

Improving Malaysian HE Knowledge Towards a Wood and Furniture Industry 4.0



Deliverable 2.1: Learning outcomes

Prepared	Verified	Approved
CETEM	All consortium	

Dissemination level: National, International

Disclaimer: The European Commission support for the production of this publication does not constitute endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



Track of changes

Date	Changes	Status
21/10/2019	1 st edition of the document	Draft

Partners

P1	Universidad Politécnica de Cartagena	UPCT	SP
P2	Warsaw University of Life Sciences	WULS	PL
P3	Karlsruhe Institute of Technology	KIT	GE
P4	Centro Tecnológico del Mueble y la Madera	CETEM	SP
P5	Universiti Putra Malaysia	UPM	MY
P6	Universiti Teknologi MARA	UiTM	MY
P7	Universiti Kebangsaan Malaysia	UKM	MY
P8	Universiti Sains Malaysia	USM	MY
P9	Malaysia Timber Industry Board	MTIB	MY

Index

0. Introduction	5
1. Selection of the necessary gaps and needs to be covered.....	6
1.1 Wood, furniture manufacturing processes, and design topic.....	7
1.2 Key Enabling Technologies (KETs) of Industry 4.0	7
1.3 Management system and integration in enterprises	8
1.4 Selected needs and gaps.....	9
2. Learning outcomes: introduction.....	10
2.1 Definition.....	10
2.2 Knowledge, skills and competences.....	10
3. The Malaysian Qualification Framework 2.0 addressed by Making4.0.....	12
3.1 Learning outcomes.....	12
3.2 Making4.0 level based on MQF2.0	12
3.3 Learning outcomes vs Master’s Degree level of learning	14
4. Learning outcomes of Making4.0.....	16
4.1 Knowledge, skills & competences.....	16
4.2 Programme learning outcomes	21
5. Programme Learning Outcomes vs MQF2.0 learning outcomes	27
6. Conclusions	28
References	29
Annex I. Description on Learning Outcomes Clusters by the MQF2.0	30

List of figures

Figure 1. Pillars of Industry4.0	8
Figure 2. Selected needs and gaps to be covered	9
Figure 3. Learning outcomes definition	10

List of tables

Table 1. Defined gaps and needs in WP1	6
Table 2. Identified gaps and needs for wood, furniture manufacturing processes and design topic.....	7
Table 3. Identified gaps and needs on management system and integration in enterprises topic	9
Table 4. MQF2.0 level definition. Source: MFQ2.0	13
Table 5. Level descriptors for Master (level 7) by the MQF2.0.....	15
Table 6. Knowledge, skills and competences of topic 1	17
Table 7. Knowledge, skills and competences of topic 2	19
Table 8. Knowledge, skills and competences of topic 3	21
Table 9. Programme Learning Outcomes of Making4.0 Master’s Degree	21
Table 10. Knowledge, skills and competences grouped in each PLO.....	26
Table 11. Programme learning outcomes vs MQF2.0 learning outcomes	27

0. Introduction

This document reports the results performed in task “**T2.1: Definition of learning outcomes**” in the framework of the **WP2 “Training path, learning content structure and methodological aspects”**.

The aim of this task, led by CETEM, is to define the learning outcomes of the future Making4.0 Master Degree in the form of specific knowledge, skills and competences. Learning outcomes will be defined based on the work performed in M1-M6 towards WP1 “Analysis and comparison of the current HE training offer and furniture and woodworking industry”. The results of WP1 were reported in deliverables 1.1, 1.2 and 1.3. Deliverable 1.1 (D1.1) summarized the information of the research and surveys done to Higher Education institutions and furniture and wood companies in Malaysia (MY) and countries in the European Union (EU). Deliverable 1.2 (D1.2) got in depth with the results provided in D1.1, in order to highlight the gaps and needs of the Malaysian Higher Education (HE) and furniture and wood industry, to adapt them to the challenges imposed by the Industry4.0. The results were also compared with those obtained from European HE and industries in the wood and furniture sector.

The gaps and needs identified in D1.2 are the starting point for the learning outcomes definition. This task must be done following the guidelines of the European Centre for the Development of Vocational Training (CEDEFOP), which defines the knowledge, skills and competences in wood and furniture sector [1]; Moreover, the learning outcomes must be in accordance with the Malaysian Qualification Framework 2nd edition [2], because they have to fulfil all the necessary requirements for the future accreditation of Making4.0 Master Degree.

With this work we have achieved **Milestone 2**: “Define and describe learning outcomes”. Moreover, this work is also linked to specific project objective **SO2**: “Create an innovative learning pathway able to provide HE students the most important competences and skills related with Industry4.0. This new learning pathway will aim to improve the level of specific and transversal competences and skills, with particular regard to those relevant for the labour market in the furniture sector, such as management, entrepreneurship, language competences and leadership”.

The results of this report are an essential point for the correct development of the WP2, as will set the basis for the future Joint Curriculum that has to be defined in **T2.2 “Design and organization of training paths: Joint Curriculum”**.

1. Selection of the necessary gaps and needs to be covered

The conclusions of WP1 “Analysis and comparisons of the current HE training offer and furniture and woodworking industry” pointed out a set of gaps and needs (Table 1), extracted from the answers received in the EU and Malaysian industry needs and the Malaysian and EU students’ knowledge:

