

Respondents have been also asked about if they are familiar with the principles of Industry 4.0 in general. 54% said yes, and 46% no (Figure 18). Results have been also filtered by field of expertise, with the aim of extract conclusions about if this is a topic more promoted in specific sectors. Results, plotted in Figure 19 confirm that in the field of forestry, wood science, furniture, wood engineering, architecture, etc., the Industry 4.0 principles are known (56.91%) more than in science and environment field (20%) or other fields (0%).

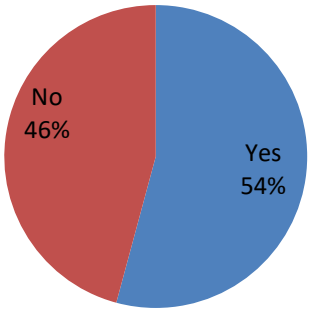

Figure 18 Responses to question about if respondents are familiar with the principles of Industry 4.0

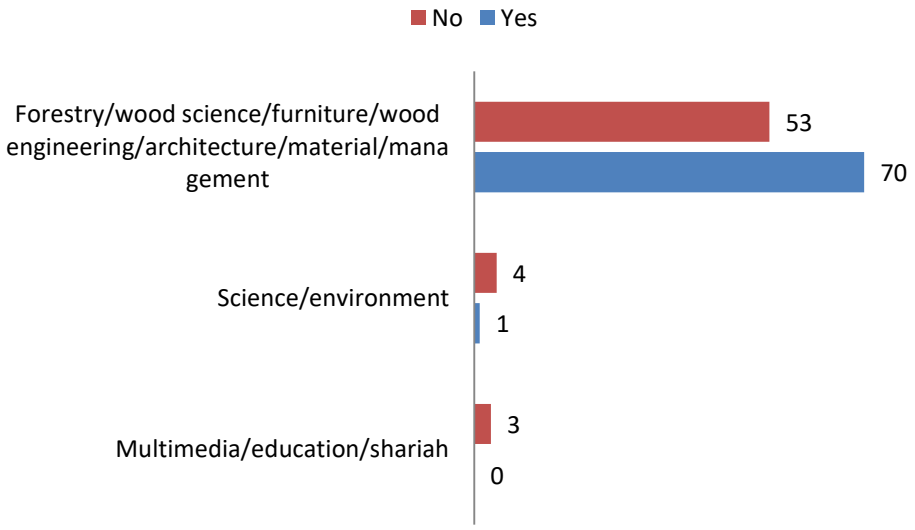

Figure 19 Responses to question about if respondents are familiar with the principles of Industry 4.0, filtered by field of expertise

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Respondents have been asked about if they believe Industry 4.0 is applicable to the wood/furniture/habitat industry. Results of this question are plotted in Figure 20. They show that, although a notable amount of respondents are not familiar with the principles of I4.0, most of them (85%) think that I4.0 can be applied to this sector. Only (15%) respondents, with field of expertise different from wood/furniture/habitat industry, think I4.0 is not applicable to that sector.

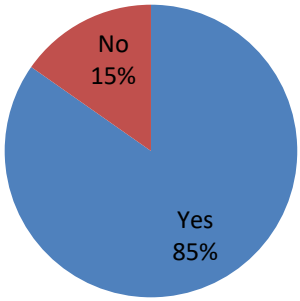

Figure 20 Results of question "Do you think industry 4.0 is applicable to the wood/ furniture/ habitat industry?"

3.2.4 Contents in current HE degree programs and future of I 4.0 in HE

In this section, responses about the contents of the current HE degree programs in topics related with I4.0 and wood/furniture/habitat field are analysed, as well as the interest of respondents in a HE program focused on I4.0, and what teaching-learning mode is the most desirable.

One of the goals of this question is to detect if current HE degree programs include those key contents focused on KET, needed to address the industrial revolution, as well as contents focused on wood / furniture / habitat industry. Moreover, this question tries to know the level of knowledge of students/researchers in those topics. This will help to identify gaps in the current European HE degree programs and competences of students.

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First, respondents were asked about which topics are addressed in their current study programmes and the level of knowledge required, with five options: not addressed, low level, basic knowledge, advanced level and expert level. Seventeen topics were included in the survey for being selected by respondents. For the analysis, they were organized regarding the close relationship between the topics into:

- Topics focused on wood/furniture/habitat (Figure 21): wood science, wood and material processing, wood production and management, Ecodesign.
- Topics focused on KET of I4.0 (no management systems) (Figure 18): Cloud Computing, IoT, ICT/Networking, AR, CAD/CAM/3D printing, Additive manufacturing, Simulation, Robotics.
- Topics focused on enterprises: management, integration, surveillance (Figure 19): Lean Manufacturing/MRP, Risk Analysis, System Integration, Low Cost Automation, System Management, Technological Surveillance and Competitive Intelligence.

Figure 21 shows those results concerning those topics focused on wood/furniture/design/etc. Results in general point out:

- In Wood science, only 35.16% of respondents have advanced or expert level and 20.31% of respondents have low level or they didn't address. 44.53% of respondents have basic level.
- In Wood and material processing, only 40.77% of respondents have advanced or expert level, while 16.15% of them have low level or they didn't address. 43.08% of respondents have basic level.
- In Wood production and management, 38.76% of respondents have advanced or expert level, and a significant rate of respondents (19.38%) have low level or they didn't address. 41.86% of respondents have basic level.
- In Ecodesign, 6.86% of respondents have advanced or expert level, but 41.18% of respondents have low level or they didn't address. 51.96% of them have basic level.

A depth analysis of these results shows that the option *basic level* is chosen in all topics by a high percentage of respondents, between 41.86% and 51.96% of them. It seems coherent because 6.11% of respondents have a program specialization different from

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these topics, that is, Engineering, Computer Science, ICTs, informatics, etc. On the other hand, those respondents in the field of expertise of wood / furniture / habitat industry (93.89%) pointed out they have advanced level or expert level in most of these topics; between 42.85% and 61.90% of the respondents.

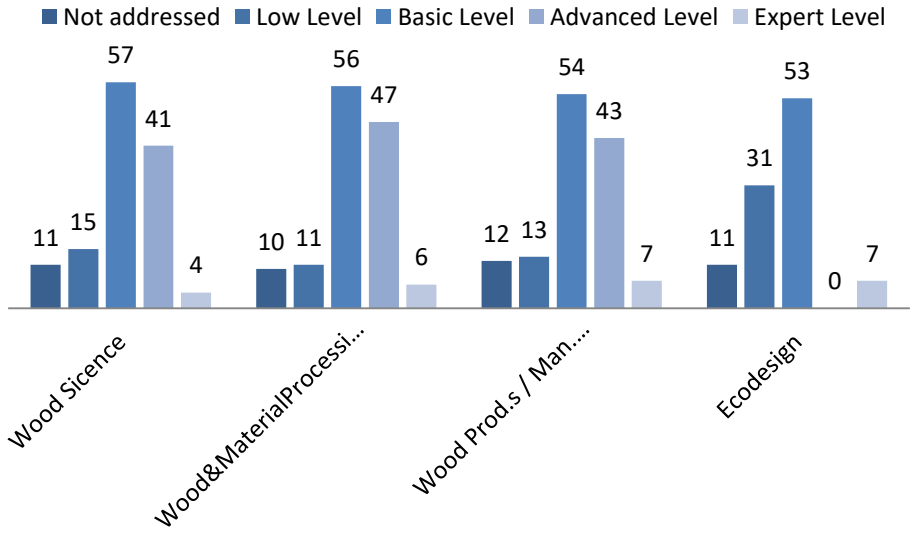

Figure 21 Results to question which topics are addressed in your current study programme and the level of knowledge required, for wood / furniture / habitat topics

Figure 22 shows those results concerning those topics focused on the KETs of I4.0. Results in general point out:

- In Cloud Computing / IoT, 12.40% of respondents have advanced or expert level and 41.86% of respondents have low level or they didn't address. 45.74% of respondents have basic level.
- In ICT / Networking, 24.03% of respondents have advanced or expert level, while 36.44% of them have low level or they didn't address. 39.53% of respondents have basic level.
- In AR, only 12.60% of respondents have advanced or expert level, and a significant rate of respondents (57.48%) have low level or they didn't address. 29.92% of respondents have basic level.

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- In CAD/CAM/ 3D printing, a significant rate of respondents (19.23%) have advanced or expert level, but 41.45%% of respondents have low level or they didn't address. 39.23% of them have basic level.
- In Simulation, 15.63% of respondents have advanced or expert level, while 51.56% of respondents have low level or they didn't address. 32.81% of respondents have basic level.
- In Robotics, only 13.49% of respondents have advanced or expert level, while a significant rate of respondents (63.49%) have low level or they didn't address. 23.02% of respondents have basic level.

A depth analysis of these results show that the option not addressed is chosen in Robotics by a high percentage of respondents (32.54%), followed by AR (26.77%) and Simulation (24.22%). The other topics have a rate between 18.46% and 9.30%. It is remarkable that 12.40% of respondents are in HE programs with specialization in ICTs and technologies close to KET in I 4.0, however, the results show that most of them don't acquire knowledge in these competences at a high level.

In most of the topics, low and basic level gets more than 50% of responses, and advanced and expert level have only remarkable high values in ICT / Networking (24.03%), CAD/CAM/ 3D printing (19.23%), Simulation (15.63%). These results seem consistent with the field of expertise of respondents. Those respondents in the field of wood /furniture/ habitat (51.21%) are typically familiar with technologies in the field of CAD / CAM/3D-printing, while those in the field of ICTs/Computer Science/Informatics (48.78%) are close to those topics in Cloud Computing /IoT / ICT / Networking, etc.

Finally, it must be highlighted that Robotics, AR and Simulation, three of the KET in I4.0 and key technologies in the digital evolution of wood / furniture / habitat industry, have the highest values in the sum of responses in not addressed and low level: 63.49%, 57.48%, and 51.56% respectively.

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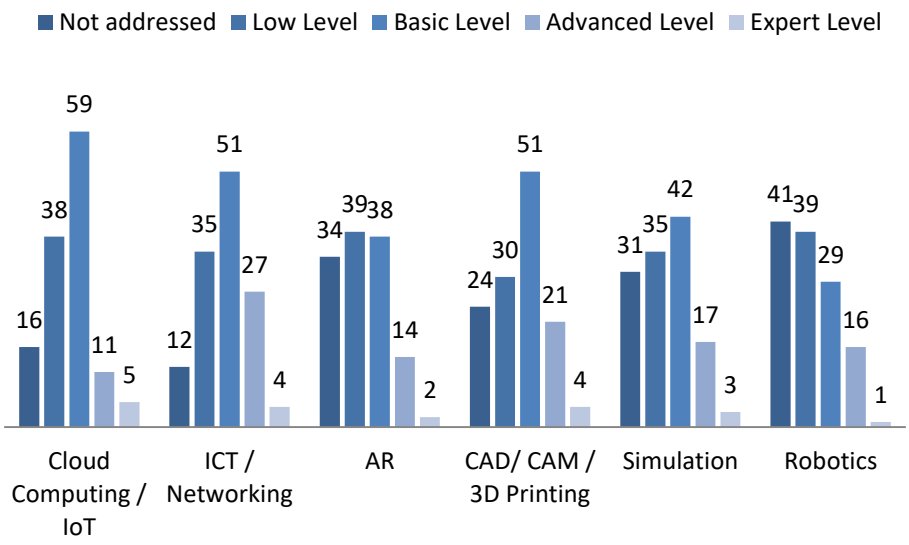

Figure 22 Results to question which topics are addressed in your current study programme and the level of knowledge required, for ICTS, KET topics

Figure 23 shows those results concerning those topics focused on the KETs of I4.0 regarding management system and integration in enterprises. Results in general point out:

- In Lean Manufacturing / MRP only 16.41% of respondents have advanced or expert level and a significant high rate of respondents, 47.66%, have low level or they didn't address. 35.94% of respondents have basic level.
- In Risk Analysis, 17.83% of respondents have advanced or expert level, while 48.06% have low level or they didn't address. 34.11% of them have basic level.
- In System Integration, 12.5% of respondents have advanced or expert level and 53.91% have low level or they didn't address. 33.59% of them have basic level.
- In Low Cost Automation, only 17.33% of respondents have advanced level of expert level, while a remarkable number of respondents, 50.39%, have low level or they didn't address. 32.28% of them have basic level.
- In System Management, only 14.96% of respondents have advanced or expert level, while 40.94% of respondents have low level or they didn't address. 44.1% of respondents have basic level.
- In Technological Surveillance and Competitive Intelligence, only 11.72% of respondents have advanced or expert level, while 51.56% of respondents have low level or they didn't address. 36.72% of respondents have basic level.

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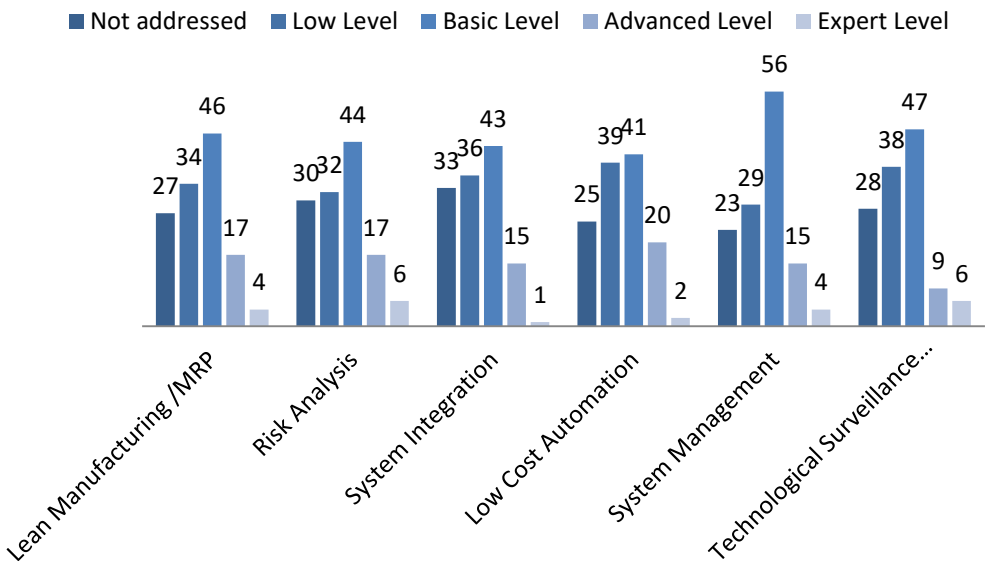

Figure 23 Results to question which topics are addressed in your current study programme and the level of knowledge required, for ICTS, KET topics in management systems and integration

A depth analysis of these results show that the option not addressed is chosen in System Integration by a high percentage of respondents (25.78%), followed by Risk Analysis (23.26%) and Technological Surveillance and Competitive Intelligence 21.88%.

On the other hand, most of topics have a low rate in advanced and expert level. In fact, in Technological Surveillance and Competitive Intelligence, only 11.72% of respondents have advanced or expert level and the highest rate in advanced and expert level is achieved by Risk Analysis (17.83%).

In most of the topics, low and basic level gets (joined) more than 50% of responses, while in Lean Manufacturing / MRP, Risk Analysis and Technological Surveillance and Competitive Intelligence, the rate of basic level is similar, varying between [36.72%-34.11%]. The lowest rate in basic level is shown in Low Cost Automation (32.28%).

In this set of results, seems that the field of expertise of respondents do not affect to the level of knowledge in most of topics, except Low Cost Automation, System Integration and System Management, where respondents of forestry, wood science, furniture, wood engineering, architecture, etc. are more familiar with.

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Finally, two questions are launched to respondents with the aim of gathering their opinion about to be enrolled in a HE degree program which includes contents about the KET of I4.0 and what type of teaching-learning mode is the most suitable for them.

Results show that 77.1% of respondents could be interested in a further degree in M.Sc. program focused on I4.0 (see Figure 24).

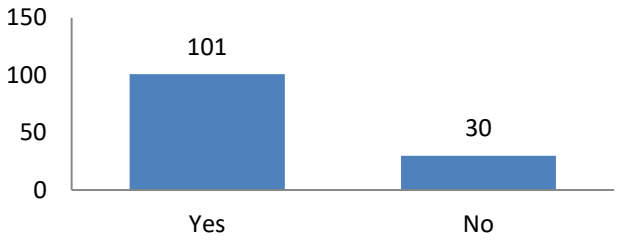

Figure 24 Responses to question: Would you consider pursuing a further degree in a M. Sc. program included towards industry 4.0?

On the other hand, about teaching-learning mode (see Figure 25), 21.1% of respondents prefer as first option, research-based program while 16.41% prefer combination (face-to-face, online) and only 18.75% prefer on-site. Regarding the scheduler of the program, 14.06% of respondents prefer modular-based, and 16.41% prefer to be scheduled in weekends. Finally, only 13.28% of respondents prefer online.

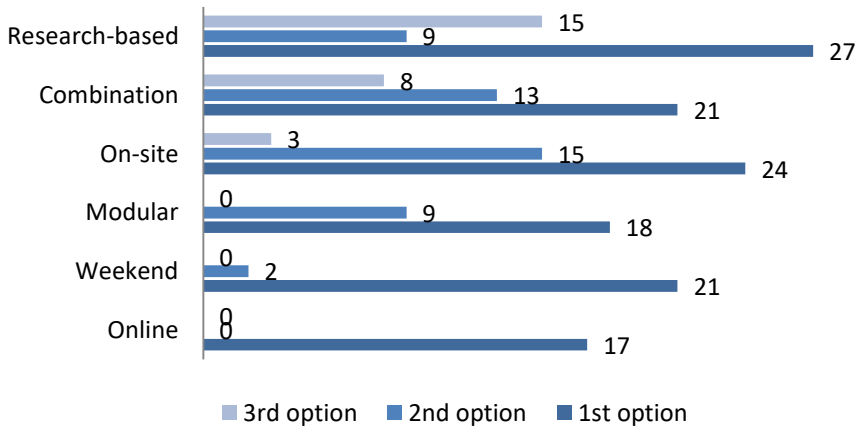

Figure 25 Responses to question: What would be the most desirable mode of delivery for such a program?

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3.3 Analysis of responses from wood / furniture / habitat industry

3.3.1 Respondents profile

Regarding the position of the respondent in the industry the main profile was of Director with 22% of the respondents, followed closely by the Managing Director with a 20% and followed by far in third place by 14% of CEO. The first two categories represent approximately 50% of the 65 individuals who participated in the survey. Senior management personnel predominate the respondents, with 57% of the respondents, whereas remaining 33% of the respondents held executive positions and 10% technical positions (see Figure 26).

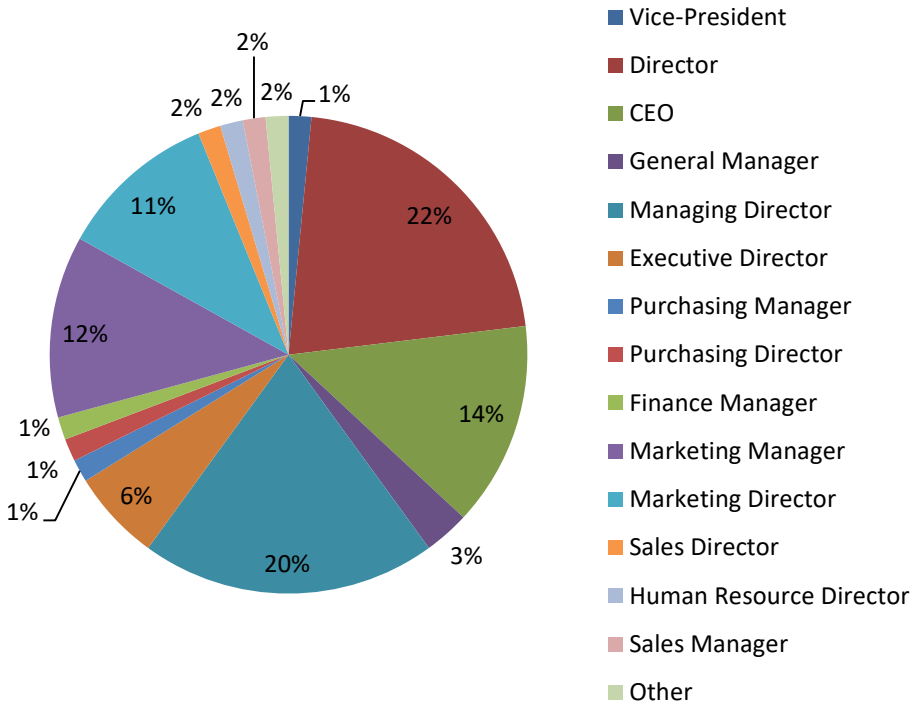

Figure 26 Distribution of responses by position of respondent

Respondents were also asked about their education level and the results are displayed in Figure 27. This figure shows that 61 of the respondents had Diploma degree or equivalent educational background whereas 64 had additionally a Bachelor degree. Only 9

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respondents had a Master level. Therefore, the respondents were equally distributed between those with university degree and those with non-university degree.