Topic		What MY Industry thinks			EU industry opinion	MY student's knowledge through HE degrees
		Important / Very Important %				
		In use	To be implemented	To train	To train	(basic/low/no addressed)
Topic wood/furniture/design/etc	Wood and material processing	100	100%	100	75.38	59.23
	Automation and Mechanization	96.29	98.14	100	90.62	82.67
	Ecodesign	3.7	77.7	81.48	89.23	93.14
Topics focused on KET of I4.0 (no management systems)	Cloud Computing / IoT	90.74	42.59	72.22	87.69	87.6
	ICT / Networking	29.62	81.48	90.74	76.92	75.97
	AR	77.77	1.85	16.66	89.23	87.4
	CAD/CAM/ 3D printing	3.7	87.03	88.88	80	80.68
	Simulation	3.7	1.85	5.55	50.76	84.37
	Robotics	3.7	31.48	44.44	90.76	86.51
	Add. Manufacturing	92.59	1.85	5.55	92.3	82.63
Topics focused on KETs of I4.0 regarding management system and integration in enterprises	Lean Manufacturing/MRP	88.88	70.37	88.88	76.92	83.6
	Risk Analysis	68.5	1.85	7.4	56.92	82.17
	System Integration	3.7	1.85	5.55	44.61	87.5
	Low Cost Aut.	24.07	74.07	92.59	58.46	82.67
	System Manag.	0	7.4	7.4	84.37	85.05
	Tech. Surveillance and Competitive Intelli.	7.4	1.85	5.55	86.15	88.28

Table 1. Defined gaps and needs in WP1

As Table 1 shows, needs and gaps have been grouped in 3 main topics. These are analysed in depth in next subsections, for selecting those that must be covered.

1.1 Wood, furniture manufacturing processes, and design topic

The defined gaps and needs for this topic are considered very important to be implemented and to train by the Malaysian industry. Only ecodesign shows a lower percentage of importance about to be implemented. Moreover, the lack of knowledge about wood and material processing by students is remarkable.

Topic		What MY Industry thinks Important / Very Important %			EU industry opinion	MY students knowledge through HE degrees
		In use	To be implemented	To train	To train	(basic/low/no addressed)
Topic wood/furniture/design/etc	Wood and material processing	100	100%	100	75.38	59.23
	Automation and Mechanization	96.29	98.14	100	90.62	82.67
	Ecodesign	3.7	77.7	81.48	89.23	93.14

Table 2. Identified gaps and needs for wood, furniture manufacturing processes and design topic

From the previous analysis, it can be concluded that the Making4.0 Master's Degree should cover the three defined gaps and needs: wood and material processing; automation and mechanization; and Ecodesign.

1.2 Key Enabling Technologies (KETs) of Industry 4.0

Under this topic it has been covered all the main pillar technologies of Industry4.0. Although the Malaysian industry does not consider very important to be trained or implemented some of these technologies (e.g. Augmented Reality, Simulation or Additive Manufacturing), the opinion of the EU industry is completely opposite, and all technologies are considered important to be trained by more than 50% of the surveyed.

Since the main goal of Making4.0 project and result of the project is a Master's Degree on the implementation of Industry4.0 on the wood and furniture industry in Malaysia, it should not be dismissed any of the main pillars of the Industry4.0 concept (figure 2). Thus, it has been decided to cover all the needs and gaps (technologies) about Industry4.0.

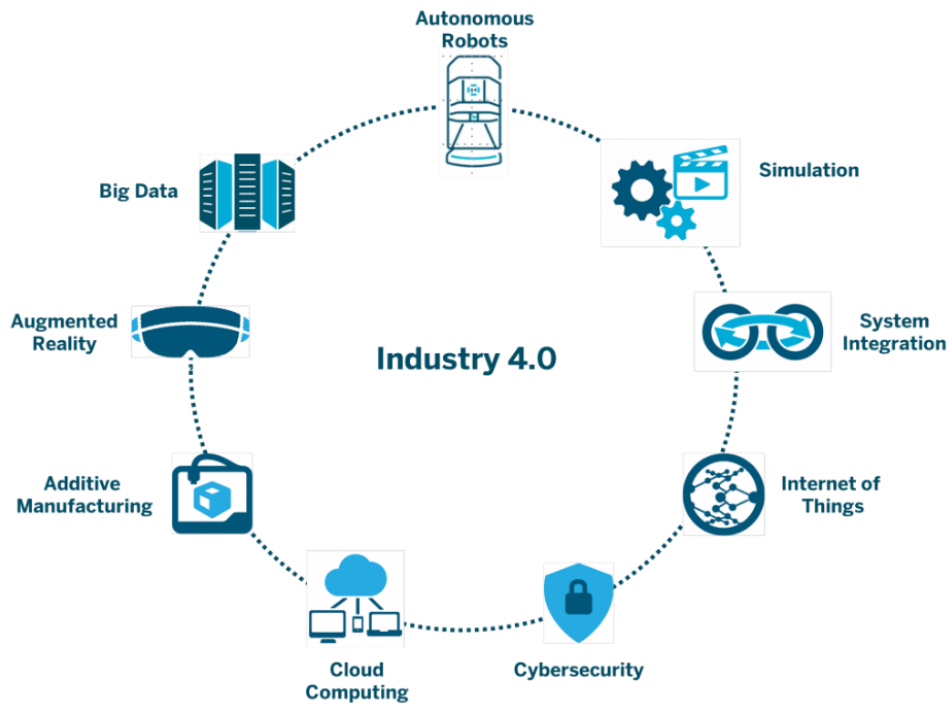


Figure 1. Pillars of Industry4.0

1.3 Management system and integration in enterprises

In this topic there are two knowledge issues that have been evaluated by the Malaysian industry as not really important to be implemented or trained in relation with the wood and furniture industry: Risk analysis and System integration. This opinion also matches with the EU industry that considered they are not very interest to be trained for future workers (table 3).

Taking this information into account, it has been decided to dismiss contents about these two points in the final Making4.0 Master’s Degree. Nevertheless, these two knowledge issues could be addressed in other subjects due to the expanded approach that will have the training materials to be developed.