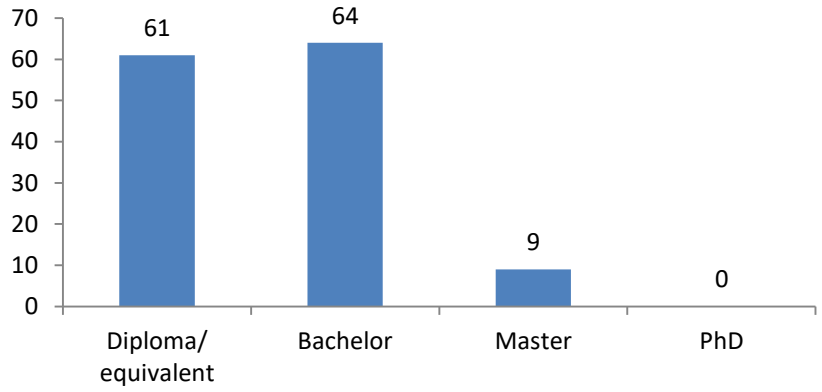

Figure 27 Distribution of responses by education level of the respondents

When asked for their courses or specialization programs their responses were very dissimilar (Figure 28). The answers indicated up to 7 different categories ranging from technical categories (i.e. 42% indicated sectors such as design, safety or ergonomics) to business categories (58% indicated marketing or management).

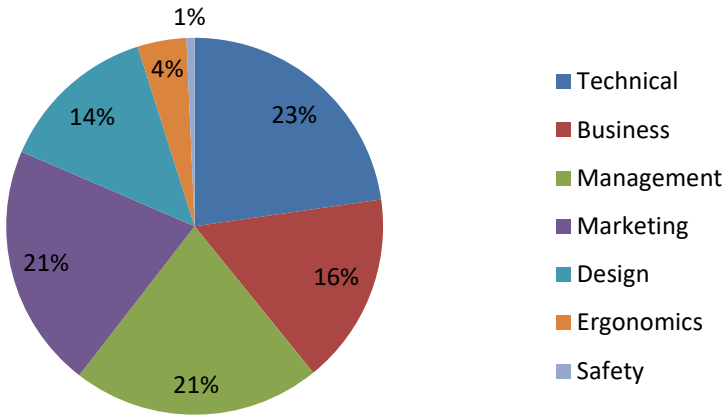

Figure 28 Program specialization of the respondents

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3.3.2 Respondents' opinion about training and I4.0 in companies

Next, the opinion of respondents on the training needs and the concept I4.0 in the companies was analysed. Support for training and education of employees among those surveyed is 100% indicated said *Yes* while 0% indicated said *No*. Also a large section of the respondents was familiar with the concept of industry 4.0 (with an 80% claiming to know it) and firmly believe that it is possible to apply it to the wood and furniture manufacturing industry. All these results are shown in Figure 29.

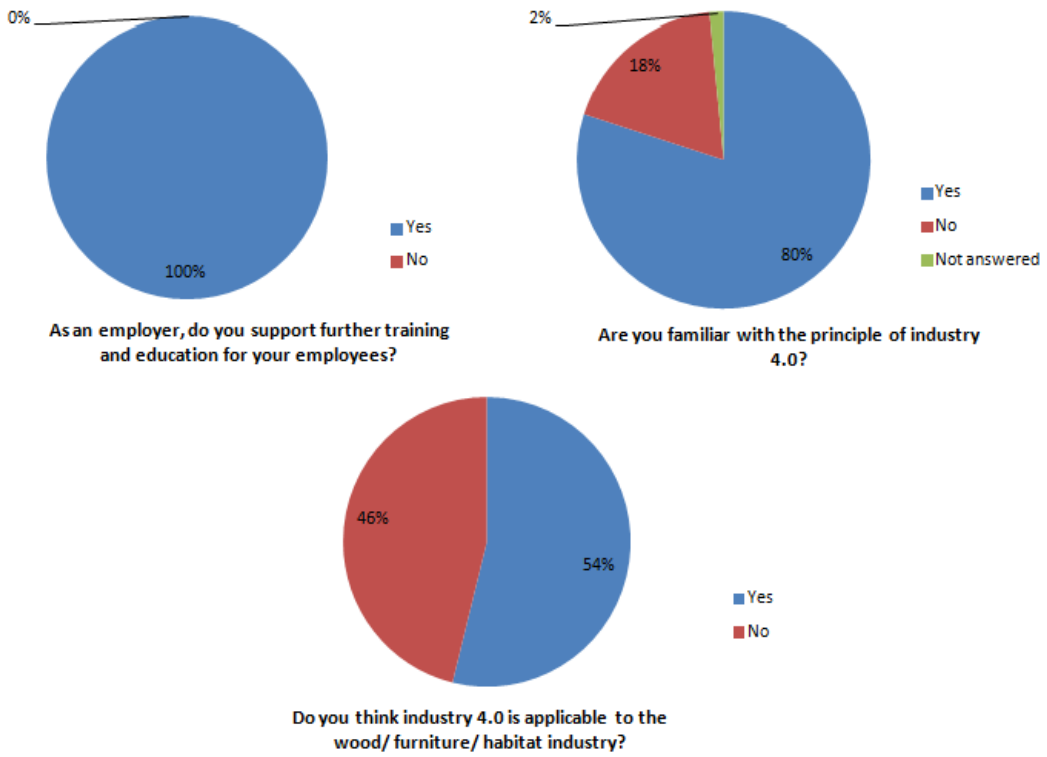

Figure 29 Distribution of responses by education level of the respondents

For those who answered positively to the previous question, they were also asked to elaborate more for their reason. The results are shown in Figure 30.

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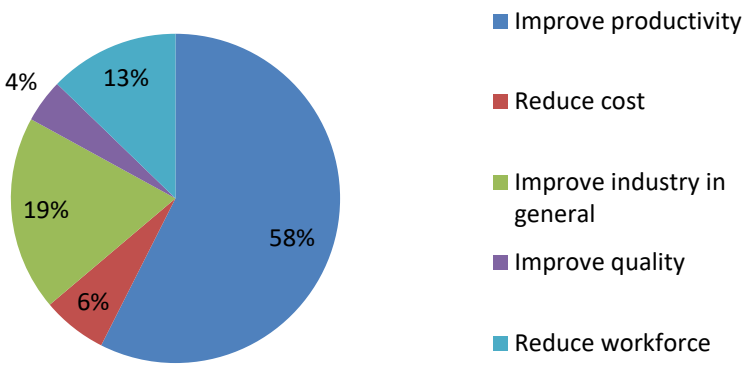

Figure 30 Reasons for application of I4.0 to wood and furniture manufacture industry

About half of those surveyed, they expected an improved productivity of its manufacturing processes and an increase in benefits. Also, a quarter of them indicated the possibility of introducing new products and opening up new markets (innovation in general) while one out of five respondents indicated as positive the development of the industry in general. Surprisingly few of them pointed out to cost or improved quality.

Also those who replied negatively were interrogated to be more precise on the reasons of their answer. The main reason given was the adoption of the technology to expensive (41% pointed out to this factor), especially in small factories with traditional production methods, followed by the concern on the industry is not ready yet to accept I4.0 (35% of respondents). 12% of the surveyed claimed that industry very sensitive to cost for I4.0 requires larger investment. This analysis is displayed in Figure 31.

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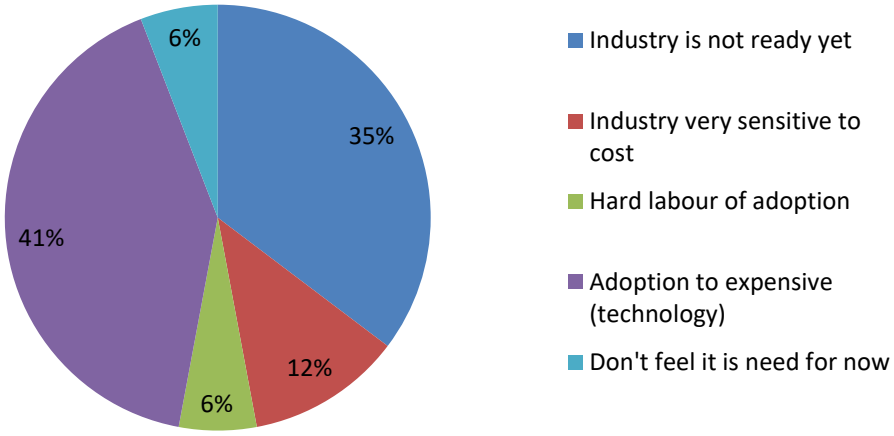

Figure 31 Reasons for application of I4.0 to wood and furniture manufacture industry

3.3.3 Company profile

66 responses were collected from 5 different Asian countries: Malaysia, Indonesia, Vietnam and Thailand (95%) came from other country: Taiwan with 5% respectively. Surprisingly, fewer responses were obtained in comparison from countries with a strong wood and furniture manufacturing industry such as Vietnam and Indonesia (see Figure 32).

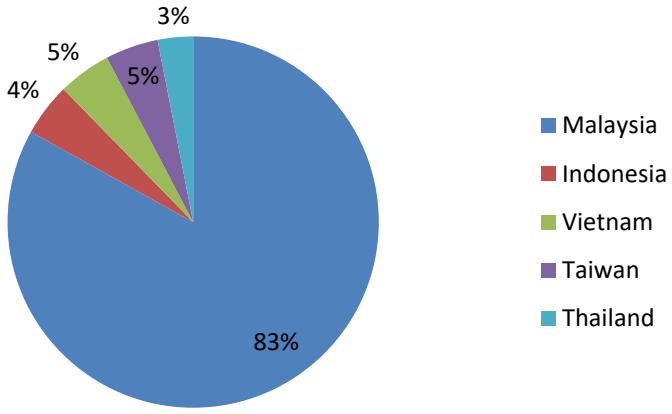

Figure 32 Distribution of responses from countries in the wood/furniture manufacture industry

The analysis of the size of the companies is displayed in Figure 33. Small businesses with less than 50 employees (0% of respondents) and companies of medium size (22

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companies, 34% of respondents) are the main components of the businesses surveyed. These companies (34% of total) are fairly representative of this sector in the Asian region. Also draws attention a significant number of micro-enterprises with less than 10 employees (0%). However, large companies with more than 250 employees were 66% of respondents in this survey.

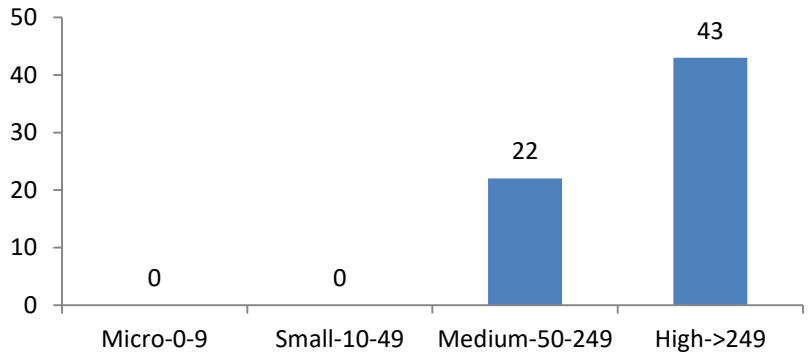

Figure 33 Size of the companies surveyed

With regards to the type of products manufactured by these industries (Figure 34) a significant majority of respondents were engaged in wooden furniture (35%) followed by the sector of the wooden furniture for home (18%) and thirdly by panel furniture manufacturers (11%) and wood panel manufacturers (9%) next. These four products add 73% of the respondents and would be in turn the main stakeholders of this project.

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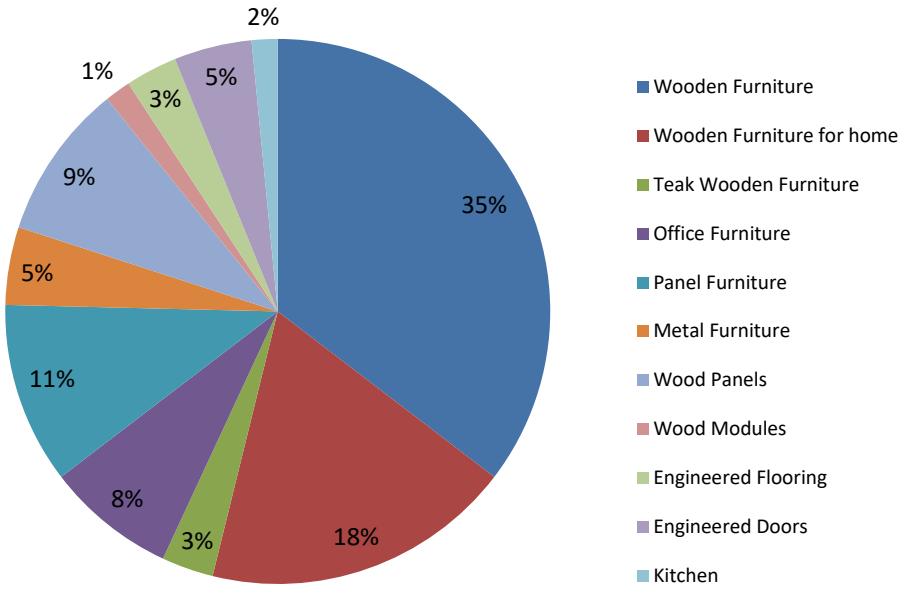

Figure 34 Type of products manufactured by the companies surveyed

On the other hand, as can be appreciated in Figure 35, 37% of respondents do business both in the domestic and international markets, 0% are devoted exclusively to the domestic market and the higher proportion is businesses that are dedicated to export (63%).

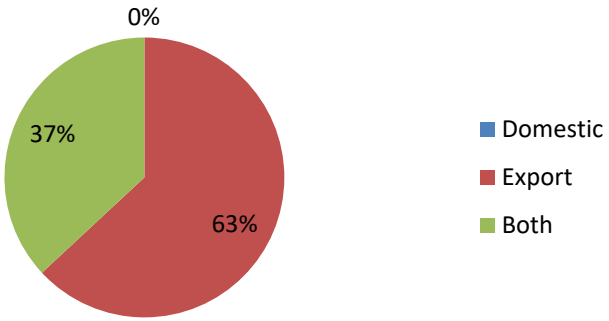

Figure 35 Market type of the companies surveyed

With regards to the formal education level of employees, the results gathered, summarized in Figure 36, show that in companies with 0-99 employees, the percentage of graduates is 29.25%; 27.96% in companies with 100-199 employees; and when the number of employees

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increases, the rate decreases up to 16.06% (200-299 employees) and 17.64% (300-399). Regarding large-sized companies, only three companies with 400 employees or more answered, indicating that all of their employees are graduated. We have doubts about the truthfulness of these answers, thinking that the respondents did not understand that term "graduate" in this case refers to HE level.

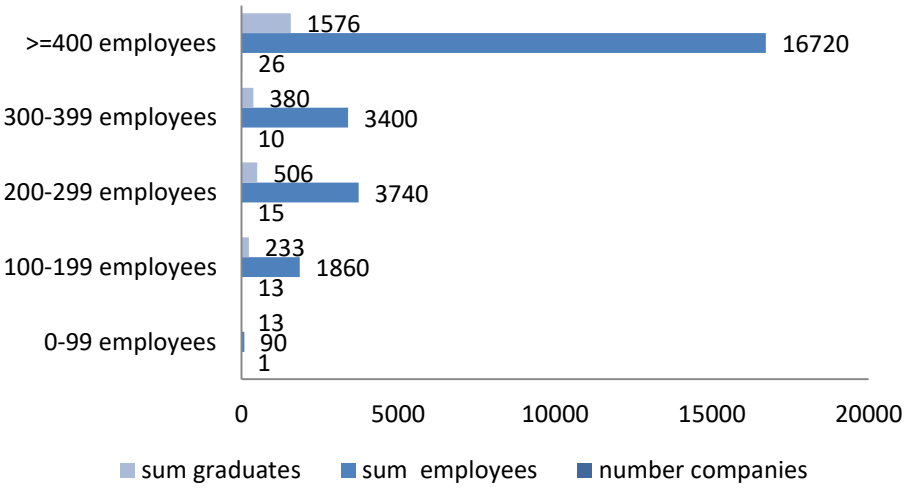

Figure 36 Results to the question "How many employees have formal education/graduates in your company?"

3.3.4 Companies' adoption to I4.0 and training support

In the next block will discuss the degree of adoption of the companies surveyed with regards to the industry 4.0 concepts and the degree of support of the business surveyed training in this field.

In first place, respondents were asked about their current situation, namely, which of the I4.0 technologies were already in place in their respective companies. Results are displayed in Figure 37.

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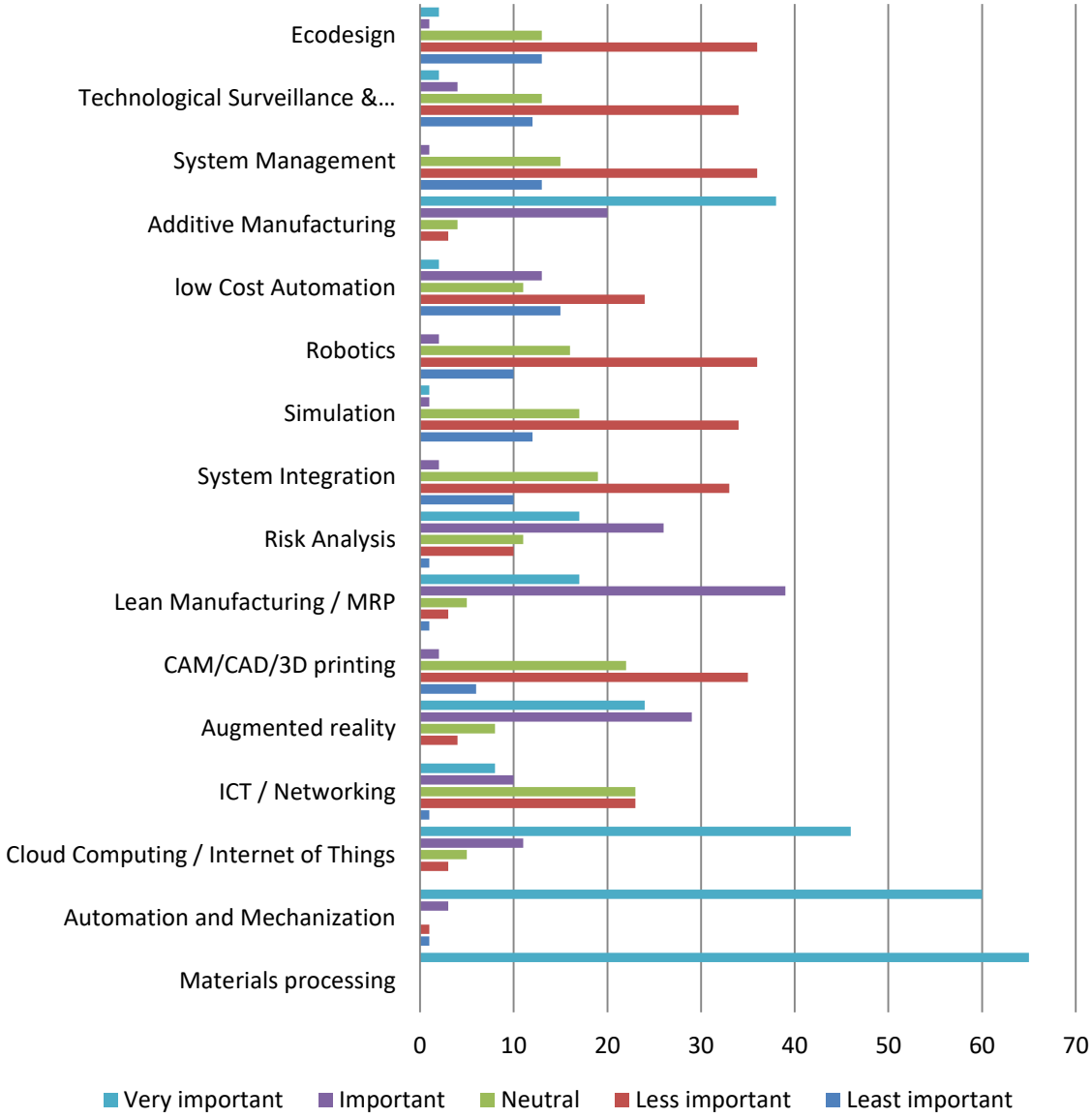

Figure 37 Results to the question "what of the following technologies/processes

When the data in Figure 37 are analysed in detail, three technologies were considered as "important" or "very important" for the sector: They were Materials Processing, Automation and Mechanization, Wood Science, Wood Products Manufacturing and Low Cost Automation with 70% of both answers in each one of the technologies. These technologies were important enough for them so that they are already implementing them.

On the other side some of these technologies were regarded as "least important" or "less important" for the sector: They were Technology Surveillance, System Management, System

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Integration, Simulation and Risk Analysis (34% of both answers), Additive Manufacturing (33%) and AR and Robotics (28%). These seemed to be less important as compared to the others and they are not being applied.

Next, respondents were inquired by the technologies that they considered essential to be implemented in the next 5 years. Results to this question are illustrated in Figure 38. Respondents were identified as "important" or "very important" (98% of both responses), Material Processing. Robotics, Wood Products Manufacturing and Wood Science (92%) and Automation and Mechanization (95%). This could give us a clue in the areas of training that the sector will need for upcoming graduates. At the other extreme, enterprises considered with a big difference (52%), that the knowledge in Technology Surveillance, System Management, System Integration, Simulation and Risk Analysis will be “less important” or “least important” to the sector. This result is striking, because apparently, in this new era this knowledge seems that it will be relegated to the University environment and it will not be strictly necessary for industrial practice.

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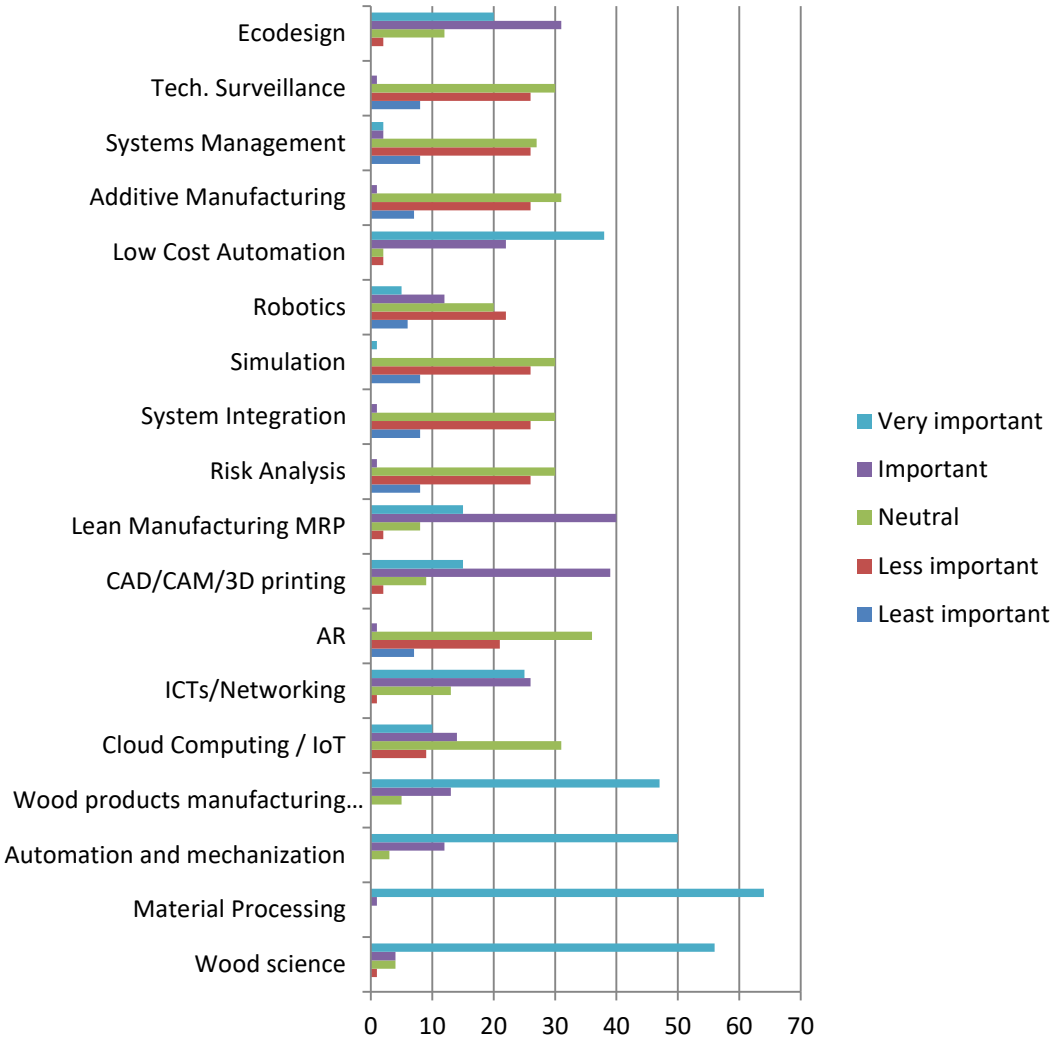

Figure 38 Results to the question "In any case, of the following technologies/ processes do you consider essential to be implemented in your company in the following 5 years?"

When they were asked if they would support their employees if they decide to pursue a program in Industry 4.0 the response was nearly unanimous: 85% of respondents said yes and only 15% said no (Figure 39). This response encourages us to think that the results of this program will be of great interest to the sector and that any training resulting from it will have an acceptable demand.

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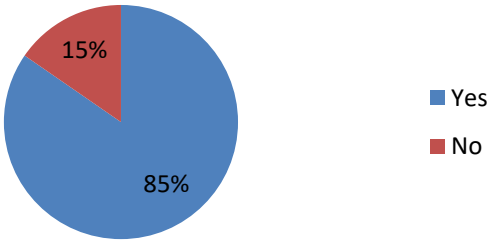

Figure 39 Results to the question "Would you support your employees if they choose to pursue

Finally, respondents were questioned about which areas should be the priority focus in the development of new training programs. These results are shown in Figure 40. As can be seen, the respondents gave priority to matters such as Material Processing, Automation and Mechanization and Low Cost Automation. These materials were evaluated by more than 90% of respondents as "important" or "very important". All materials of the proposals in the survey obtained high results, but "Cloud Computing", "Ecodesign" and "Lean Manufacturing" were shown as the least interesting.

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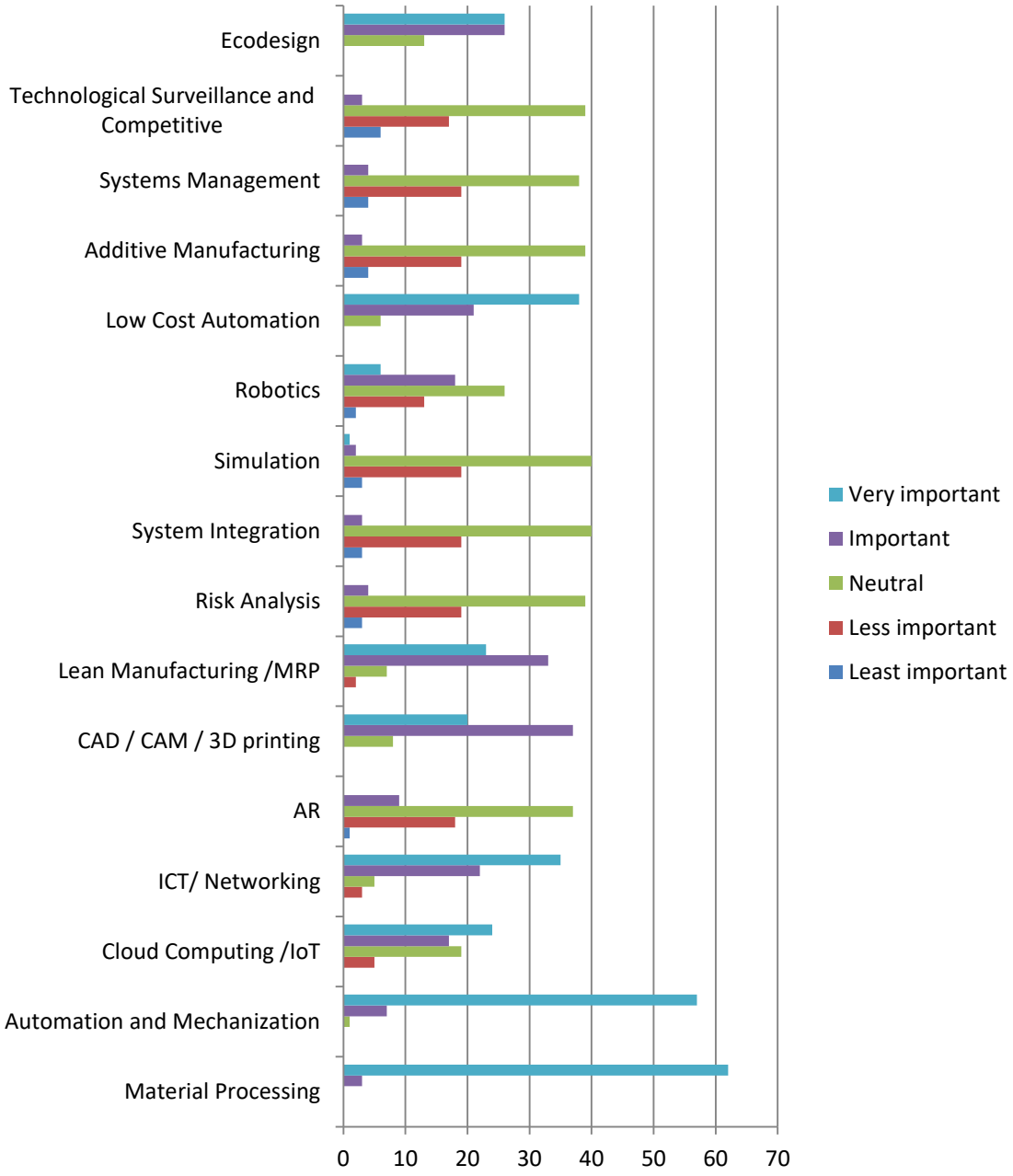

Figure 40 Results to the question "If a new training and education was developed to support employers in I4.0 in the wood, furniture and habitat sector, where should the priority focus be"

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4. Analysis of European Industry and HE

This section summarizes the results obtained from task **T1.3**, where the MAKING 4.0 consortium analyses the situation of industry 4.0 skills, knowledge and competences in the European Higher Education (HE) students, HE program degrees, and in the wood / furniture / habitat industry.

The goal of this analysis is to report the lacking, needed and requested competences and skills with specific attention to Key Enabling Technologies (hereinafter, KETs) of Industry 4.0 (hereinafter, I4.0) in the European HE and in the wood and furniture sector all over Europe, as well as the level of implementation in the industry of last technological trends.

Task **T1.3** has been performed thanks to those results obtained in task **T1.1**, reported in **O1.1**: "Questionnaires or other tools to gather information" and **O1.3**: First contact in situ with Malaysian situation.

This work is also linked to specific project objective **SO1**: Define how the HE offer for future workers of the Malaysian wood industry could be improved in comparison with the current HE offer and the technologies already implemented in Europe.

This work also fulfils the indicator numbers defined in the MAKING 4.0 project:

	Target	Gathered
Responses from EU industry	60	65
Responses form European HE institutions	20	25

Table 3 Indicator numbers in WP1 of MAKING 4.0 project

4.1 Methodology for analysing the results

The methodology and tool used for gathering results are the same as those used in the analysis of Malaysia HE and industry. Two types of questionnaires were designed:

- Survey for entrepreneurs/managers/CEOs of wood and furniture manufacturers
- Survey for students/researchers/teachers in HE

The way the responses are collected and managed is the same as the Asian surveys. The analysis has been performed by UPCT following the recommendations of the report

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"developing and running an establishment skills survey", by the European Centre for the Development of Vocational Training (CEDEFOP) [20].

Data have been managed to plot representative graphs that permit to get in depth in the responses and report first conclusions. Next two sections provide a complete analysis of the results obtained from both surveys in Europe.

4.2 Analysis of responses from HE students and teachers

4.2.1 Country and Institution of respondents

82 responses were collected from 11 different EU countries: Austria, Croatia, Estonia, Georgia, Ireland, Germany, Italy, Poland, Portugal, Slovenia and Spain. The highest percentage of respondents correspond to those EU countries with partners participating in MAKING 4.0 project: Spain (38%-31 responses), Germany (37%-30 responses), and Poland (12%-10 responses).

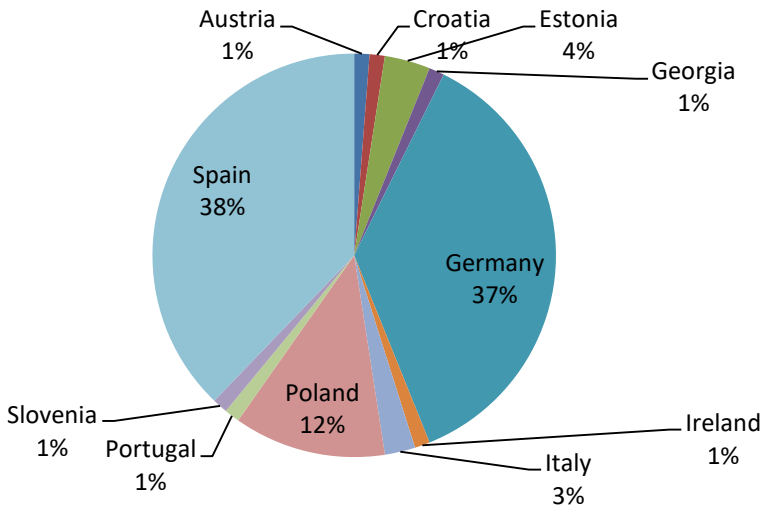

Figure 41 Responses of HE institutions placed in EU, identified by country

Responses were from 25 European HE institutions and 3 VET schools (2 from Spain, 1 from Germany). Annex I summarizes the number of responses per institution and country. The analysis of those responses from countries in the MAKING 4.0 consortium show that HE partners from Europe (UPCT, KIT and WULS) made a big effort for receiving responses in their countries, getting more success in their own institutions, as Figure 42 shows.

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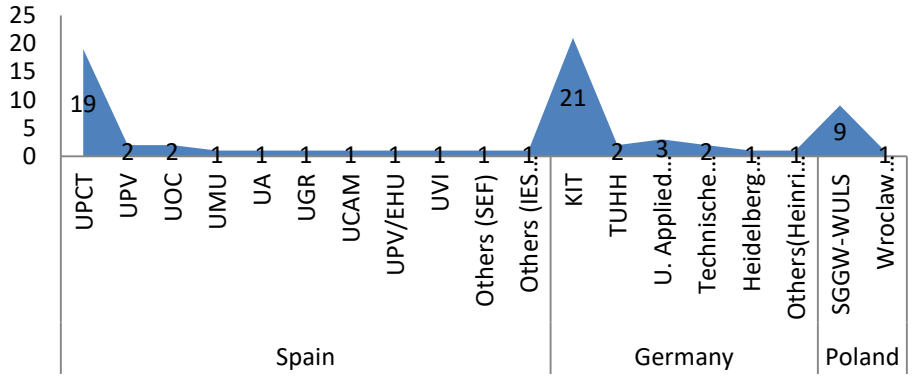

Figure 42 Responses of HE institutions placed in EU countries in MAKING 4.0 consortium

The number of responses from other European countries was lower than the previous one, reaching eight countries, nine HE institutions and eleven responses.

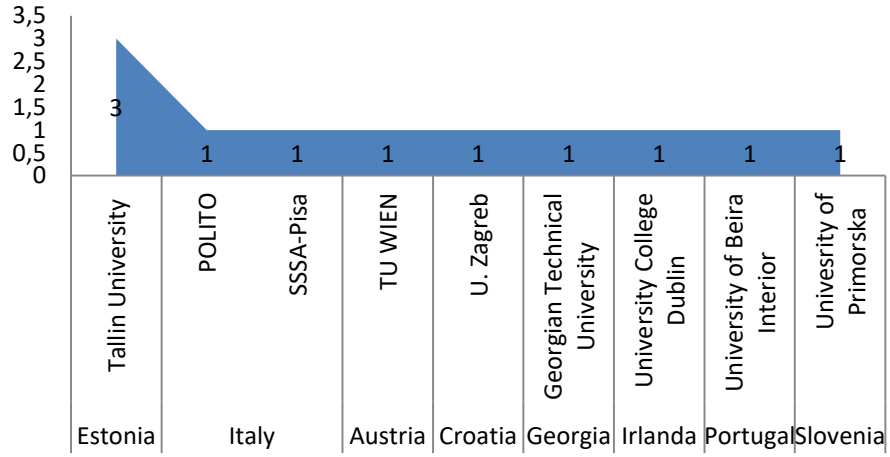

Figure 43 Responses of HE institutions placed in EU countries out of MAKING 4.0 consortium

4.2.2 Education level and specialization of respondents

Respondents were asked by their education level. Results plotted in Figure 44 show that most of them are mainly of Bachelor's degree (48.78%), Master's degree (29.26%) and Ph.D. level (13.41%). Only 8.53% of respondents have Professional Qualification or Diploma/equivalent. The way to ask the question does not permit to know if the responder is already graded in the level marked, or is running for that.

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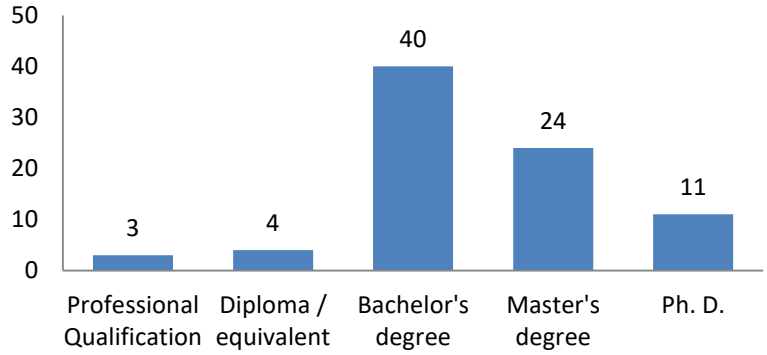

Figure 44 Education level of respondents

The program specialization or field of expertise of the respondents was found to be very diverse. Figure 45 shows that respondents indicated ten different specialities. In Figure 46, responses have been shortened into three topics: Wood/furniture/architecture/etc. comprises 51.21% of responses and Computer Science/ICTs/Informatics, comprise 39.2% of respondents. Other engineering and science fields are the specialization of 9.75% of respondents.