Topics focused on KETs of I4.0 regarding management system and integration in enterprises		What MY industry thinks Important / Very Important %			EU industry opinion	MY students knowledge through HE degrees
		In use	To be implemented	To train	To train	(basic/low/no addressed)
	Lean Manufacturing/MRP	88.88	70.37	88.88	76.92	83.6
	Risk Analysis	68.5	1.85	7.4	56.92	82.17
	System Integration	3.7	1.85	5.55	44.61	87.5
	Low Cost Aut.	24.07	74.07	92.59	58.46	82.67
	System Manag.	0	7.4	7.4	84.37	85.05
	Tech. Surveillance and Competitive Intelli.	7.4	1.85	5.55	86.15	88.28

Table 3. Identified gaps and needs on management system and integration in enterprises topic

1.4 Selected needs and gaps

As summary of this section, figure 2 shows the selected gaps and needs to be covered by Making4.0 Master's Degree, grouped in three main topics:

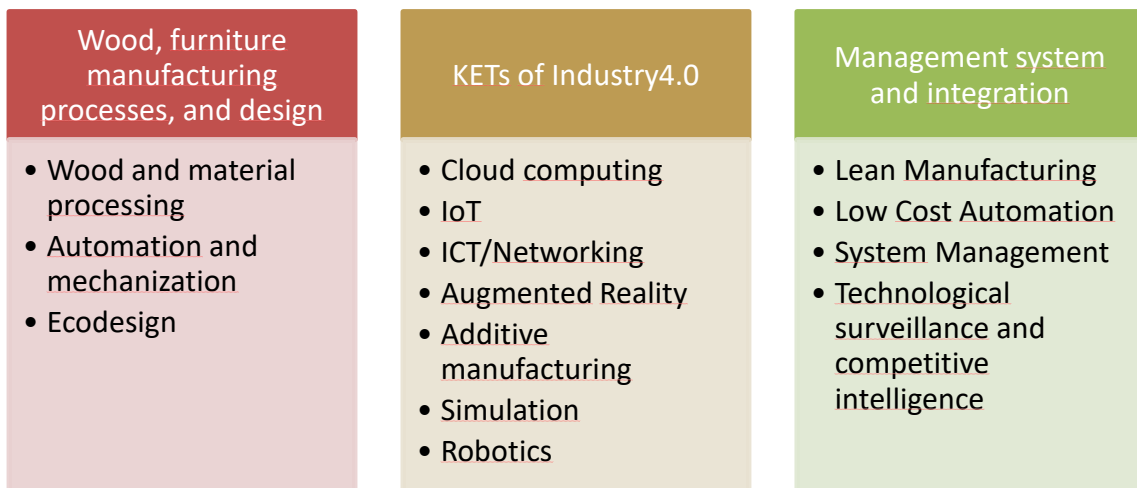


Figure 2. Selected needs and gaps to be covered

2. Learning outcomes: introduction

2.1 Definition

According to the Recommendations on the European Qualifications Framework – EQF [3], learning outcomes are statements of what a learner knows, understands and is able to do on completion of a learning process. In addition, CEDEFOP defined them as sets of knowledge, skills and/or competences that an individual has acquired and/or is able to demonstrate after completion of a learning process, either formal, non-formal or informal.

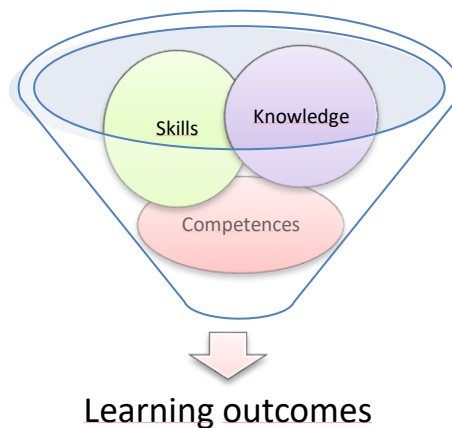


Figure 3. Learning outcomes definition

In the same way, the Malaysian Qualification Framework 2nd edition (MQF2.0) defined learning outcomes as statements on what students should know, understand and can do upon successful completion of a period of study, which generally lead to a qualification or part of a qualification.

Moreover, the MQF2.0 also states that “the generic learning outcomes are intended to provide a framework to reduce the gap between the world of education, work and responsible global citizenship and to further harmonise/integrate the systems. This is demonstrable by the skills and knowledge of learners to successfully perform in professional, educational, and other life contexts”.

2.2 Knowledge, skills and competences

Based on both descriptions, it is necessary to define learning outcomes by using the terms of Knowledge, Skills and Competences according to the Council Recommendation on the European Qualification Framework for lifelong learning [4].

Knowledge means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is

related to a field of work or study. In the context of the EQF, knowledge is described as theoretical and/or factual.

Skills means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Competences mean the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.

3. The Malaysian Qualification Framework 2.0 addressed by Making4.0

3.1 Learning outcomes

The MQF2.0 set the following 5 clusters of learning outcomes:

1. knowledge and understanding
2. Cognitive skills
3. Functional work skills with focus on:
 - a) Practical skills
 - b) Interpersonal skills
 - c) Communication skills
 - d) Digital skills
 - e) Numeracy skills
 - f) Leadership, autonomy and responsibility
4. Personal and entrepreneurial skills
5. Ethics and professionalism

The different educational programmes in the Malaysian HE have to address the above clusters of learning outcomes appropriately, in the way described for its level. Thus, the application of the learning outcomes in each level is situational-based, and it depends on the complexity of tasks, study and work to be performed. The level descriptors explain the context of application of the learning outcomes broadly and are often influenced by levels of autonomy and responsibility.

The definition of each of the 5 clusters by the MQF2.0 are in Annex I of this deliverable.

3.2 Making4.0 level based on MQF2.0

Making4.0 project result will be a Master's Degree, that is defined as level 7 by the MQF2.0 (table 4)

MQF Level	Minimum Graduating Credit	Academic Sector	TVET Sector
8	No credit rating	PhD by Research	
	80	Doctoral Degree by Mixed Mode & Coursework	
7	No credit rating	Master's by Research	
	40	Master's by Mixed Mode & Coursework	
	30	Postgraduate Diploma	
	20	Postgraduate Certificate	
6	120	Bachelor's degree	
	66*	Graduate Diploma	
	36*	Graduate Certificate	
5	40	Advanced Diploma	5
4	90	Diploma	4
3	60	Certificate	3
2	30	Certificate	2
1	15	Certificate	1

* Inclusive of 6 credits from general studies subjects.