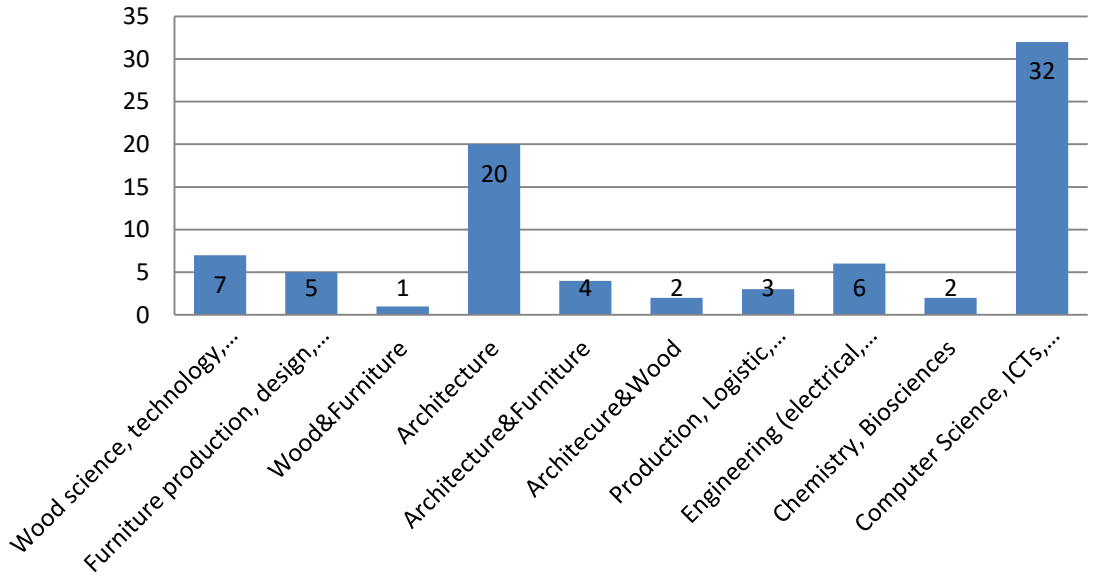

Figure 45 Program specialization of respondents

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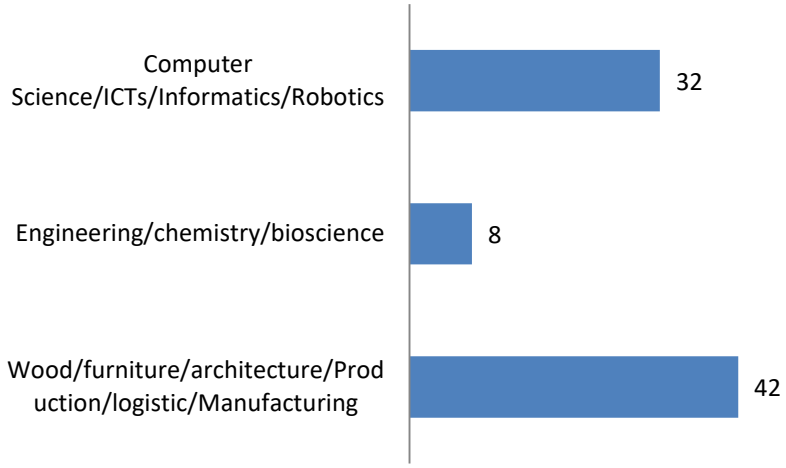

Figure 46 Summary of program specialization of respondents

4.2.3 Employment interests and knowledge about KET of I4.0

Respondents were asked about their interest in seeking employment in the wood/ furniture/ habitat industry when they complete their studies. Results (Figure 47) show that only 45% of respondents are interested in this field sector.

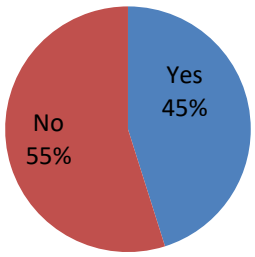

Figure 47 Responses to interest of seeking employment in Wood/furniture/habitat industry

Surprisingly, these results analysed in depth show (Figure 48) that 35.71% of respondents in a program specialization of wood/furniture/architecture, etc., are not interested in seeking employment in that sector. The reasons of that may vary, but most probably come from the fact that most of respondents are running for a HE degree, and employ in wood and furniture industry are typically known by the high percentage of low qualification jobs.

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However, 31.25% of respondents with a program specialization focused on ICTs, Computer Sciences or similar field are interested on that. This result could reflect the fact that the field of expertise in ICTs is transversal to all industrial sectors, and students in this field are open to job vacancies where they can apply their knowledge.

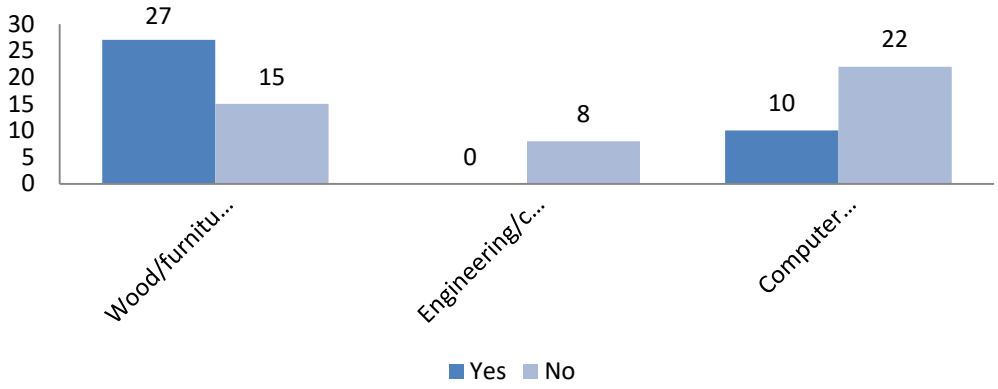

Figure 48 Responses to interest of seeking employment in Wood/furniture/habitat industry distinguishing among field of expertise

Respondents were asked if they think automation and mechanization is important to the wood / furniture / habitat industry. There is no doubt that the vast majority of respondents think that automation is mandatory in this industrial sector, 99% (see Figure 49). This feeling is shared by the society in general.

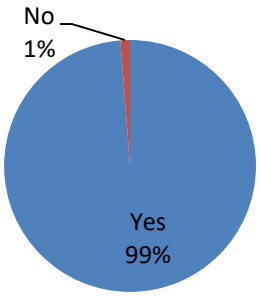

Figure 49 Responses to question about if automation and mechanization is important to the wood / furniture / habitat industry

Although most of them are conscious about the need of transforming industry to the digital evolution through automation and mechanization, a 57% of respondents are not aware of which technologies are used in the industry presently, as results in Figure 50 shows.

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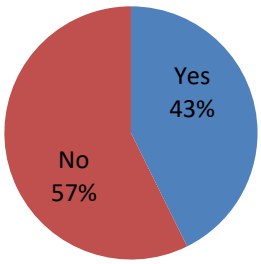

Figure 50 Responses to question about if respondents are aware of automation technologies used in the industry presently

These results are analysed in depth to know if the field of expertise in their program specialization affects to their knowledge in that. Results were plotted in Figure 51, showing that the area of expertise has not influence, a priori. In fact, negative responses in the program specialization of wood/furniture have a similar result (in percentage) than those in the field of ICTs, 59.52% and 59.37% respectively.

It is quite surprising that those respondents in the field of ICTs have no knowledge about how to apply automation technologies in the industry. We have studied in depth the results of this set of responses, and we have found that 94.37% of negative responses (18 from 19) come from people with Diploma/equivalent or Bachelor's degree. As we stated in section 3.1, we cannot confirm the respondents have been graded with that level of education or they are running for that. Hence, it is not unreasonable to think that those respondents have not enough knowledge about automation and new technologies if they are running the first courses of a bachelor's degree. Anyway, the lack of knowledge detected in this question could be given by other factors, not measured in this survey, such us: HE programs with obsolete contents [22], contents in subjects with low examples of application in industry, respondents with no experience in industry, etc.

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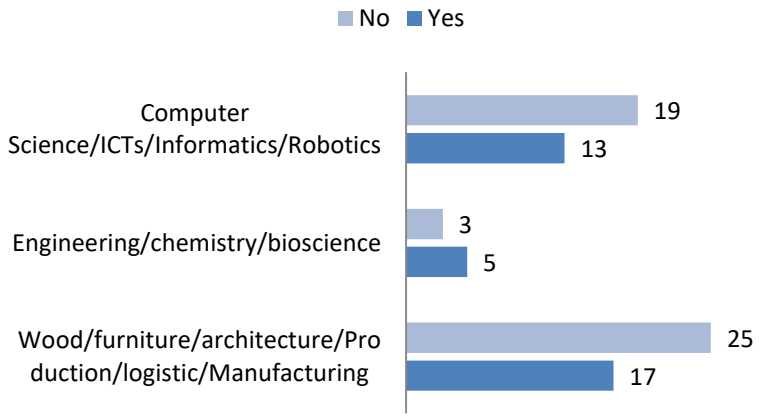

Figure 51 Responses to question about if respondents are aware of automation technologies used in the industry presently, filtered by program specialization of respondents

Those 43% of respondents that said yes to the question above (see Figure 51), were also asked to respond what technologies they are familiar with. The results are plotted in Figure 52, and analysed following the learning branches followed in IN4WOOD project [8,14]: Digital and physic world hybridising, Telecommunication and data and Management systems. These are summarized in next table.

As it can be seen, there are two KET that are the most familiar for respondents: Robotics and sensors-wearables (37.14%). This result seems obvious because both technologies are being integrated in our daily life. On the other hand, 3D-printing/ additive manufacturing is known by 31.42% of respondents. A high rate if we take into account that 3D-printing is a quite new technology not included in most of HE degree programs. From these respondents, 63.63% of them are from field of expertise wood/furniture, which seems normal because it is a KET more used in those sectors. The previous KET are three of the seven catalogued in the Digital and physic world hybridising. The remainder have less interest for respondents, reaching 14.28% RFID/NFC and CNC, and virtual reality (VR) and augmented reality (AR) only 5.71% and 8.57% respectively. These last results seem coherent because these are emerging new technologies, missing in almost all HE degree programs. In the range between 20%-29% are found most of KET focused on Telecommunication and Data, but cyber-security and communication networks decrease up to 8.57% and 5.71%. These values show that people are user of telecommunication networks and the use of digital information, but they are not familiar with those technologies involved on that from the technical point of view.

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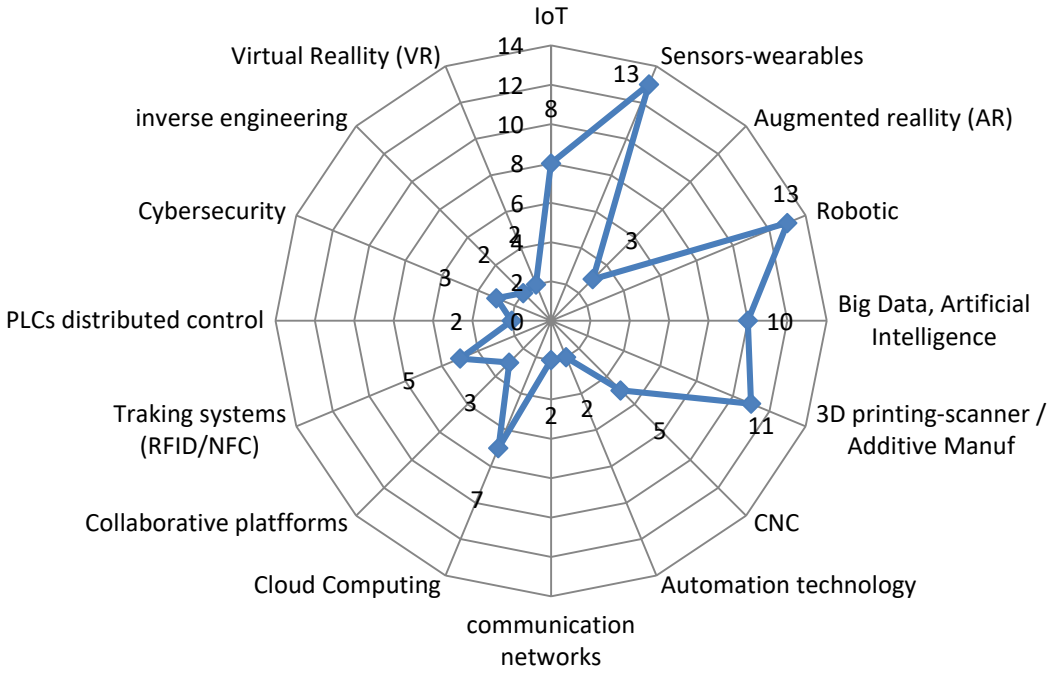

Figure 52 Technologies in which respondents are familiar with

Industry 4.0 technologies	KET	Who knows
Digital and physic world hybridising	RFID/NFC	14.28%
	Sensors-wearables	37.14%
	Augmented reality	8.57%
	Virtual reality	5.71%
	Robotic	37.14%
	3D printing/ additive manufacturing	31.42%
	CNC	14.28%
Telecommunication and data	Cloud Computing	20%
	Communication Networks	5.71%
	Cyber-security	8.57%
	Internet of Things	22.85%
	Big Data	28.57%
	Artificial Intelligence	28.57%
	PLCs distributed control	5.71%
Management Systems	Collaborative platforms	8.57%
	Automation technology	5.71%
	Inverse engineering	5.71%

Table 4 Summary of EU responses by KET in which respondents are familiar with

Finally, all KET in Management system classification, have a rate lower than 10%. This result could come from the fact that these technologies are not usually taught in conventional HE degrees, but in specialized courses.

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Respondents have been also asked about if they are familiar with the principles of Industry 4.0 in general. 66% said yes, and 34% no (Figure 53). Results have been also filtered by field of expertise, with the aim of extract conclusions about if this is a topic more promoted in specific sectors.

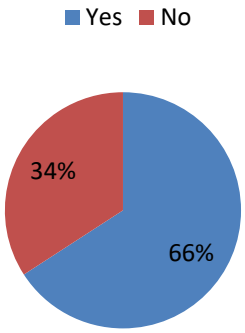

Figure 53 Responses to question about if respondents are familiar with the principles of I4.0

Results, plotted in Figure 54 confirm that in the field of ICTs, the Industry 4.0 principles are known (71.87%) more than in Wood/Furniture field (64.28%) or other fields of expertise like chemistry, bioscience, industrial engineering) (50%).

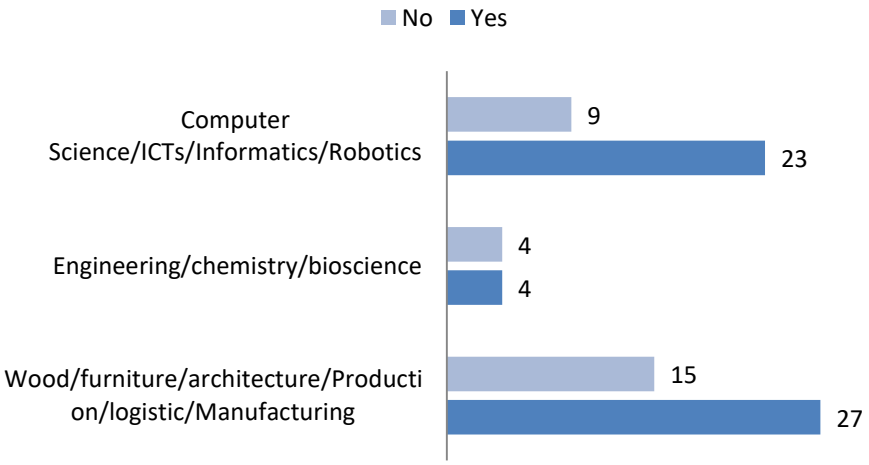

Figure 54 Responses to question about if respondents are familiar with the principles of I4.0, filtered by field of expertise

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Respondents have been asked about if they believe Industry 4.0 is applicable to the wood/furniture/habitat industry. Results of this question are plotted in Figure 55. They show that, although a notable amount of respondents are not familiar with the principles of I4.0, most of them (96%) think that I4.0 can be applied to this sector. Only three respondents, with field of expertise different from wood/furniture/habitat industry, think I4.0 is not applicable to that sector.

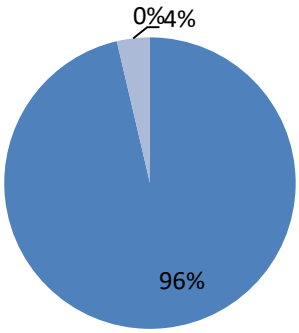

Figure 55 Results of question "Do you think I4.0 is applicable to the wood/furniture/habitat industry?"

4.2.4 Contents in current HE degree programs and future of I4.0 in HE

In this section, responses about the contents of the current HE degree programs in topics related with I4.0 and wood/furniture/habitat field are analysed, as well as the interest of respondents in a HE program focused on I4.0, and what teaching-learning mode is the most desirable.

One of the goals of this question is to detect if current HE degree programs include those key contents focused on KET, needed to address the industrial revolution, as well as contents focused on wood / furniture / habitat industry. Moreover, this question tries to know the level of knowledge of students/researchers in those topics. This will help to identify gaps in the current European HE degree programs and competences of students.

First, respondents were asked about which topics are addressed in their current study programmes and the level of knowledge required, with five options: not addressed, low level, basic knowledge, advanced level and expert level. Seventeen topics were included

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in the survey for being selected by respondents. For the analysis, they were organized regarding the close relationship between the topics into:

- Topics focused on wood/furniture/habitat (Figure 56): wood science, wood and material processing, wood production and management, Ecodesign.
- Topics focused on KET of I4.0 (no management systems) (Figure 57): Cloud Computing, IoT, ICT/Networking, AR, CAD/CAM/3D printing, Additive manufacturing, Simulation, Robotics.
- Topics focused on enterprises: management, integration, surveillance (Figure 58): Lean Manufacturing/MRP, Risk Analysis, System Integration, Low Cost Automation, System Management, Technological Surveillance and Competitive Intelligence.

Figure 56 shows those results concerning those topics focused on wood/furniture/design/etc. Results in general point out:

- In Wood science, only 17.07% of respondents have advanced or expert level and 59.75% of respondents have low level or they didn't address. 23.18% of respondents have basic level.
- In Wood and material processing, only 18.29% of respondents have advanced or expert level, while 53.65% of them have low level or they didn't address. 28.06% of respondents have basic level.
- In Wood production and management, 19.51% of respondents have advanced or expert level, and a significant rate of respondents (60.97%) have low level or they didn't address. 19.51% of respondents have basic level.
- In Ecodesign, 21.95% of respondents have advanced or expert level, but 56.09% of respondents have low level or they didn't address. 21.95% of them have basic level.

A depth analysis of these results show that the option *not addressed* is chosen in all topics by a high percentage of respondents, between 35.36% and 43.90% of them. It seems coherent because 48.78% of respondents have a program specialization different from these topics, that is, Engineering, Computer Science, ICTs, informatics, etc. On the other hand, those respondents in the field of expertise of wood / furniture / habitat industry

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(51.22%) pointed out they have advanced level or expert level in most of those topics; concretely between 42.85% and 61.90% of them.

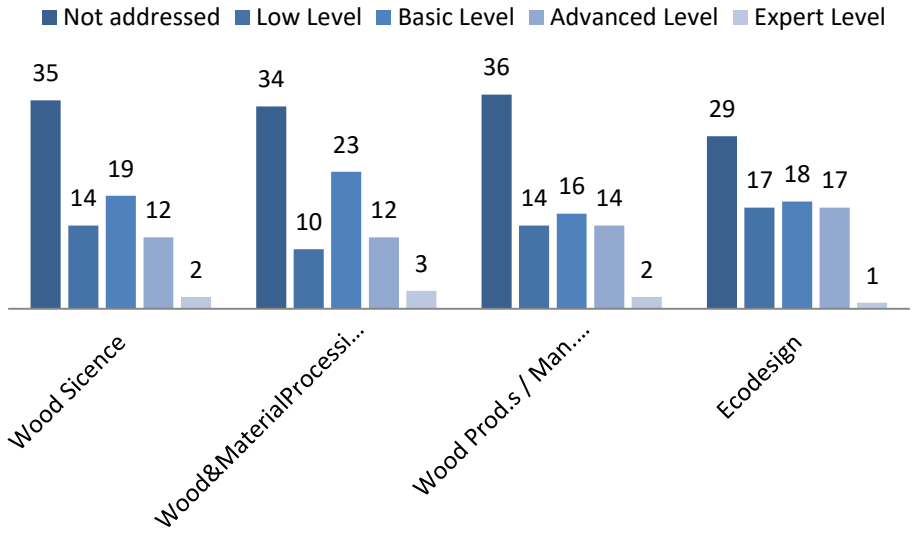

Figure 56 Results to question which topics are addressed in your current study programme and the level of knowledge required, for wood / furniture / habitat topics

Figure 57 shows those results concerning those topics focused on the KETs of I4.0. Results in general point out:

- In Cloud Computing / IoT, 35.36% of respondents have advanced or expert level and 41.46% of respondents have low level or they didn't address. 23.17% of respondents have basic level.
- In ICT / Networking, 34.14% of respondents have advanced or expert level, while 43.90% of them have low level or they didn't address. 21.95% of respondents have basic level.
- In AR, only 7.31% of respondents have advanced or expert level, and a significant rate of respondents (60.97%) have low level or they didn't address. 31.70% of respondents have basic level.
- In CAD/CAM/ 3D printing, a significant rate of respondents (43.90%) have advanced or expert level, but 35.36%% of respondents have low level or they didn't address. 20.73% of them have basic level.
- In Simulation, 21.95% of respondents have advanced or expert level, while 47.56% of respondents have low level or they didn't address. 30.48% of respondents have basic level.

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- In Robotics, only 6.09% of respondents have advanced or expert level, while a significant rate of respondents (64.63%) have low level or they didn't address. 29.26% of respondents have basic level.
- In Additive Manufacturing, only 6.09% of respondents have advanced or expert level, and 59.75% have low level or they didn't address. 34.14% of respondents have basic level.

A depth analysis of these results show that the option not addressed is chosen in AR by a high percentage of respondents (37.80%), followed by Additive Manufacturing (32.92%) and Robotics (26.82%). The other topics have a rate between 13.41% and 20.73%. It is remarkable that 39.02% of respondents are in HE programs with specialization in ICTs and technologies close to KET in I4.0, however, the results show that most of them don't acquire knowledge in those competences at high level.

In most of the topics, low and basic level gets more than 50% of responses, and advanced and expert level have only remarkable high values in CAD/CAM/3D printing (43.90%), Cloud Computing /IoT (35.36%), ICT/Networking (34.14%). These results seem consistent with the field of expertise of respondents. Those respondents in the field of wood /furniture/ habitat (51.21%) are typically familiar with technologies in the field of CAD / CAM/3D Printing, while those in the field of ICTs/Computer Science/Informatics (48.78%) are close to those topics in Cloud Computing / IoT / ICT / Networking, etc.

Finally, it must be highlighted that Robotics, AR and Additive Manufacturing, three of the KET in I4.0 and key technologies in the digital evolution of wood / furniture / habitat industry, have the highest values in the sum of responses in not addressed and low level: 64.63% , 60.97% and 59.75% respectively.

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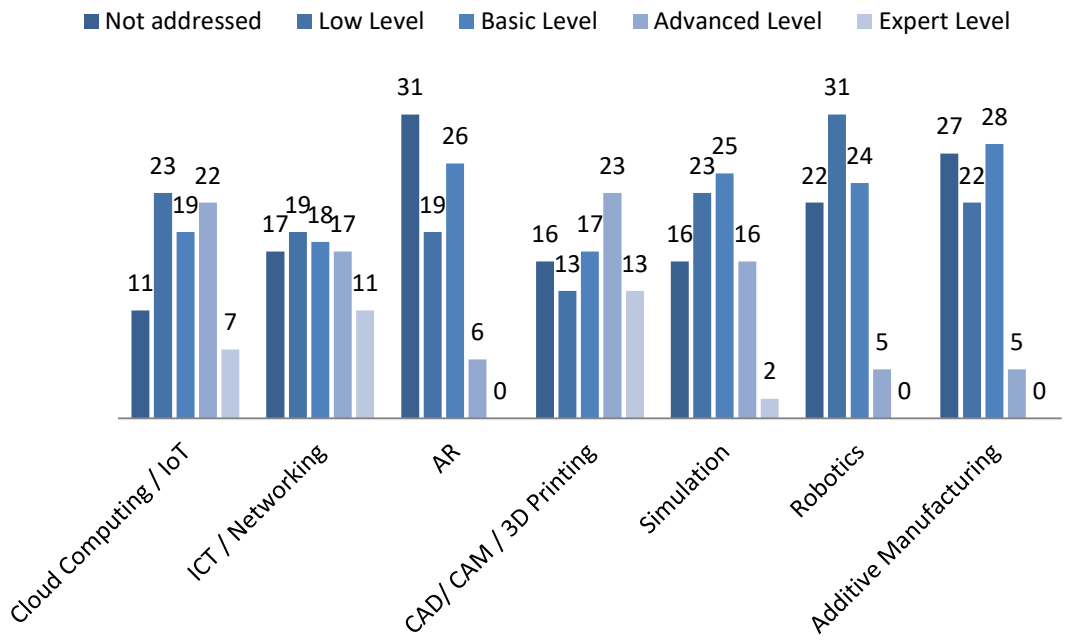

Figure 57 Results to question which topics are addressed in your current study programme and the level of knowledge required, for ICTS, KET topics

Figure 58 shows those results concerning those topics focused on the KETs of I4.0 regarding management system and integration in enterprises. Results in general point out:

- In Lean Manufacturing / MRP only 6.09% of respondents have advanced or expert level and a significant high rate of respondents, 64.63%, have low level or they didn't address. 29.26% of respondents have basic level.
- In Risk Analysis, 17.07% of respondents have advanced or expert level, while 41.46% of them have low level or they didn't address. 41.46% of them have basic level.
- In System Integration, 21.95% of respondents have advanced or expert level, and 47.56% have low level or they didn't address. 30.48% of respondents have basic level.
- In Low Cost Automation, only 6.09% of respondents have advanced level of expert level, while a remarkable number of respondents, 68.29%, have low level or they didn't address. 25.6% of them have basic level.
- In System Management, only 17.07% of respondents have advanced or expert level, while 42.68% of respondents have low level or they didn't address. 40.24% of respondents have basic level.

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- In technological Surveillance and Competitive Intelligence, only 8.2% of respondents have advanced or expert level, while 65.85% of respondents have low level or they didn't address. 21.95% of respondents have basic level.

A depth analysis of these results show that the option not addressed is chosen in Technological Surveillance and Competitive Intelligence by a high percentage of respondents (34.14%), followed by Lean Manufacturing (29.26%) and Risk Analysis and Low Cost Automation, both with 25.6%.

On the other hand, most of topics have a low rate in advanced and expert level. In fact, In Lean Manufacturing and Low Cost automation, only 6.09% of respondents have advanced or expert level and the highest rate in advanced and expert level is achieved by System Integration (21.95%).

In most of the topics, low and basic level gets (joined) more than 50% of responses, while in Risk Analysis, Low Cost Automation and System Management, the rate of basic level is similar, varying between [42.68%-40.24%]. The lowest rate in basic level is shown in Technological Surveillance (21.95%).

In this set of results, seems that the field of expertise of respondents do not affect to the level of knowledge in most of topics, except Low Cost Automation, System Integration and System Management, where respondents of ICTs/Computer Science/ etc. are more familiar with.

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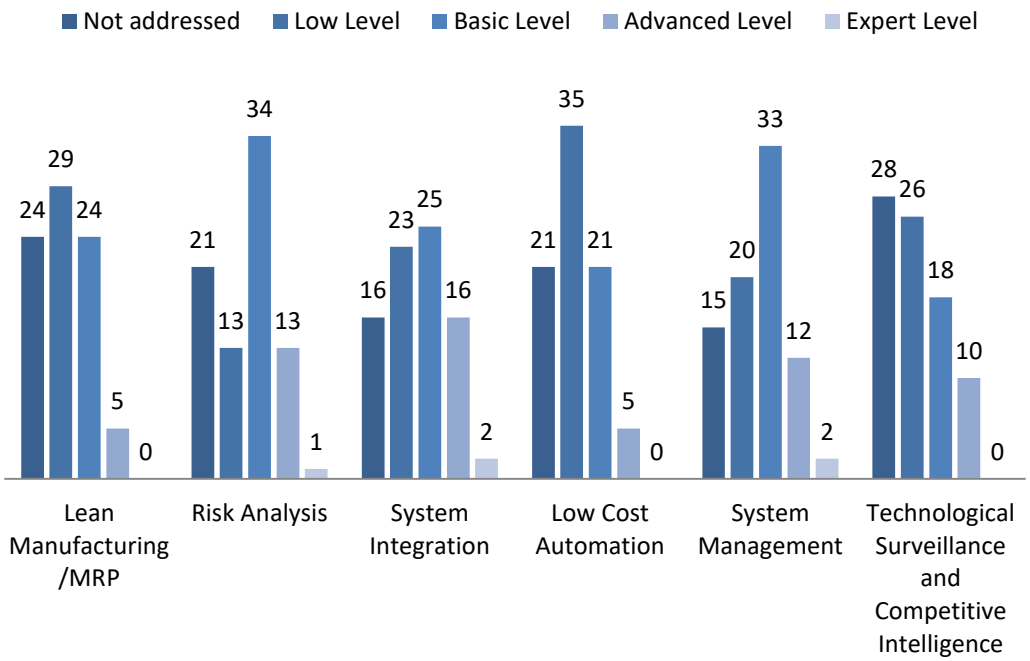

Figure 58 Results to question which topics are addressed in your current study programme and the level of knowledge required, for ICTS, KET topics in management systems and integration

Finally, two questions are launched to respondents with the aim of gathering their opinion about to be enrolled in a HE degree program which includes contents about the KET of I4.0 and what type of teaching-learning mode is the most suitable for them.

Results show that 78.04% of respondents could be interested in a further degree in M.Sc. program focused on I4.0 (see Figure 59).

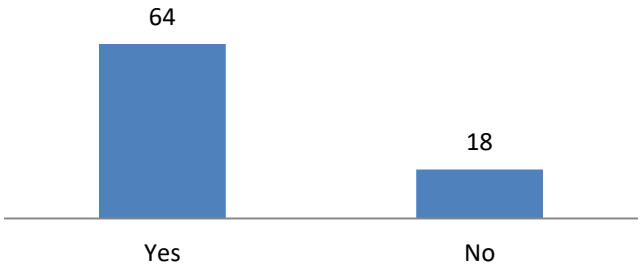

Figure 59 Responses to question: Would you consider pursuing a further degree in a M.Sc. program included towards I4.0?

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On the other hand, about teaching-learning mode (see Figure 60), 52.43% of respondents prefer as first option, online while 15.85% prefer combination (face-to-face, online) and only 9.75% prefer on-site. Regarding the scheduler of the program, 14.63% of respondents prefer modular-based, and 3.65% prefer to be scheduled in weekends. Finally, only 3.65% of respondents prefer a research-based program.

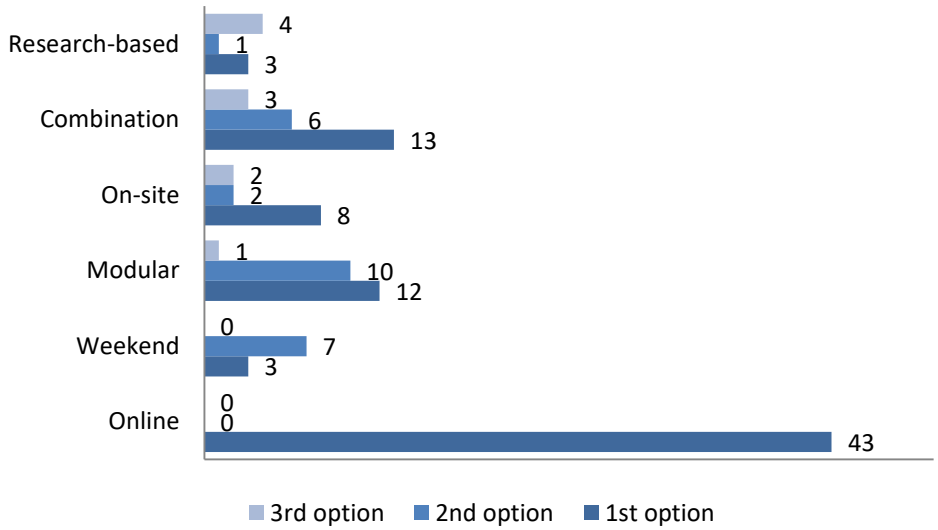

Figure 60 Responses to question: What would be the most desirable mode of delivery for such a program?

4.3 Analysis of responses from wood / furniture / habitat industry

4.3.1 Respondents profile

Regarding the position of the respondent in the industry the main profile was of Sales Manager with 26% of the respondents, followed closely by the CEO with a 25% and followed by far in third place by 9% of Marketing Managers. The first two categories represent approximately 50% of the 65 individuals who participated in the survey. Managerial positions predominate with 57% of the respondents whereas remaining 33% of the respondents held executive positions and 10% technical positions.

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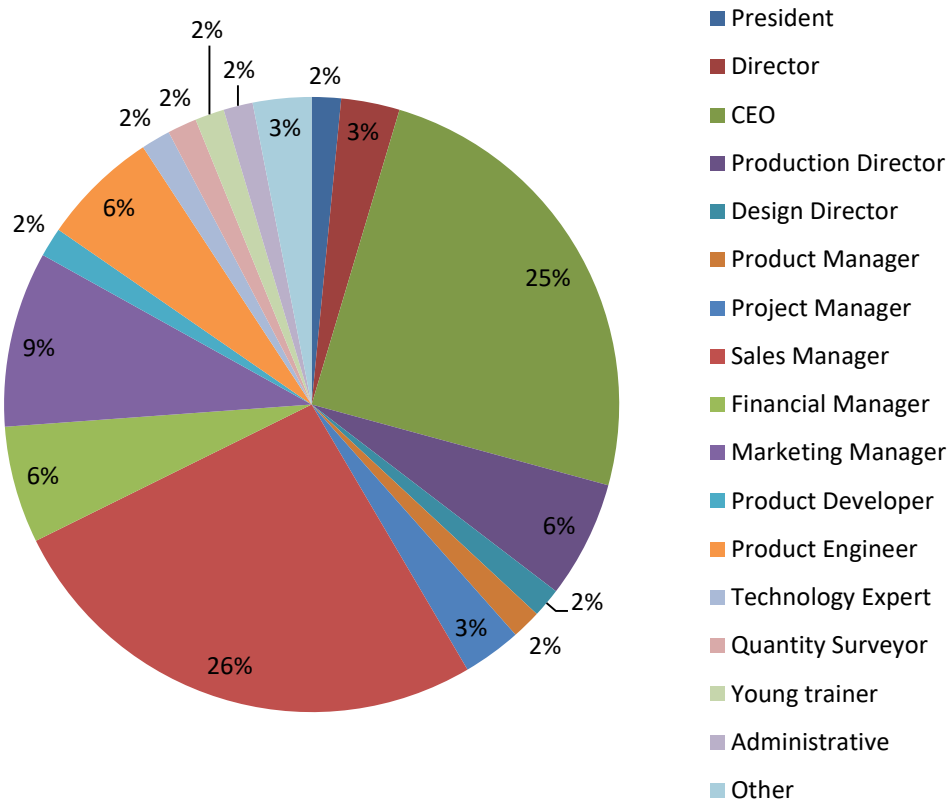

Figure 61 Distribution of responses by position of respondent

Respondents were also asked about their education level and the results are displayed in Figure 62. This figure shows that 31 of the respondents had Diploma degree or equivalent educational background whereas 21 had additionally a Bachelor degree. Only 9 respondents had a Master level and only 2 held a doctorate. Therefore, the respondents were equally distributed between those with university degree and those with non-university degree.

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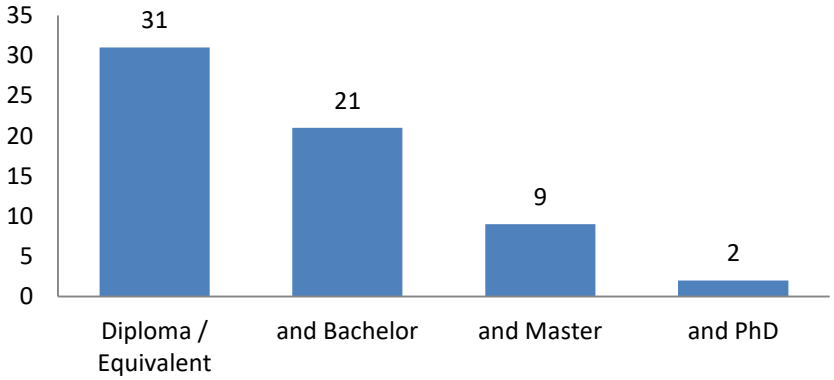

Figure 62 Distribution of responses by education level of the respondents

When asked for their courses or specialization programs their responses were very dissimilar (Figure 63). The answers indicated up to 10 different categories ranging from technical categories (i.e. 40% indicated sectors such as design, engineering or ergonomics) to business categories (60% indicated financial, marketing, human resources or management).

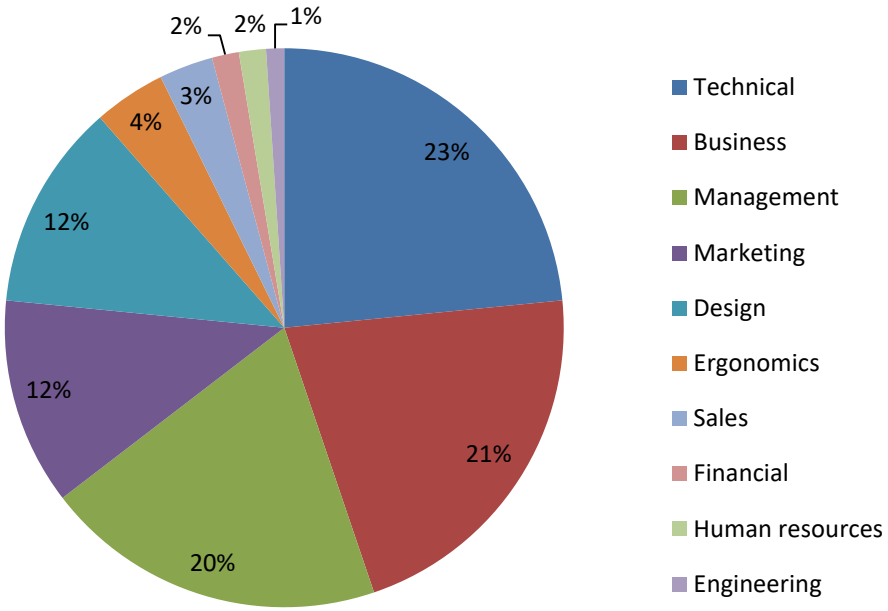

Figure 63 Program specialization of the respondents

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4.3.2 Respondents' opinion about training and I4.0 in companies

Next, the opinion of respondents on the training needs and the concept I4.0 in the companies were analysed. Support for training and education of employees among those surveyed is remarkable enough since 63% indicated *Yes* while 37% indicated said *No*. Also many of the respondents were familiar with the concept of industry 4.0 (with a 72% claiming to know it) and firmly believe that it is possible to apply it to the wood and furniture manufacturing industry. All these results are shown in Figure 64.