Table 4. MQF2.0 level definition. Source: MFQ2.0

The MQF2.0 sets the following principles to take into account for “level 7 Master’s Degree” (points 81-83):

- Master’s qualification at Level 7 is typically an extension of study undertaken at bachelor’s level in similar discipline area, or one or more disciplines or based on extensive professional practice experience. The master’s degree programme may be a research-based, mixed-mode (coursework and research) or coursework/taught type. The minimum credits for the learning load of coursework/taught and mixed-mode master’s programme are 40 and normally entails 1 year of full-time study. No credit is provided for master’s programme by research and this type normally requires 2 years of full-time study.
- A master’s degree demonstrates an in-depth, and significant advanced specialised theoretical or applied knowledge, which is current and with some at the forefront of a specific field of study or with inter/multi-disciplinary approach; or professional practice. The learners demonstrate critical, evaluative and cognitive skills, and applied research skills or advanced professional practice to solve complex issues and problems with reasonable degree of originality and

independence. They demonstrate leadership and managerial skills which are critical competencies, particularly within a multicultural or transnational work or learning environment. Dependent on the type of programme, the learners are competent to inform, share views on contemporary and new issues in related fields or advise new solutions or improved innovations to a range of audience and to conduct further research besides practicing.

- The outputs of master's degree are generally in the form of a thesis/dissertation, long case study, project reports, innovative technical solutions/professional practices and creative art forms.

3.3 Learning outcomes vs Master's Degree level of learning

As it was already explained, the MQF2.0 described for each level shows how the 5 clusters of learning outcomes have to be addressed by each level. In table 5 is shown the necessary learning outcomes description for a Master's Degree (level 7):

Summary of learner's profile	CLUSTER1: knowledge and understanding	CLUSTER 2: cognitive skills	CLUSTER 3				CLUSTER 4: Personal and entrepreneurial skills	CLUSTER 5: Ethics and professionalism
			Practical skills	Interpersonal and communication skills	Digital and numeracy skills	Leadership, autonomy and responsibility		
<p>Learners at this level will demonstrate a mastery of knowledge in specific field/fields of study/work and through further learning, research, and/or professional practice; and Buttressed by a comprehension of strong theoretical knowledge, critical thinking, creative and innovative skills.</p> <p>They will also be able to generate new solutions to problems. They operate with confidence, knowledge and skills both in Malaysia/ASEAN as well as the wider world</p>	<p>Demonstrate originality and independence in undertaking analytical and critical evaluation, and synthesis of complex information, specialized concepts, theories, methods and practice in a field(s) of study/practice as a basis for research.</p>	<p>Apply knowledge critically and interactively to manage and resolve complex problems/issues in a field(s) of study/practice through research, using advance techniques, tools, skills or by a range of approaches or (integrative) combination of approaches for decision making and producing new ideas, and/or innovative solutions or practice.</p> <p>Exemplify capacity to solve and manage complex problems or issues in a field(s) of study/practice.</p>	<p>Conduct standard and specialized research methods/ approaches and/or apply practical skills, tools or investigative techniques which are informed by knowledge at its forefront and the latest development in the subject/discipline.</p>	<p>Communicate clearly the knowledge, skills, ideas, critique and conclusion/rationale using appropriate methods to peers, experts, and non-experts in at least one international language.</p> <p>Work together and collaboratively with different people in learning and working communities and other groups and networks, ethically and professionally.</p> <p>Demonstrate competencies to work and undertake advanced study in at least one foreign language</p>	<p>Competently use a wide range of suitable digital technologies and appropriate software to enhance study, research and/or work/practice.</p> <p>Adapt applications and systems to address defined and new situations/problems.</p> <p>Show skills to design, plan evaluation activities, using quantitative/ statistical tools.</p> <p>Apply mathematical and other quantitative, qualitative tools to analyse and evaluate numerical and graphical data for study/work.</p>	<p>Demonstrate significant autonomy, independence, leadership, and interpersonal skills at work and class.</p> <p>Show substantial responsibility in planning, resource management, supervision and problem solving and managing work within own team and collaboratively with other teams especially in the context of complex application and unpredictable situations.</p>	<p>Exemplify self-advancement through continuous academic and/or professional development.</p> <p>Initiate and/or lead entrepreneurial ventures/ projects.</p>	<p>Demonstrate adherence to legal, ethical and professional codes of practice. Demonstrate confidence to give advice and make decision(s) on complex issues based on critical reflections and ethical considerations.</p> <p>Contribute professionally to social, technological and economic development both nationally and internationally.</p> <p>Demonstrate ability to engage meaningfully on a range of civic and global issues in one's own area of expertise.</p>

Table 5. Level descriptors for Master (level 7) by the MQF2.0

4. Learning outcomes of Making4.0

4.1 Knowledge, skills & competences

As first step, each of the selected thematic areas to be covered by the Making4.0 Master's Degree has been described in the form of knowledge, skills and competences based on the European Skills/Competences, qualifications and Occupations [5], and the expert knowledge of the partners involved in the project.

• Topic 1. Wood, furniture manufacturing processes, and design.

Thematic area	Knowledge	Skills	Competences
Wood and material processing	<ul style="list-style-type: none"> ▪ Basics of material science ▪ New materials. ▪ Eco-sustainability of materials ▪ Future trends 	<ul style="list-style-type: none"> ▪ Development a basis for systematization of new materials for the Malaysian furniture and wood industry ▪ Identification of new and eco-sustainable materials for the furniture and wood industry ▪ Definition of future trends in the development of materials for the furniture and wood industry 	<ul style="list-style-type: none"> ▪ Technical (chemical, physical, environmental) ▪ Economic
Automation and mechanization	<ul style="list-style-type: none"> ▪ Basics of technology ▪ Mechanical processing of wood and wood-based materials ▪ Gluing technology ▪ Finishing technology ▪ Knowledge about existing types of production planning with the demand forecast 	<ul style="list-style-type: none"> ▪ Ability to work, understand and improve technology of furniture. ▪ Ability to use knowledge of production stages in the production process. ▪ Ability to distinguish different production system depending on the demand and temporal horizon. ▪ Ability to adapt and create different production planning systems 	<ul style="list-style-type: none"> ▪ Working in the production process as the supervisor. ▪ Managing company's technology and production routines in accordance to knowledge, good practices and standards existing in furniture production. ▪ With the help of other modules, one can apply innovation to the technology or improve processes. ▪ Implement different production planning system in a company of the furniture sector.