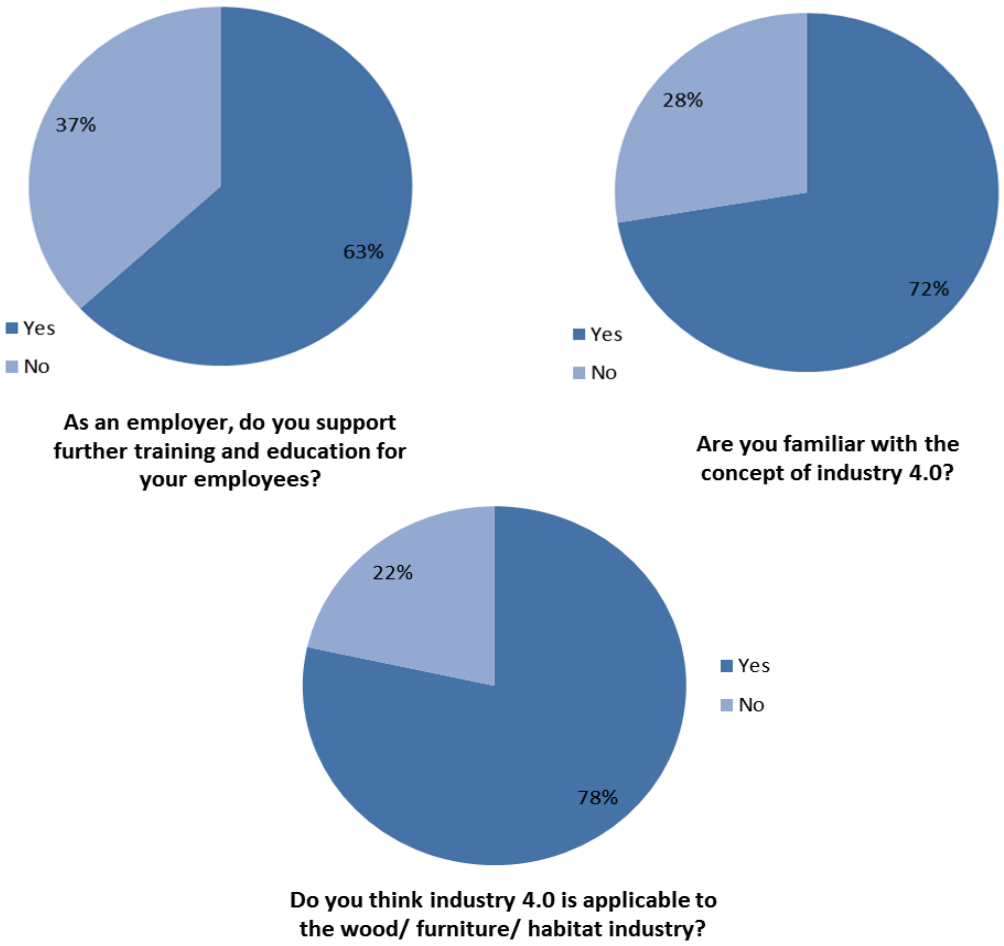

Figure 64 Distribution of responses by education level of the respondents

To those who answered positively to the previous question, were also asked to specify a bit more the reason for his belief. The results are shown in Figure 65. About one-third of those surveyed, they expected an increased productivity of its manufacturing processes and an

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increase in benefits. Also, a quarter of them indicated the possibility of introducing new products and opening up new markets (innovation in general) while one out of five respondents indicated as positive the development of the industry in general. Surprisingly few of them pointed out to cost or workforce reduction.

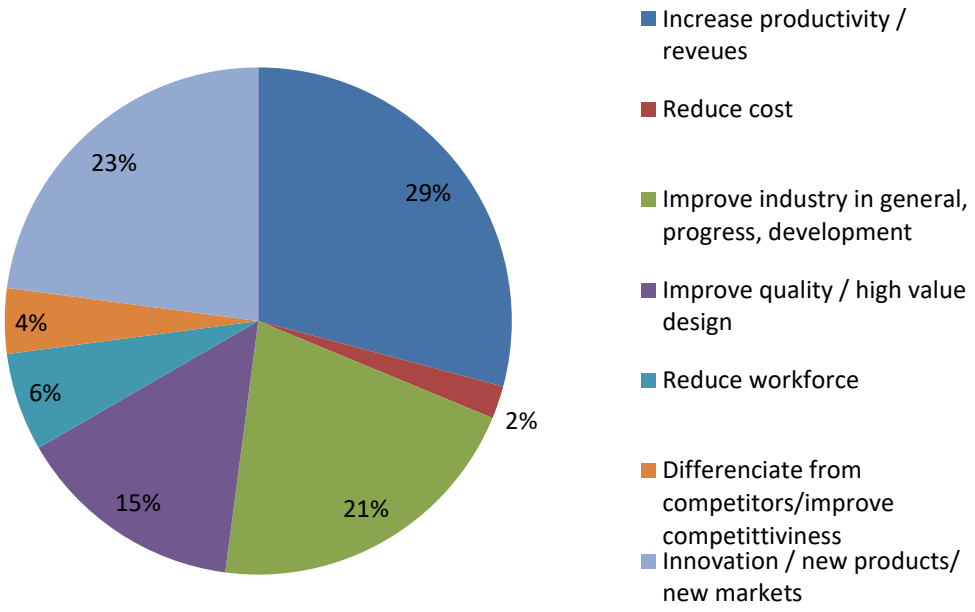

Figure 65 Reasons for application of I4.0 to wood and furniture manufacture industry

Also those who replied negatively were interrogated to be more precise on the reasons of their answer. The main reason given was the difficulty of implementation (35% pointed out to this factor), especially in small factories with traditional production methods, followed by the concern on the lack of knowledge and skills for workers and managers (17% of respondents). 12% of the surveyed claimed that I4.0 requires larger investment and has no added value for small factories. This analysis is displayed in Figure 66.

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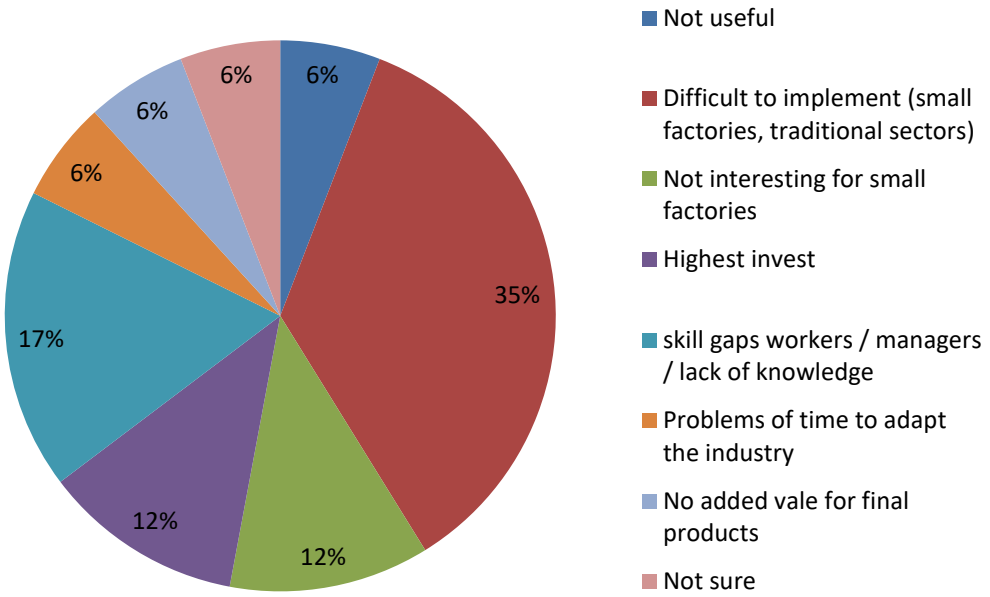

Figure 66 Reasons for application of I4.0 to wood and furniture manufacture industry

4.3.3 Company profile

65 responses were collected from 9 different EU countries: Bulgaria, France, Germany, Italy, Slovenia, Spain, Sweden, Poland and United Kingdom. Majority of respondents (72%) came from only three countries: Spain, Italy and UK with 37%, 23% and 22% respectively. Surprisingly, fewer responses were obtained in comparison from countries with a strong wood and furniture manufacturing industry such as Poland, Germany or Sweden.

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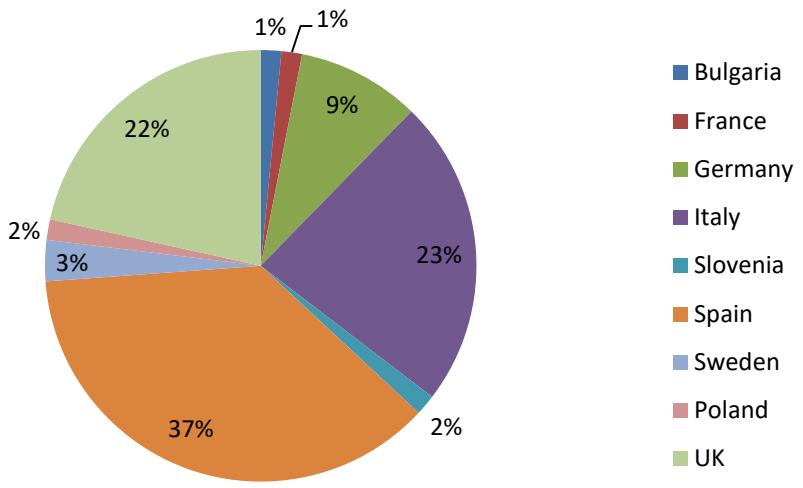

Figure 67 Distribution of responses from countries in the wood/furniture manufacture industry

The analysis of the size of the companies is displayed in Figure 68. Small businesses with less than 50 employees (25 replies, 38% of respondents) and companies of medium size (19 companies, 29% of respondents) are the main components of the businesses surveyed. These companies (67% of total) are fairly representative of the size of this sector in European companies. Also draws attention a significant number of micro-enterprises with less than 10 employees (23%). However, large companies with more than 250 employees were only 10% of respondents in this survey.

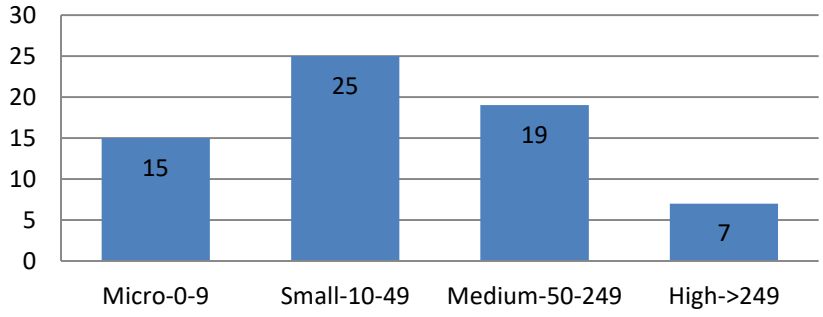

Figure 68 Size of the companies surveyed

With regards to the type of products manufactured by these industries (Figure 69) a significant majority of respondents were engaged in furniture fabrication (40%) followed by the sector of the upholstery (20%) and thirdly by chairs manufacturers (9%) and wood/furniture

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manufacture (8%) next. These four products add 75% of the respondents and would be in turn the main stakeholders of this project.

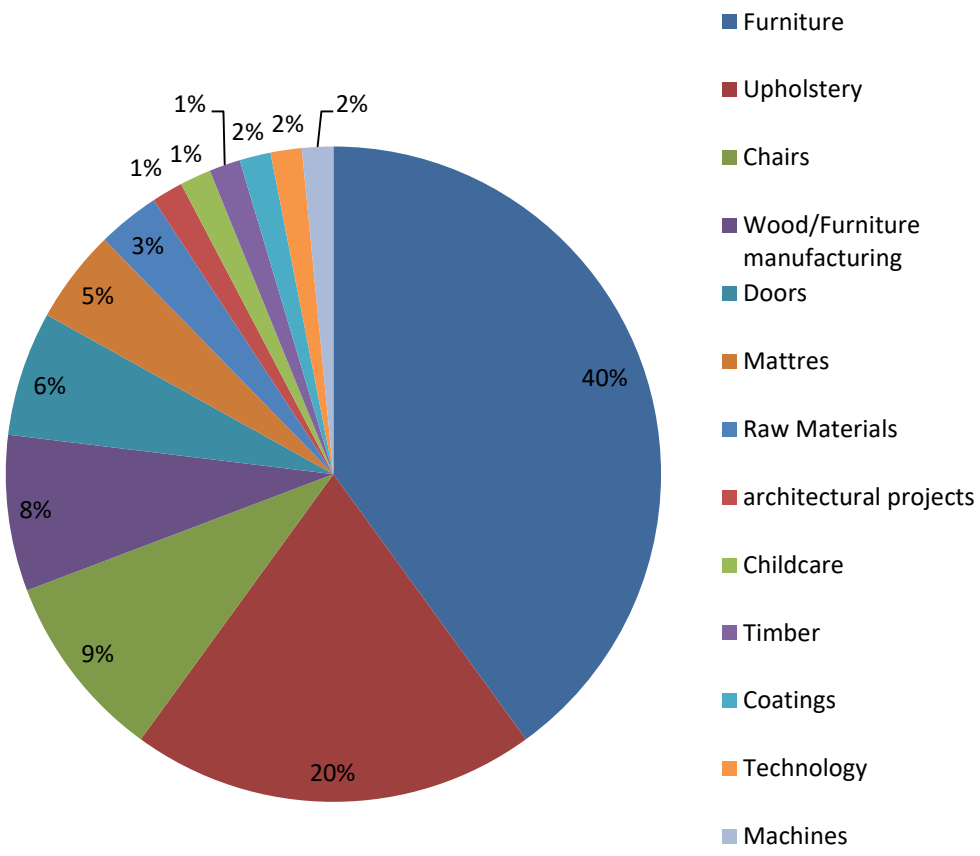

Figure 69 Type of products manufactured by the companies surveyed

On the other hand, as can be appreciated in Figure 70, 52% of respondents do business both in the domestic and international markets, 36% are devoted exclusively to the domestic market and the lowest proportion is businesses that are dedicated only to export (12%).

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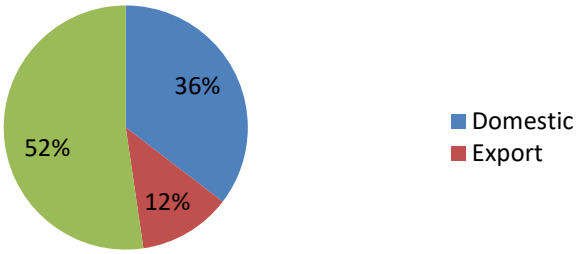

Figure 70 Market type of the companies surveyed

With regards to the formal education level of employees, the results gathered (Figure 71), show that in companies with 0-99 employees, the percentage of graduates is 29.25%; 27.96% in companies with 100-199 employees; and when the number of employees increases, the rate decreases up to 16.06% (200-299 employees) and 17.64% (300-399). Regarding big size companies, only three companies with 400 employees or more answered, indicating that all of their employees are graduated. We have doubts about the truthfulness of these answers, thinking that the respondents were not understand that graduate in this case refers to HE level.

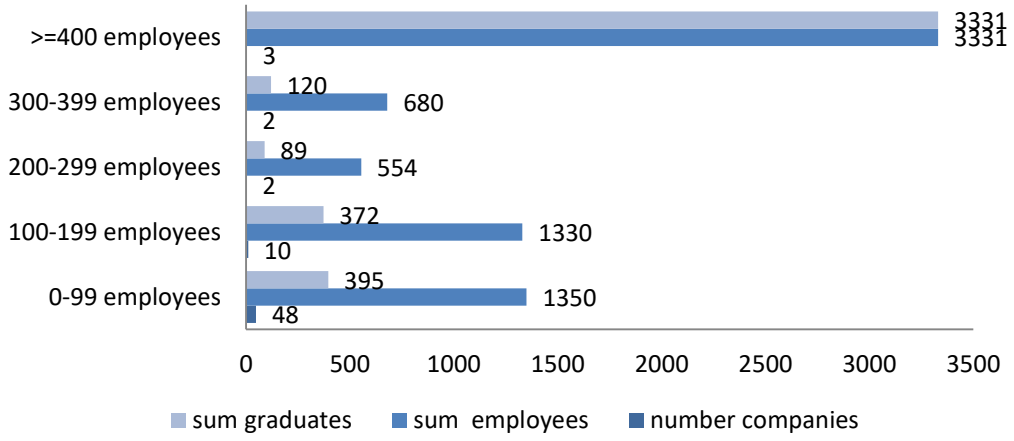

Figure 71 Results to the question "How many employees have formal education/graduates in your company?"

4.3.4 Companies' adoption to I4.0 and training support

In the next block will discuss the degree of adoption of the companies surveyed with regards to the industry 4.0 concepts and the degree of support of the business surveyed training in this field.

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In first place, respondents were asked about their current situation, namely, which of the I4.0 technologies were already in place in their respective companies. Results are displayed in Figure 72.

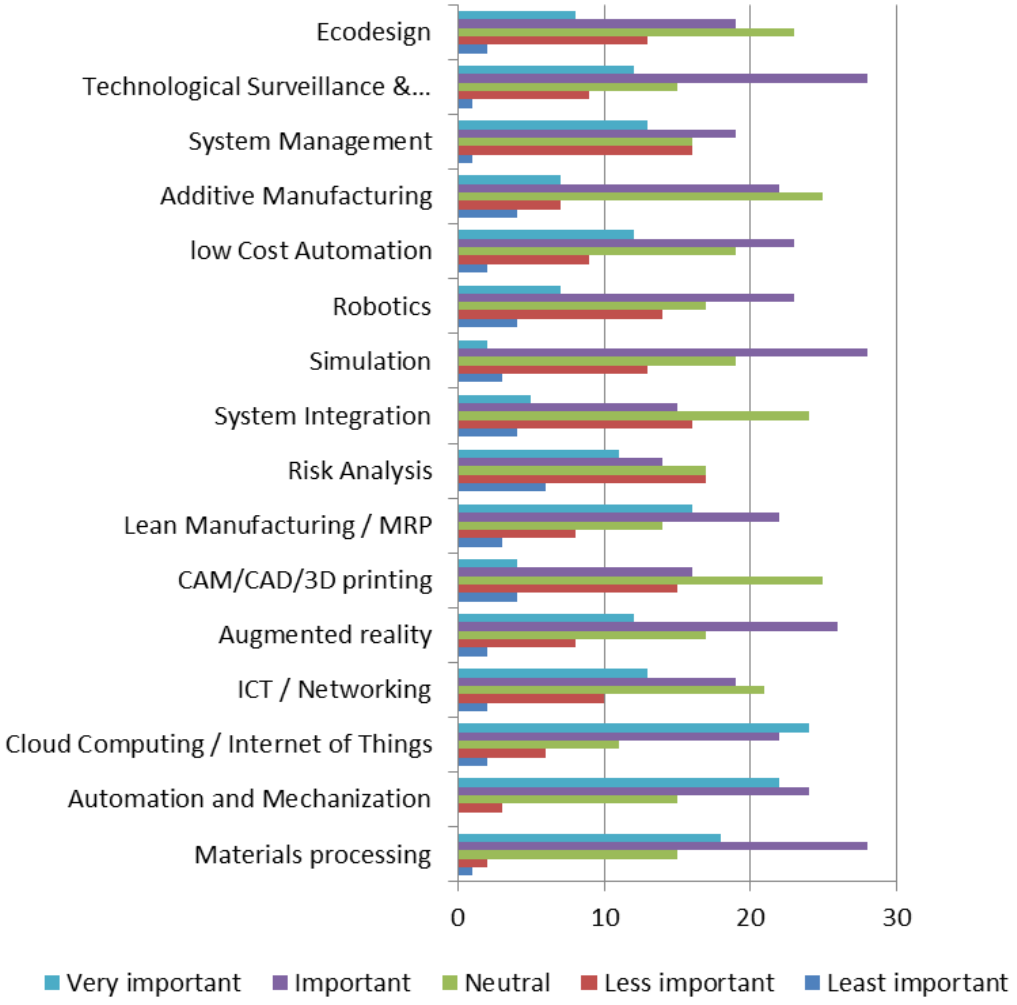

Figure 72 Results to the question "what of the following technologies/processes are already implemented in your company?

When the data in Figure 72 is analysed in detail, three technologies were considered as "important" or "very important" for the sector: They were Cloud Computing/Internet of Things, Automation and Mechanization and Materials Processing with 70% of both answers in each one of the technologies. These technologies were important enough for them so that they are already implementing them. On the other side some of these technologies were regarded as "least important" or "less important" for the sector: They were Risk Analysis

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(35% of both answers), System analysis (31%) and CAS/CAM/3D printing (29%). These seemed to be less important as compared to the others and they are not being applied.

Next, respondents were inquired by the technologies that they considered essential to be implemented in the next 5 years. Results to this question are illustrated in Figure 73. Respondents were identified as "important" or "very important" (86% of both responses), Robotics Automation and Mechanization (82%) and Augmented Reality (75%). This could give us a clue in the areas of training that the sector will need for upcoming graduates. At the other extreme, enterprises considered with a big difference (46%), that the knowledge in Wood Science will be “less important” or “least important” to the sector. This result is striking, because apparently, in this new era this knowledge seems that it will be relegated to the University environment and it will not be strictly necessary for industrial practice.

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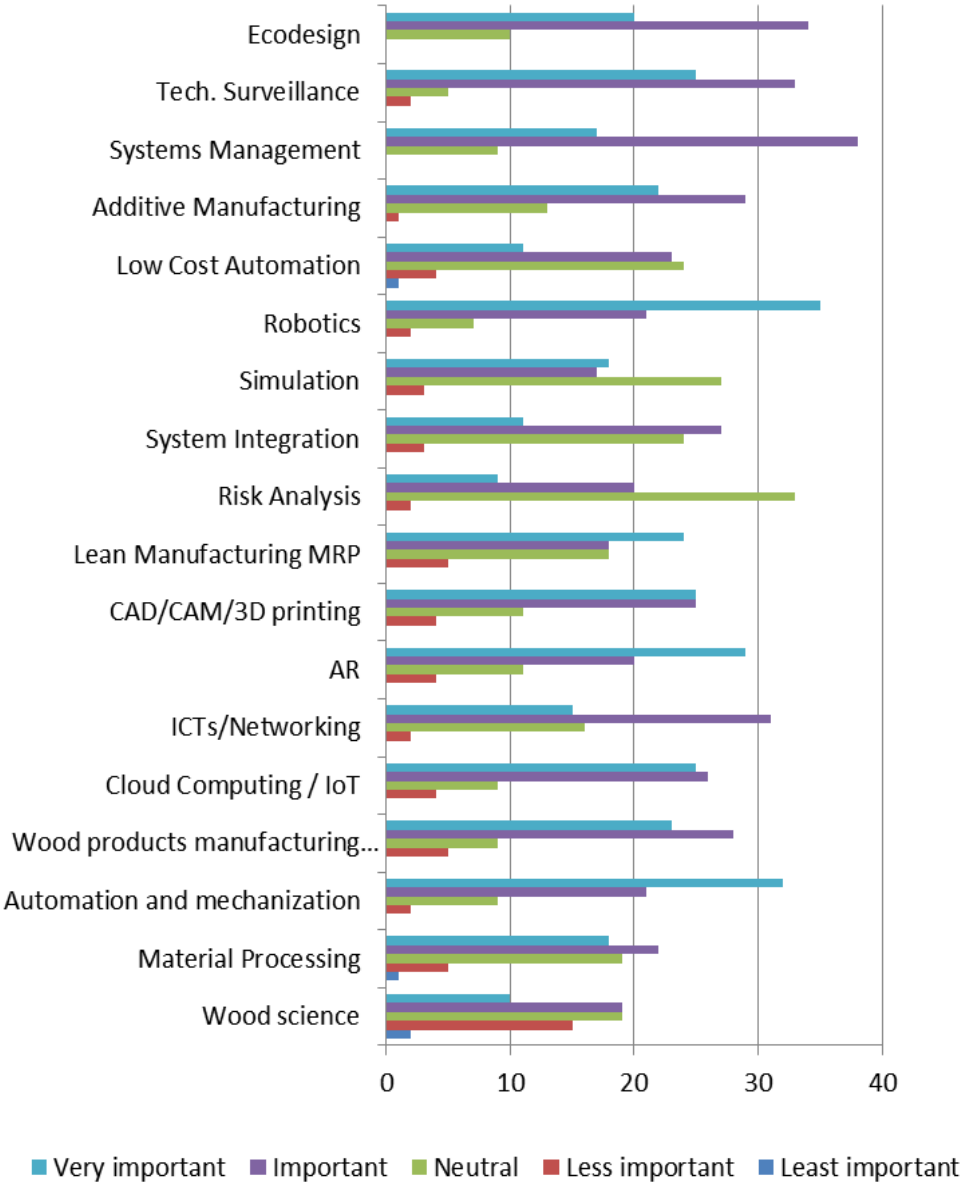

Figure 73 Results to the question "In any case, of the following technologies/ processes do you consider essential to be implemented in your company in the following 5 years?"

When they were asked if they would support their employees if they decide to pursue a program in Industry 4.0 the response was nearly unanimous: 89% of respondents said yes and only 11% said no (see Figure 74). This response encourages us to think that the results of this program will be of great interest to the sector and that any training resulting from it will have an acceptable demand.

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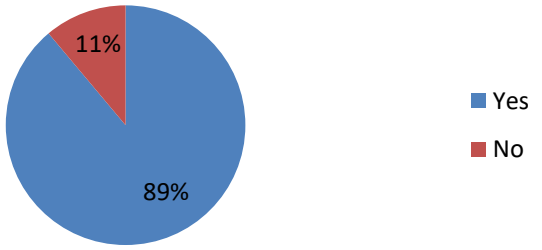

Figure 74 Results to the question "Would you support your employees if they choose to pursue a further degree program towards I4.0?"

Finally, respondents were questioned about which areas should be the priority focus in the development of new training programs. These results are shown in Figure 75. As can be seen, the respondents gave priority to matters such as Additive Manufacturing, Robotics, Ecodesign and Augmented Reality. These materials were evaluated by more than 90% of respondents as "important" or "very important". All materials of the proposals in the survey obtained high results, but "System Integration", "Risk analysis" and "Low cost automation" were shown as the least interesting.

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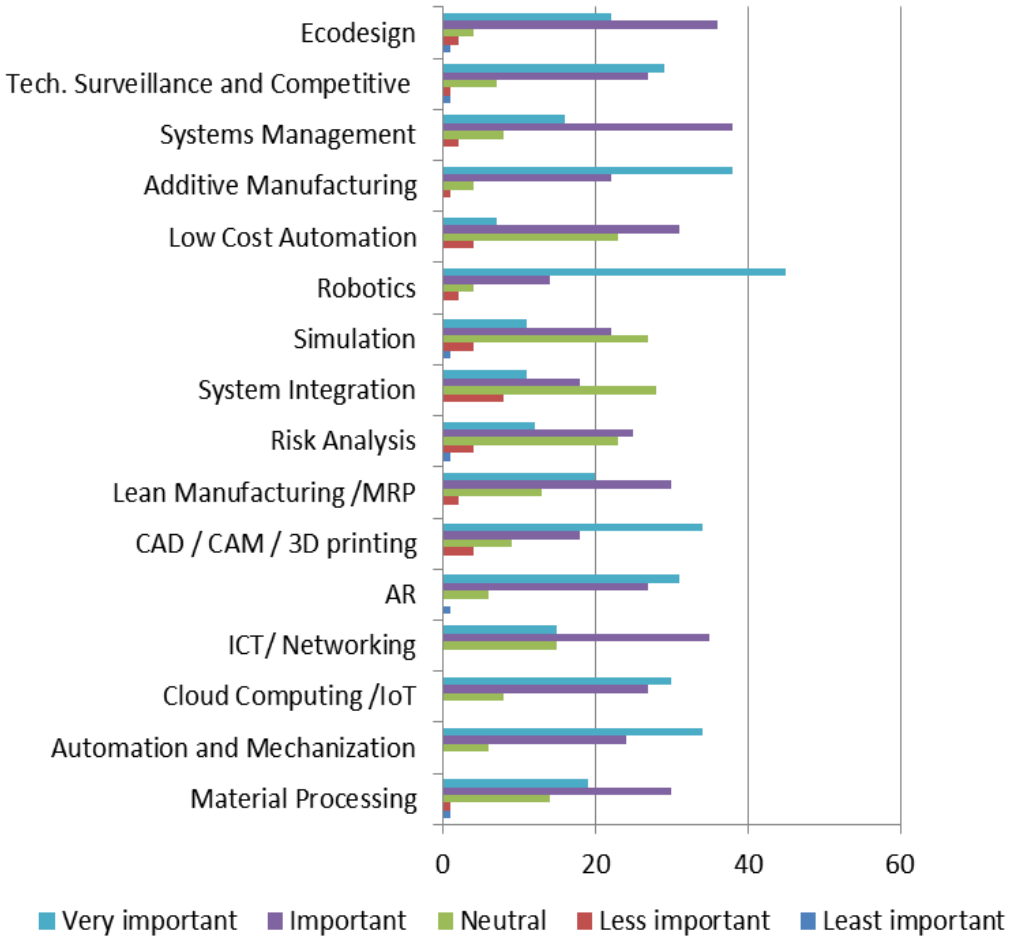

Figure 75 Results to the question "If a new training and education was developed to support employers in I4.0 in the wood, furniture and habitat sector, where should the priority focus be"

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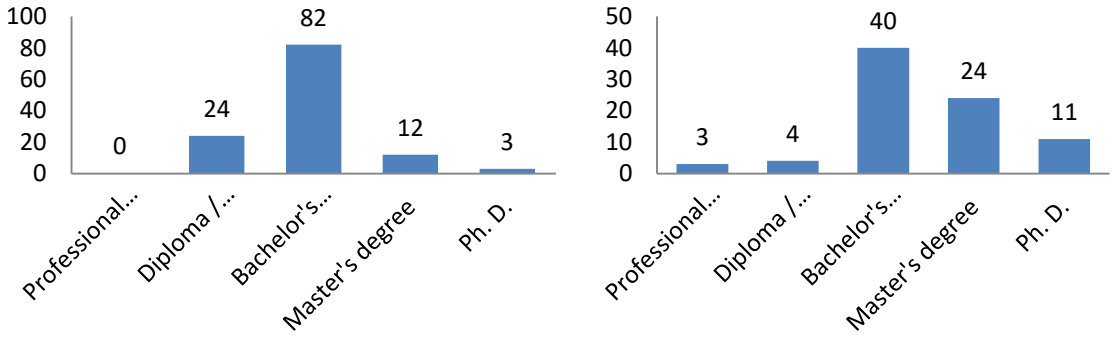
5. Comparison of Malaysian and European results. Gaps and needs identified in the HE and Industry in Malaysia.

In this section the data analysed regarding Malaysian and European HE and Industry in Sections 2.2 and 3.2 are compared with the aim of identified the strengths and weaknesses in both, and the gaps about the skills and competences demanded by the I4.0, in the specific case of Malaysia.

5.1 Comparison of Malaysian and European HE results

The questionnaires performed by Malaysian partners reported 131 responses from Asia, where 95% were from students and teachers in Malaysian HE institutions and the remaining 5% from Vietnam, Indonesia, Thailand and Philippines. We have filtered responses from Asia, taking only those from Malaysia (MY), 121 responses.

On the contrary, the responses gathered from Europe (EU) by European partners (82) were shared among eleven countries, being Spain and Germany those with the highest percentage of responses: 38% and 37% respectively.



(a) (b)

Figure 76 Comparison of Educational level of responders: (a) Malaysia, (b) Europe

The **educational level** of most of respondents in both Continents is Bachelor degree: 67'76% in Malaysia and 48.78% in EU. These are students target for a tentative new Master degree. But Diploma/Equivalent and Master's degree graduates could be also interested in improving their skills and competences with an innovate Master in I4.0. In

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this analysis their responses are the 24% (Dipl.) and 9.91% (MSc) of responses in MY and 4.87% (Dipl.) and 29.26% (MSc) in EU respectively.

The **program specialization** and/or field of expertise of the respondents vary in each Continent. In MY, most of respondents are from specialization close to wood, furniture, wood science or design (>70%). On the contrary, in EU only the 51% of respondents are in program specializations close to wood, furniture, design, architecture, production, logistic or manufacturing.

5.1.1 Employment interests and knowledge about KET of I4.0

The **field of expertise** has a **direct impact on the interest in seeking employment in the wood/furniture/habitat industry**, and also the importance of the industry in the countries where the respondents are from. Most of respondents in MY, 89%, answered they are interested in that sector as a job opportunity, while in EU only 45% of respondents were interested (Figure 77). Note that in EU, some of the positive responses come from people whose area of expertise is ICTs. As we stated in Section 3.2, this result could reflect the fact that the field of expertise in ICTs is transversal to all industrial sectors, and students in this field are open to job vacancies where they can apply their knowledge.

(a) (b)

Figure 77 Comparison of respondents about to seek employment in wood/furniture/habitat industry: (a) Malaysia (b) Europe

Respondents in both surveys have the same **opinion (good) about the importance of automation and mechanization in the wood / furniture / habitat industry** (Figure 78).

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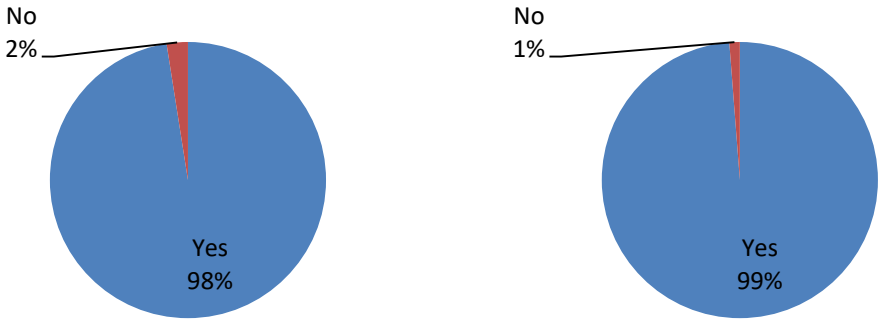

(a) (b)

Figure 78 Comparison of responses to question about if automation and mechanization is important to wood/furniture/habitat industry: (a) Malaysia, (b) Europe

Moreover, although most of them are conscious about the need of transforming industry to the digital evolution through automation and mechanization, in **MY and EU** the percentages are similar (l**ow**) when the respondents are asked if they are **aware of which technologies are used in the industry presently** (see Figure 79).

(a) (b)

Figure 79 Comparison of respondents about if they are aware of automation technologies used in the industry presently: (a) Malaysia (b) Europe

As we analysed in the previous sections, the **area of expertise has no influence on these results**, and these results could be influenced by the fact that respondents have not enough knowledge about automation and new technologies if they are running the first courses of a bachelor's degree, or maybe by other factors such us HE programs with obsolete

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contents, contents in subjects with low examples of application in industry, respondents with no experience in industry, etc.

Technologies (KET) in which the respondents are familiar with have been also analysed in Sections X and X. The percentages obtained in MY and EU for those technologies matching are quite different. Table below summarizes the responses in both surveys, setting in red colour those KET where the results obtained are different in more than ten points.

As it can be seen, in most of KET enumerated, **respondents from EU are more familiar with than those in MY**. Only in CNC and Robotics MY respondents show higher percentage. The low percentages obtained from MY respondents in many KETs seem coherent because these are emerging new technologies, missing in almost all HE degree programs, while 42% of respondents from EU have ICTs as field of expertise.

Industry 4.0 technologies	**KET**	**Who knows**	
		EU	**MY**
	Augmented reality	8.57%	1.79%
	Virtual reality	5.71%	1.79%
	Robotic	37.14%	23.21%
	3D printing/ additive manufacturing	31.42%	8.93%
	CNC	14.28%	32.14%
Telecommunication and data	Cloud Computing	20%	1.79%
	Communication Networks	5.71%	1.79%
	Big Data	28.57%	1.79%
	Automation technology	5.71%	8.93%

Table 5 Comparison of EU and MY responses about those KET familiar with

Respondents have been also asked about if they are familiar with the principles of Industry 4.0 in general. Responses differ in twelve points in MY and EU (see Figure 80), being **slightly higher the knowledge about the principles of I4.0 in EU.**

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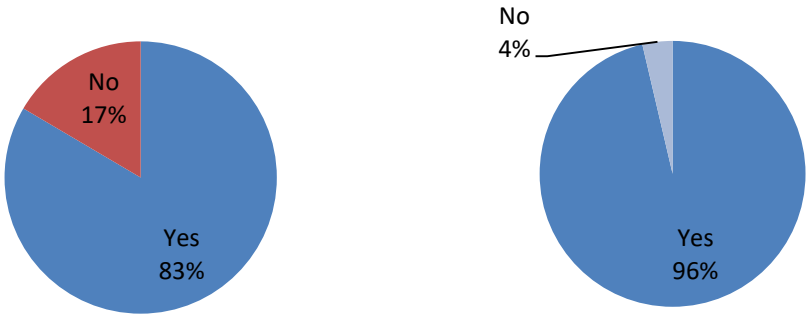
(a) (b)

Figure 80 Responses to question about if respondents are familiar with the principles of Industry 4.0: (a) MY respondents, (b) EU respondents

Respondents have been asked about if they believe Industry 4.0 is applicable to the wood/furniture/habitat industry. In both surveys is concluded that, **although a notable amount of respondents are not familiar with the principles of I4.0, most of them think that I4.0 can be applied to this sector** (Figure 81).



(a) (b)

Figure 81 Results of question "Do you think I4.0 is applicable to the wood/ furniture/ habitat industry?. (a) Responses in MY, (b) Responses in EU

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5.1.2 Contents in current HE degree programs and future of I4.0 in HE

In this section the responses about the contents of the current HE degree programs in topics related with I4.0 and wood/furniture/habitat field in MY and EU are compared, as well as the interest of respondents in a HE program focused on I4.0, and what teaching-learning mode is the most desirable.

The topics and results in Asia and EU have been analysed in depth in Sections 2.1 and 3.1 respectively. Here we compare the main results in Table 6, for reporting conclusions that can help to identify those gaps and needs in Malaysian HE.

Note that the goal is to detect if current HE degree programs include those key contents focused on KET, needed to address the industrial revolution, as well as contents focused on wood / furniture / habitat industry. Moreover, this question tries to know the level of knowledge of students/researchers in those topics.

Only those percentages about basic/low level and not addressed are included in the comparison. They give us interesting information about the lack of knowledge in the topics asked.

For those topics focused on wood/furniture/habitat, MY respondents show a better level than EU respondents. These results seem coherent because 48.78% of EU respondents have a program specialization different from these topics, that is, Engineering, Computer Science, ICTs, informatics, etc. However, the percentage of basic/low+not addressed in both is quite high, reaching 80% in almost all topics in EU and around 60% in MY, but Ecodesign, here the basic/low+not addresseed reaches more than 90% of respondents.

The results are in accordance with a previous study done by MY partners in [21] and EU partners in [22].