Thematic area	Knowledge	Skills	Competences
Ecodesign	<ul style="list-style-type: none"> Explain why it is important to design interactive products that are usable. Understand what is ecodesign, its different stages, what it provides to a company. 	<ul style="list-style-type: none"> Creative thinking Green design Create new products Research new materials 	<ul style="list-style-type: none"> Be able to apply basics of ecodesign when a new furniture product is designed and developed.

Table 6. Knowledge, skills and competences of topic 1

• **Topic 2. KETs of Industry4.0**

	Knowledge	Skills	Competences
Cloud Computing (CC)	<ul style="list-style-type: none"> Acquires basic knowledge about CC and its main features. Knows the utility of CC in the industrial context. Knows the advantages and disadvantages of developing services in the cloud versus locally. Knows business experiences where CC has been used. 	<ul style="list-style-type: none"> Give a definition about what CC is Enumerate the main characteristics of CC. Describe some industrial scenarios where CC can be deployed. Enumerate the advantages and disadvantages of CC versus local servers. Describe the current use and the future of CC in the industry. 	<ul style="list-style-type: none"> Give a general view of CC Provide uses of CC in industrial scenarios. Analyze an industrial scenario in order to identify if the use of CC could improve the performance of the industrial activity. Take decisions about the most suitable deployment of CC for a specific industrial need.
Internet of Things (IoT)	<ul style="list-style-type: none"> Describe IoT and its uses. Understand the features of IoT. Be familiar with both IoT technologies and IoT-related technologies. 	<ul style="list-style-type: none"> Understand the advantages and disadvantages of IoT Describe possible uncertainties of IoT and how to mitigate them. Can understand the pros and cons of technologies to be used in an IoT environment. 	<ul style="list-style-type: none"> Make decisions related to the development of IoT projects. Can start working in an IoT environment.
ICT/ Networking	<ul style="list-style-type: none"> Acquires basic knowledge about communication networks and their specific uses in the industry. 	<ul style="list-style-type: none"> Provide a definition about the different communications networks and their context in the industry. 	<ul style="list-style-type: none"> Identify the need and usability of communication networks in different industrial scenarios.

	Knowledge	Skills	Competences
	<ul style="list-style-type: none"> ▪ Gets an extensive knowledge about the different types of current communication networks. ▪ Knows some business experiences (use cases) where the communication networks have been used. ▪ Acquires a general view about the future of communication networks in the industrial sector. 	<ul style="list-style-type: none"> ▪ Enumerate the main industrial communication networks. ▪ Describe the impact of the communication networks in the industry. ▪ Give some examples of business success stories related to communication networks. 	<ul style="list-style-type: none"> ▪ Take decision about kind of industrial communication networks to be implemented. ▪ Enumerate use cases where communication networks are used in an industrial scenario. ▪ Enumerate the advantages and disadvantages of each communication technology
Augmented Reality (AR)	<ul style="list-style-type: none"> ▪ Understands the functioning of AR and its differences with virtual reality. ▪ Knows the influence of AR on the design and prototyping of a product. ▪ Knows the uses of AR throughout the production chain of furniture, from the design to the final piece. ▪ Knows how AR is being used in the furniture market. 	<ul style="list-style-type: none"> ▪ Define and determine what AR is and how it works. ▪ Identify the elements needed to create AR. ▪ Recognize the different uses of AR in the production chain. ▪ Start working with this technology within a company. ▪ Identify the different uses of AR in the furniture market. 	<ul style="list-style-type: none"> ▪ Identify programs used in AR. ▪ Recognize the different types of AR. ▪ Adapt the prototype to the specifications of the customer through the use of AR. ▪ Analyze the production and Improve costs and times in the production process. ▪ Understand the new way of work with AR.
Additive manufacturing	<ul style="list-style-type: none"> ▪ Knows the steps to follow since you get the 3D model up to the printed piece. ▪ Knows the Influence of additive manufacturing on the design and prototyping of a product. ▪ Knows the application of the additive manufacturing for the production of pre-mold or molds for short series. 	<ul style="list-style-type: none"> ▪ Obtain and print a 3D object. ▪ Identify what is printable or not. ▪ Know what types of software are needed for each step of the 3D printing process. ▪ Recognize what types of pieces of furniture can be printed in 3D. ▪ Increase the added value of the product through this technology. 	<ul style="list-style-type: none"> ▪ Make decisions within the printing process. ▪ Analyse the part before printing. ▪ Adapt the prototype to the specifications of the customer. ▪ Analyse the production and improve costs and times in the production process.

	Knowledge	Skills	Competences
	<ul style="list-style-type: none"> Knows how 3D printing is being used in the furniture market. 		<ul style="list-style-type: none"> Work with hybrid technology (Pieces of wood assembled with 3D printing parts).
Simulation	<ul style="list-style-type: none"> Realizes modelling in order to complete the rendering through the application of materials and finishes Realizes 3D modelling techniques in order to correctly represent the contents of the project. 	<ul style="list-style-type: none"> Transfer the design contents expressed by designers into 3D drawings Realize 3d models Realize photorealistic images Define presentation rendering of the project to be proposed to the company or the market. 	<ul style="list-style-type: none"> Build the transition from CAD tools to CAM tools to ensure correct industrialization of the product Develop virtual modelling of projects presented by designers to communicate content of the same to the managers of the company and / or the market Manage virtual product archives.
Robotics	<ul style="list-style-type: none"> knows how to use a robotics mobile platform for logistics and transportation tasks in the furniture market. knows how to use a robot for different tasks in the furniture market. 	<ul style="list-style-type: none"> Program using the programming language. Use robotics middleware. 	<ul style="list-style-type: none"> Define mapping algorithms in order to a robot understands the environment where it works Define localization algorithms in order to a robot knows where it is to successfully carry out tasks Implement robotics motion planning algorithms for mobile platforms that have to navigate in industrial Improve the efficiency of logistics process because robotics can sort through incoming and outgoing packages faster. Improve costs and times in the logistics process.

Table 7. Knowledge, skills and competences of topic 2

• **Topic 3. Management system and integration**

	Knowledge	Skills	Competences
Lean manufacturing	<ul style="list-style-type: none"> Knows the uses and functionality of the Enterprise Resource Planning (ERP). Know the basics of the most relevant Lean Manufacturing tools. 	<ul style="list-style-type: none"> Acquire the basic skills for working with a ERP system. Be able to implement Lean tools in a production plan. 	<ul style="list-style-type: none"> Identify and implement improvements in different manufacturing processes from furniture/woodworking companies.
Low cost automation	<ul style="list-style-type: none"> Basics of technology Discuss accessibility issues for engineering products. Knowledge about existing types of low-cost production planning. Manufacturing process. 	<ul style="list-style-type: none"> Ability to work, understand and improve technology of furniture. Ability to use knowledge of production stages in the production process. Definition of best practices to be implemented for quality products and processes. 	<ul style="list-style-type: none"> Planning production processes. Managing company's technology and production routines low cost. Implement basic production planning system in a company of the furniture sector.
System management	<ul style="list-style-type: none"> Knows the principles and basics of Warehouse Management. Knows the principles and basics of Inventory Management. Gains knowledge and expertise on Key Performance Indicators (KPI) analysis and advanced techniques. Gets familiar with the production management systems and their main tool. 	<ul style="list-style-type: none"> Ability to use knowledge of production stages in the production process Carry out industry plant layouts. Knowledge of industrial processes and techniques Create and define KPI that help any business unit. 	<ul style="list-style-type: none"> Carry out the most suitable plant layout at a furniture/wood products manufacturing plant. Implement a manage monitoring and evaluation management system.
Technological surveillance and	<ul style="list-style-type: none"> Be familiar with the strategic intelligence tools and methods. 	<ul style="list-style-type: none"> Define the most appropriate information resources Know how to implement a strategic watch strategy 	<ul style="list-style-type: none"> Define strategic intelligence and the relevance of sharing strategic information

	Knowledge	Skills	Competences
competitive intelligence	<ul style="list-style-type: none"> Know the technological watch processes and information resources, emphasising on the industry roles. Know the main relevant technological watch software. 	<ul style="list-style-type: none"> Identify the information that should be shared. 	<ul style="list-style-type: none"> Identification of information resources Define a search strategy in accordance of the company requirements Implement a technological watch system in a company.

Table 8. Knowledge, skills and competences of topic 3

4.2 Programme learning outcomes

In accordance with the MQF2.0, it has been defined the Programme Learning Outcomes (PLOs) of Making4.0 Master’s Degree as follows (table 9).

PLO n°	Description
PLO 1	Acquire and understand the necessary concepts and knowledge on Industry4.0.
PLO 2	Manage complex problems in the industry through the implementation of industry4.0 techniques.
PLO 3	Research and apply about the trendy tools and technologies of the Industry4.0
PLO 4	Demonstrate team work and critique communicative ability on industry4.0 topics.
PLO 5	Use digital technologies and apply mathematical tools to analyse and solve problems in industrial process management.
PLO 6	Be able to work and solve own solutions for industry problems related with the implementation of Industry4.0 technologies.
PLO 7	Show the ability to lead entrepreneurial projects on smart factories of the wood and furniture industry.
PLO 8	Learn about how to boost the Malaysian industry and demonstrate the ability to provide professional advice on it.

Table 9. Programme Learning Outcomes of Making4.0 Master’s Degree

Moreover, knowledge, skills and competences determined for each thematic area in previous tables have been grouped in the defined PLOs as it is shown in table 10.

Ecodesign								
Explain why it is important to design interactive products that are usable.	X		X					
Understand what is ecodesign, its different stages, what it provides to a company.	X			X				
Creative thinking				X				
Green design	X							
Create new products		X			X			
Research new materials			X					
Be able to apply basics of ecodesign when a new furniture product is designed and developed.						X		X
TOPIC 2. KET'S OF INDUSTRY 4.0								
Cloud computing								
Acquires basic knowledge about Cloud Computing and its main features	X							
Knows the utility of Cloud Computing in the industrial context					X			
Knows the advantages and disadvantages of developing services in the cloud versus locally			X					
Knows business experiences where Cloud Computing has been used						X	X	
Give a definition about what Cloud Computing is	X			X				
Enumerate the main characteristics of cloud computing	X							
Describe some industrial scenarios where Cloud Computing can be deployed		X			X	X		
Enumerate the advantages and disadvantages of Cloud computing versus local servers.	X							
Describe the current use and the future of cloud computing in the industry.			X			X		
Give a general view of cloud computing.	X							
Provide uses of cloud computing in industrial scenarios.						X	X	
Analyse an industrial scenario in order to identify if the use of cloud computing could improve the performance of the industrial activity.							X	X
Take decisions about the most suitable deployment of cloud computing for a specific industrial need.							X	X
Internet of Things (IoT)								
Describe Internet of Things and its uses.	X							
Understand the features of IoT.	X	X						
Be familiar with both IoT technologies and IoT-related technologies.	X		X					
Understand the advantages and disadvantages of Internet of Thing.	X							
Describe possible uncertainties of IoT and how to mitigate them.		X	X	X				
Can understand the pros and cons of technologies to be used in an IoT environment.			X					
Make decisions related to the development of IoT projects.					X	X		
Can start working in an IoT environment.					X	X		
ICT / Networking								
Acquires basic knowledge about communication networks and their specific uses in the industry.	X							
Gets an extensive knowledge about the different types of current communication networks.	X		X					
Knows some business experiences (use cases) where the communication networks have been used.		X			X	X		