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		EU		MY	
		Basic Level	Low Level / didn't address	Basic Level	Low level / didn't address
Topic wood/furniture/design/etc	Wood Science	23.18	59.75	44.53	20.31
	Wood and material processing	28.06	53.65	43.08	16.15
	Wood production and management	19.51	60.97	41.86	19.38
	Ecodesign	21.95	56.09	51.96	41.18
Topics focused on KET of I4.0 (no management systems)	Cloud Computing / IoT	23.17	41.46	45.74	41.86
	ICT / Networking	21.95	43.90	39.53	36.44
	AR	31.70	60.97	29.92	57.48
	CAD/CAM/ 3D printing	20.73	35.36	39.23	41.45
	Simulation	30.48	47.56	32.81	51.56
	Robotics	29.26	64.63	23.02	63.49
	Additive Manufacturing	34.14	59.75	38.01	44.62
Topics focused on KETs of I4.0 regarding management system and integration in enterprises	**Lean Manufacturing / MRP**	29.26	64.63	35.94	47.66
	Risk Analysis	41.46	41.46	34.11	48.06
	System Integration	30.48	47.56	33.59	53.91
	Low Cost Automation	25.6	68.29	32.28	50.39
	System Management	40.24	42.68	44.11	40.94
	Tech. Surveillance & Competitive Intell.	21.95	65.85	36.72	51.56

Table 6 Summary of lack of knowledge about KET for EU and MY respondents

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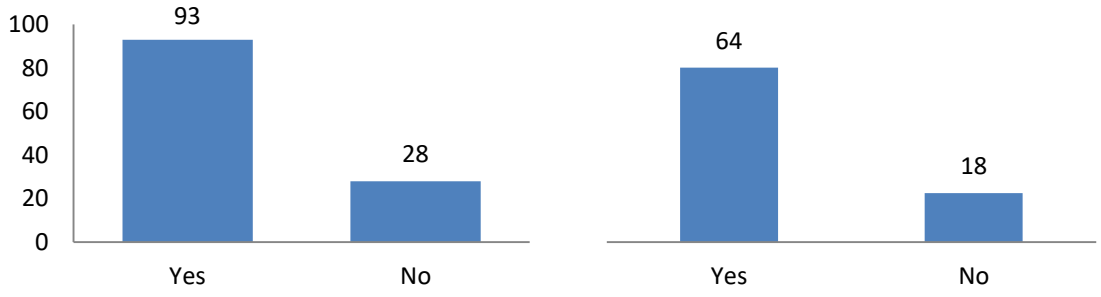
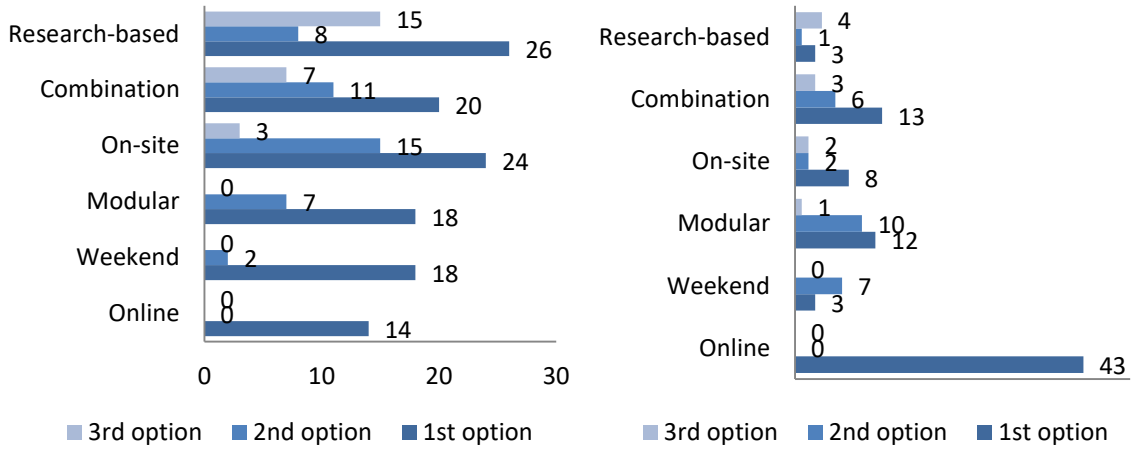
Finally, two more questions are compared: opinion about to be enrolled in a Master HE degree program which includes contents about the KET of I4.0 and what type of teaching-learning mode is the most suitable for them. In the former, more than 76% of respondents from MY and more than 78% of respondents in EU could be interested in a further degree in M.Sc. program focused on I4.0 (Figure 82 and 83).



(a) (b)

Figure 82 Comparison of question "Intention to be enrolled in a Master HE degree program oriented to KET technologies of I4.0 (a) Responses in MY, (b) Responses in EU



(a) (b)

Figure 83 Results of question "Type of training a Master degree program focused on KET of I4.0" (a) Responses in MY, (b) Responses in EU

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6. Qualification frameworks in Asia and Europe

Finally, the qualification frameworks being executed in Asia (also focused on Malaysia) and Europe are introduced, as a last contribution in WP1, and essential to the execution of WP2.

6.1 Asian Qualification Framework

Since this project is focused primarily on Malaysia, the following description of the qualification framework will be based on the existing Malaysian experience in this area. A review of the existing Asian Qualification Framework, especially those related to Thailand, Indonesia, the Philippines and Malaysia have somewhat found a lot of similarities.

The Malaysian Qualifications Framework (MQF) is Malaysia's declaration about its qualifications and their quality in relation to its education system. MQF is an instrument that develops and classifies qualifications based on a set of criteria that are approved nationally and benchmarked against international best practices, and which clarifies the earned academic levels, learning outcomes of study areas and credit system based on student academic load. These criteria are accepted and used for all qualifications awarded by recognized higher education providers in the country. Hence, MQF integrates with and links all national qualifications. MQF also provides educational pathways through which it links qualifications systematically. These pathways will enable the individual to progress through credit transfers and accreditation of prior experiential learning, in the context of lifelong learning.

The MQF sets basic qualifications standards rationalized, streamlined, and consolidated to cover all Malaysian post-secondary qualifications of the various sectors. Simply stated, the MQF and the learning outcomes it advocates are vital parts of the quality assurance practices of the MQA. The practice of programme accreditation focuses on inputs, systems, resources, outputs and measurable outcomes. International good practices and conventions requires all nationally conferred qualifications, subject to robust quality assurance assessments in order to ensure the quality of the learning experience which is transparent, consistent and recognized by users of the qualifications locally and internationally.

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The quality assurance standards will address seven areas as provided in the Code of Practice for Programme Accreditation (MQF 2nd edition, 2017) which incorporates the learning outcomes in all relevant aspects of the programme design and delivery aligned to programme development and delivery; assessment of student learning; student selection and support services; academic staff; educational resources; programme management; and programme monitoring, review and continual quality improvement as part of an institutional management and assurance system.

Learning outcomes must be made clear in the educational objectives of a programme at the course level, through constructive alignment and guided by the template/format provided. Teaching, learning and assessment strategies and methods are critical items in the accreditation exercise in the programme design and are assessed and verified in programmes accreditation exercises. The internal quality assurance system helps to inculcate institutional quality culture with regular internal monitoring and assessment whilst institutions concurrently seeking new and innovative ways of teaching, and assessment to enhance learning.

All academic and training programmes leading to the conferment of named qualifications are subjected to the three (3) stage assessment cycle. The process begins with an application for provisional accreditation to the Agency and approval to conduct the programme from Ministry of Higher Education (MOHE). On maturation of the programme, it will undergo an assessment for full accreditation and on receiving the full accreditation, subsequently it will be subjected to a further maintenance audit every five years. Those universities that have been granted self-accreditation powers must conduct similar internal processes to assure the quality of their programs.

Programmes which lead to professional recognition of regulated occupation/profession are subject to collaborative arrangement with a number of professional bodies in assessment and accreditation of these programmes and qualifications as the standards for accreditation is set by them. The accredited programmes are registered in the MQR, which undertakes the role of National Information Centre for all accredited and recognized programmes and qualifications in Malaysia.

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6.2 European Qualification Framework

The European Qualifications Framework (EQF) acts as a translation device to make national qualifications more readable across Europe, promoting workers' and learners' mobility between countries and facilitating their lifelong learning. The EQF aims to relate different countries' national qualifications systems to a common European reference framework. Individuals and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems. Since 2012, all new qualifications issued in Europe carry a reference to an appropriate EQF level.

The core of the EQF concerns eight reference levels describing what a learner knows, understands and is able to do – 'learning outcomes'. Levels of national qualifications will be placed at one of the central reference levels, ranging from basic (Level 1) to advanced (Level 8). This will enable a much easier comparison between national qualifications and should also mean that people do not have to repeat their learning if they move to another EU country.

The National Qualification Frameworks (NQF) in each European country of the MAKING consortium (Spain, Germany, Poland) have their own NQF, and must be verified in order to identify their correspondence with EQF and MQF with specific attention to professional educational level for guaranteeing harmonization of work and results in the MAKING 4.0 project progress.

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Level of qualification	Knowledge	skills
Level 1	Basic general knowledge	Basic skills
Level 2	Basic factual knowledge	Basic cognitive and practical skills
Level 3	Knowledge of facts, principles, processes and general concepts	Range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information
Level 4	Factual and theoretical knowledge in broad contexts	Range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study
Level 5	Comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in specialized field of work or study
Level 7	Highly specialized knowledge; critical awareness of knowledge issues in a field	Specialized problem-solving skills
Level 8	Knowledge at the most advanced frontier of a field of work or study	The most advanced and specialized skills and techniques, including synthesis and evaluation.

Table 7 Levels of the European Qualifications Framework

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References

[1] H. Kagermann, R. Anderl, J. Gausemeier, G. Schuh and W. Wahlster, "Industrie 4.0 in a Global Context: Strategies for cooperating with International Partners", Ed. acatech Study, 2016.

[2] Industry4WRD: national Policy on Industry 4.0. Ministry of International Trade & Industry (MITI) of Malaysia, Kuala Lumpur. 2018.

[3] Malaysia Education Blueprint 2015-2025 (Higher Education). Ministry of Education Malaysia, Kuala Lumpur, 2015.

[4] World Furniture Outlook 2017/2018- New 100 countries Edition' report. Center for Industrial Studies (CSiL), Milano, 2018.

[5] NATIP: National Timber Industry Policy 2009-2020. Ed. Secretary General Ministry of Plantation Industries and Commodities & MTIB, Kuala Lumpur, 2009.

[6] Furniture Industry Sector report, Mega Science 3.0. Available online at: https://bm.akademisains.gov.my/download/ms3.0/Furniture_Industry_Sector.pdf

[7] Is Malaysia ready for industry4.0?, white paper. Solidance Digital, Nov 2017. Available online at: http://www.solidiancedigital.com/insights/white-papers/is-malaysia-ready-for-industry-4-0

[8] M.V. Bueno-Delgado, J.L. Romero-Gázquez, P. Pavón-Mariño, F.J. Melero-Muñoz and G. Cañavate-Cruzado, "IN4WOOD: Developing an online and free training course to adapt the curricula of workers and managers of wood and furniture sector to the skills required in the Industry 4.0", in Proc. of 9th International Conference on Education and New Learning Technologies (EDULEARN 2017), July 2017.

[9] Industria Conectada 4.0. Available online at: http://www.industriaconectada40.gob.es/Paginas/index.aspx

[10] Factory of the Future (FoF). Available online at: http://ec.europa.eu/research/industrial_technologies/factories-of-the-future_en.html

[11] European Commission, Communication: Digitising European Industry-Reaping the full benefits of a Digital Single Market, 2016. Available online at: https://ec.europa.eu/digital-single-market/en/news/communication-digitising-european-industry-reaping-full-benefits-digital-single-market

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[12] VDI, ASME, A Discussion of Qualifications and Skills in the Factory of the Future: A German and American Perspective. Abril 2015. Available online at: http://www.vdi.eu/fileadmin/vdi_de/redakteur/karriere_bilder/VDI-ASME__2015__White_Paper_final.pdf

[13] Markus Lorenz, M., Küpper D., Rüßmann M., Heidemann, A., Bause, A., Time to Accelerate in the Race Toward Industry 4.0, May 2016. Available online at: https://www.bcgperspectives.com/content/articles/lean-manufacturing-operations-time-accelerate-race-toward-industry-4

[14] Erasmus+ Project IN4WOOD. Available online at: https://in4wood.eu/

[15] Erasmus+ Project E3D+VET. Available online at: www.e3dplusvet.eu

[16] Erasmus+ Project IMFUTURE. Available online at: http://www.im-future.eu/

[17] PROVET 4.0. Available online at: http://provet40.eu/es

[18] SO-SMART. Available online at: http://cordis.europa.eu/project/rcn/109048_en.html

[19] HIGHTECH EUROPE. Available online at: http://www.hightecheurope.eu/the-project.html

[20] Developing and running an establishment skills survey Guide to anticipating and matching skills and jobs, CDEFOP. Available online at (last accessed 27/03/2019):

http://www.cedefop.europa.eu/de/publications-and-resources/publications/2219

[21] J. Ratnasingam, M. McCormick, T. Elangovan and H. Nazim. “Extent of Automation and Readiness of Wood Products Industry in Malaysia to Industry 4.0”, in Industrial Automation Workshop, Malaysian Industrial Development Authority (MIDA), 13 September 2017, Kuala Lumpur.

[22] M.V. Bueno-Delgado, J.L. Romero-Gázquez, G. Cañavate-Cruzado and F.J. Melero-Muñoz, “Gaps between skills required by Industry 4.0 and academic programs focused on ICTs: a case study of Computer Science degrees in a Spanish University”, in 10th annual International Conference of Education, Research and Innovation (ICERI 2017), Nov. 2017.

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Annex I Responses of Malaysian HE from country and institution

Country	Institution	Acronym	Responses
Malaysia	Universiti Putra Malaysia	UPM	14
	Universiti Sains Malaysia	USM	23
	Universiti Teknologi Mara	UiTM	7
	Universiti Kebangsaan Malaysia	UKM	37
	Polytechnic Shah Alam	PSA	2
	Polytechnic of Kota Kinabalu	PKK	21
	Universiti Malaysia Kelantan	UMK	8
	Universiti Tun Hussein Onn Malaysia	UTHM	1
	Universiti Malaysia Terengganu	UMT	1
	Universiti Malaysia Sarawak	UNIMAS	2
	Universiti Malaysia Sabah	UMS	2
	Universiti Selangor	UniSEL	1
	Universiti Teknologi Malaysia	UTM	2
	Universiti Kuala Kumpur	UniKL	1
	University College of Technology Sarawak	UCTS	2
	Universiti Sains Islam Malaysia	USIM	1
Philippines	University of the Philippines at Los Banos	UPLB	2
Indonesia	Bogor Agricultural university	IPB	1
Vietnam	Vietnam National University of Forestry	VNUF	1
Thailand	Kasetsart University	KU	1
	King Mongkut University of Technology	KMUT	1

Table 8 List of responses of Malaysian HE, classified by country and institution

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Annex II Responses of Malaysian Wood/Furniture/Habitat industry from country and company name

Country	Company name
Malaysia	Acacia Home Furnishing
	Aik Chee Furniture
	Artak Design
	Boston Office Furniture
	Bowlman Furniture
	CLS Furniture
	Decor Trend
	Elk-Desa Furniture
	Eureka Home Furnishing
	Euro Chairs Manufacturing
	Eurospan Furniture
	Evergreen Fiberboard
	Fella Design
	Formosa Cabinets
	Furnstar Concept
	Gao Sheng Furniture
	Golden Home Elegance
	Grand Victery Furniture
	Green Panel Products
	Yen Zoon Industries Sdn Bhd
	Heveaboard S/B
	Segamat Panel S/B
	Dongwha Malaysia
	Pesama Timber Products
	Fow Seng Industries
	Heveapac
	Inter Multi Furniture
	Jemaramas Jaya
	Justfurn
	KGF Resources
	KLF Furniture
	Len Cheong Manufacturing
	LF Furniture
	Mau Sin bentwood Industry
	MerryFair Chair Systems
	Mieco Manufacturing
	Muar Industries

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	Nicolo Designs
	Oasis Furniture
	Poh Huat Furniture Industries
	Seng Yip Furniture
	SJY Furniture
	SHH Industries
	LY Furniture
	TA Furniture
	Wegmans Furniture
	Yeo Aik Wood Industries
	Corinthians
	Weng Meng Industries
	Ivory Pearl International
	KTL Industries
	Samling Housing Products
	BKB Industries
Taiwan	Green River Wood
	Hotwin Furniture
	Latitude Tree
	Kao Yang Industries
Thailand	Nature Corners
	Thai Falang Golden Teak
Vietnam	Woodnet
	Hoang Moc Furniture
	PMA Furniture
Indonesia	Pijar Sukma Furniture
	Wisanka Furniture
	Kalingga Jati

Table 9 List of Asian Companies surveyed

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Annex III Responses of European HE from country and institution

Country	Institution	Acronym	Responses
Spain	Universidad Politécnica de Cartagena	UPCT	19
	Universidad Politécnica de Valencia	UPV	2
	Universitat Oberta de Catalunya	UOC	2
	Universidad de Murcia	UMU	1
	Universidad de Alicante	UA	1
	Universidad de Granada	UGR	1
	Universidad Católica de Murcia	UCAM	1
	Universidad del Pais Vasco/ Eskalherriko Unibersitatea	UPV/EHU	1
	Universidad de Vigo	UVI	1
	Servicio de Empleo y Formación	SEF	1
	Higher School Castillo Puche	ISECP	1
Germany	Karlsruhe Institute of Technology	KIT	21
	Hamburg University of Technology	TUHH	2
	University of Applied Science Karlsruhe	HKTW	3
	Technische Hochschule Rosenheim	THR	2
	Heidelberg University	HU	1
	Heinrich-Hübsch-Schule	HHS	1
Poland	Warsaw University of Life Sciences	WULS	9
	Wroclaw University	UWr	1
Estonia	Tallin University	TLU	3
Italy	Politécnico di Torino	POLITO	1
	Sant'Anna School of Advanced Studies - Pisa	SSSA	1
Austria	Technische Universität Wien	TUW	1
Croatia	University of Zagreb	UniZG	1
Georgia	Georgian Technical University	GTU	1
Irlanda	University College Dublin	UCD	1
Portugal	University of Beira Interior	UBI	1
Slovenia	Univesrity of Primorska	UP	1

Table 10 List of responses of European HE, classified by country and institution

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Annex IV Responses of Wood/Furniture/Habitat industry from country and company name

Country	Company name
Bulgaria	Bulgarian Chamber of Commerce and Industry
France	Hess France
Germany	KAMO GmbH
	SchwörerHaus KG
	Thole
	Pfleiderer
	Binos GmbH
	Festool
Italy	Bardi
	Mobilificio Fattorini
	Effeti Industrie
	Aurora
	Antique Mirror
	Sedex
	Mobilificio Benedetti
	Segis
	VITAP
	Spazio Arredo
	Marioni SRL
	Matrix International SRL
	Albero Bambino
	LIAF di Fossi Graziano
	Lualdi
Poland	Kupsa Polska Sp. z o.o.
Slovenia	Melu mizarstvo d.o.o.
Spain	Fama
	Acomodel
	Puertas Perciber
	Bricosureste
	Mosser
	Xuppins
	Puertas Castalla
	Caudex Mobel
	Micuna S.L.
	Lax Sofa

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	Mapay
	Tapicerias Navarro
	Eccus
	Sancal
	Mobil Fresno
	EGA
	Altinox Francisco Muñoz Marti
	Tapiline S.L.
	Comercial Muñoz
	Puertas Padilla SL
	Contract line
	Ibblo
	Indra Sistemas TI
	Galindo
Sweden	IKEA Poland
	IKEA
UK	British Coatings Federation
	DFD
	Leisure and Outdoor
	Richard Byrne
	Lathams
	AL Furniture Production
	Brewers
	Silent Night
	BedrIght
	Parker Knoll
	Westbridge
	Art Forma
	Gascoigne Designs
	AJ Way

Table 11 List of EuropeanCompanies surveyed

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Improving Malaysian HE Knowledge Towards a Wood and Furniture Industry 4.0

Deliverable 1.2

Report of gaps and needs of the Malaysian HE and Industry in comparison with Europe

Dissemination level: National / International

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