Acquires a general view about the future of communication networks in the industrial sector.						X	X	X
Provide a definition about the different communications networks and their context in the industry.	X							
Enumerate the main industrial communication networks.	X			X				
Describe the impact of the communication networks in the industry.	X	X		X	X			
Give some examples of business success stories related to communication networks.		X				X	X	
Identify the need and usability of communication networks in different industrial scenarios.					X	X		X
Take decision about kind of industrial communication networks to be implemented.		X			X	X		
Enumerate use cases where communication networks are used in an industrial scenario.				X		X	X	
Enumerate the advantages and disadvantages of each communication technology	X			X				
Augmented reality								
Understands the functioning of augmented reality and its differences with virtual reality.	X							
Knows the influence of Augmented Reality on the design and prototyping of a product.	X		X					
Knows the uses of Augmented Reality throughout the production chain of furniture, from the design to the final piece.			X		X			
Knows how Augmented Reality is being used in the furniture market.			X		X	X		
Define and determine what Augmented Reality is and how it works.	X							
Identify the elements needed to create Augmented Reality.		X			X			
Recognize the different uses of augmented reality in the production chain.				X		X		
Start working with this technology within a company.		X		X		X	X	
Identify the different uses of Augmented Reality in the furniture market.	X					X		
Identify programs used in Augmented Reality.	X		X					
Recognize the different types of Augmented Reality.	X							
Adapt the prototype to the specifications of the customer through the use of AR.				X	X			
Analyse the production and Improve costs and times in the production process.						X	X	X
Understand the new way of work with AR.	X	X						X
Additive manufacturing								
Knows the steps to follow since you get the 3D model up to the printed piece.	X		X		X			
Knows the Influence of additive manufacturing on the design and prototyping of a product.	X					X		
Knows the application of the additive manufacturing for the production of pre-mold or molds for short series.	X				X			
Knows how 3D printing is being used in the furniture market.					X	X		X
Obtain and print a 3D object.		X		X	X			
Identify what is printable or not.		X		X	X			
Know what types of software are needed for each step of the 3D printing process.				X	X			
Recognize what types of pieces of furniture can be printed in 3D.					X	X		
Increase the added value of the product through this technology.						X	X	X
Make decisions within the printing process.				X			X	

Analyse the part before printing.		X	X	X				
Adapt the prototype to the specifications of the customer.				X	X	X	X	
Analyse the production and improve costs and times in the production process.		X			X		X	
Work with hybrid technology (Pieces of wood assembled with 3D printing parts).			X		X	X		
Simulation								
Realizes modelings in order to complete the rendering through the application of materials and finishes		X			X			
Realizes 3D modeling techniques in order to correctly represent the contents of the project.		X			X			
Transfer the design contents expressed by designers into 3D drawings				X	X			
Realize 3d models					X	X		
Realize photorealistic images					X	X		
Define presentation rendering of the project to be proposed to the company or the market.						X	X	
Build the transition from CAD tools to CAM tools to ensure correct industrialization of the product		X				X	X	
Develop virtual modeling of projects presented by designers to communicate content of the same to the managers of the company and / or the market				X	X		X	
Manage virtual product archives.			X		X			
Robotics								
knows how to use a robotics mobile platform for logistics and transportation tasks in the furniture market.	X					X		
knows how to use a robot for different tasks in the furniture market.	X		X			X		X
Program using the programming language.		X			X			
Use robotics middleware.		X			X	X		
Define mapping algorithms in order to a robot understands the environment where it works				X	X			
Define localization algorithms in order to a robot knows where it is to successfully carry out tasks			X		X			
Implement robotics motion planning algorithms for mobile platforms that have to navigate in industrial		X				X		
Improve the efficiency of logistics process because robotics can sort through incoming and outgoing packages faster.						X	X	X
Improve costs and times in the logistics process.						X	X	X
TOPIC 3. MANAGEMENT SYSTEM AND INTEGRATION								
Lean manufacturing								
Knows the uses and functionality of the Enterprise Resource Planning (ERP).	X		X					
Know the basics of the most relevant Lean Manufacturing tools.	X							
Acquire the basic skills for working with a ERP system.	X	X						
Be able to implement Lean tools in a production plan.				X		X		
Identify and implement improvements in different manufacturing processes from furniture/woodworking companies.						X	X	X
Low Cost Automation								
Basics of technology	X							
Discuss accessibility issues for engineering products.	X			X				

Knowledge about existing types of low-cost production planning.	X		X					
Manufacturing process.	X					X		
Ability to work, understand and improve technology of furniture.			X			X		
Ability to use knowledge of production stages in the production process.				X	X	X	X	
Definition of best practices to be implemented for quality products and processes.	X		X					
Planning production processes.		X			X	X		
Managing company's technology and production routines low cost.		X				X	X	
Implement basic production planning system in a company of the furniture sector.		X					X	X
System management								
Knows the principles and basics of Warehouse Management.	X							
Knows the principles and basics of Inventory Management.	X							
Gains knowledge and expertise on Key Performance Indicators (KPI) analysis and advanced techniques.	X		X					
Gets familiar with the production management systems and their main tool.				X		X	X	
Ability to use knowledge of production stages in the production process		X				X	X	
Carry out industry plant layouts.		X					X	
Knowledge of industrial processes and techniques	X		X	X				
Create and define KPI that help any business unit.		X				X		
Carry out the most suitable plant layout at a furniture/wood products manufacturing plant.				X		X	X	
Implement a manage monitoring and evaluation management system.					X	X	X	X
Technological surveillance and competitive intelligence								
Be familiar with the strategic intelligence tools and methods.	X							
Know the technological watch processes and information resources, emphasising on the industry roles.	X		X					
Know the main relevant technological watch software.	X		X	X				
Define the most appropriate information resources	X		X					
Know how to implement a strategic watch strategy		X			X	X	X	
Identify the information that should be shared.		X	X	X				
Define strategic intelligence and the relevance of sharing strategic information	X					X		
Identification of information resources			X		X	X		
Define a search strategy in accordance of the company requirements				X	X	X	X	
Implement a technological watch system in a company.		X			X	X		X

Table 10. Knowledge, skills and competences grouped in each PLO

5. Programme Learning Outcomes vs MQF2.0 learning outcomes

To ensure that Making4.0 Master’s Degree fulfils all the requirements of the MQF2.0 for such level, it is necessary to demonstrate that clusters learning outcomes, described in section 3.1, are aligned with the PLOs defined for the planned Master’s Degree. Table 11 shows how each PLOs is aligned with one of the necessary MQF2.0 learning outcomes.

MQF2.0 learning outcomes Programme learning outcomes	CLUSTER1: knowledge and understanding	CLUSTER 2: cognitive skills	CLUSTER 3				CLUSTER 4: Personal and entrepreneurial skills	CLUSTER 5: Ethics and professionalism
			Practical skills	Interpersonal and communication skills	Digital and numeracy skills	Leadership, autonomy and responsibility		
PLO 1	X							
PLO 2		X						
PLO 3			X					
PLO 4				X				
PLO 5					X			
PLO 6						X		
PLO 7							X	
PLO 8								X

Table 11. Programme learning outcomes vs MQF2.0 learning outcomes

6. Conclusions

The work carried out permit us to conclude that the Making4.0 Master's Degree will fulfil the requirements of both qualifications systems, European and Malaysian, because:

- The defined 8 Programme Learning Outcomes are aligned with the MQF2.0 learning outcomes.
- It has been defined the learning outcomes based on the concept of the EQF: knowledge, skills and competences. These has been also aligned with the PLOs.

Finally, the PLOs will be the base of the future Master's Degree (Making4.0), that will cover gaps and needs identified in the Malaysian HE and wood and furniture industry.

References

- [1] Cedefop (2017). Defining, writing and applying learning outcomes: a European handbook. Luxembourg: Publications Office. <http://dx.doi.org/10.2801/566770>
- [2] Malaysian Qualification Agency. (2019) Malaysian Qualification Framework (MQF) 2nd edition (updated version 02/10/2019)
- [3] Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning.
- [4] Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning.
- [5] European Skills/competences, qualifications and Occupations portal. <https://ec.europa.eu/esco>

Annex I. Description on Learning Outcomes Clusters by the MQF2.0

Knowledge and Understanding

- Knowledge and understanding refers to a systematic understanding of facts, ideas, information, principles, concepts, theories, technical knowledge, regulations, numeracy, practical skills, tools to use, processes and systems.
- It may relate to a subject, a field of study or discipline as well as to technical and occupational or workplace aspects of knowledge and understanding. It starts with basic general knowledge and progress to varied, broader, specialised and advanced knowledge including those relating to sustainable practices, rules and regulations, health and safety, especially relevant to TVET type and even professional programmes.
- The scope of knowledge should include the common everyday knowledge within the learners' environment. This may also be acquired through formal, informal, and non-formal learning circumstances-experiences. Developing personal values and ethics may derive from knowledge and experiences.
- Knowledge and understanding enables the learners to relate to their prior knowledge in the course of learning or work as well as to expand to related fields. Knowledge provides the basis for applications of all other learning outcomes.

Cognitive Skills

This relates to thinking or intellectual capabilities and the ability to apply knowledge and skills. The capacity to develop levels of intellectual skills progressively begins from understanding, critical/creative thinking, assessment, and applying, analysing, problem solving as well as synthesizing to create new ideas, solutions, strategies or new practices. Such intellectual skills enable the learner to search and comprehend new information from different fields of knowledge and practices.

Functional Work Skills

a) Practical work skills

These are generally work skills and operational skills applicable in common employment environment such as planning; organisational skills; selection of tools, material,

technology methods and procedures, while in study context, it may include study skills and preparations, undertaking procedures, scientific skills, designs, research and so forth. It also includes specialised skills which are set by specific subject, discipline, technical or occupation-related work skills and professional practice which enhance professional competence. It should include safe and sustainable practices.

b) Interpersonal skills

Interpersonal skills refer to a range of skills which, amongst others, include interactive communications; relationships and collaborative skills in managing relationships in teams and within the organisations; networking with people of different cultures; as well as social skills/etiquette.

c) Communication skills

Communication skills refer generally to the ability to communicate/convey information/ideas/reports cogently and professionally in appropriate language. The communication must be effective and in appropriate forms, in various medium, to a range of audience and different situations. The ability to communicate in more than one language is encouraged.

d) Digital skills

Digital skills generally refer to the ability to use information/digital technologies to support work and studies. The skills include sourcing and storing information, processing data, using applications for problem solving and communication, as well as ethics in applying digital skills.

e) Numeracy skills

These are the quantitative skills that require learners to acquire increasingly higher levels of numerical abilities. It is acknowledged as an important living skill relevant in study, work and daily life. Within the MQF levels, this learning outcome may not be specifically mentioned for every level but it is expected that numerical skills are required as an outcome ought to be indicated for every specific programme. It may include understanding of basic mathematics, symbols relating to statistical techniques and etc.

f) Leadership, autonomy and responsibility

This cluster of skills refers to an individual's ability to build relationships and work with teams made up of peers or in managerial capacities with varying degrees of autonomy to

make decisions or setting goals at organisational/unit/team levels; to take responsibilities and provide accountability; to be confident, knowledgeable, articulate, honest, professional, concerned, resilient, a risk taker and possess other intrapersonal skills including working in, and leading teams.

Personal and Entrepreneurial Skills

Personal skills are life skills that learners are expected to use daily. They are normally portrayed through enthusiasm for independent learning, intellectual and self-development; by demonstrating confidence, self-control; social skills and proper etiquette; and commitment to professionalism in the work place. It also includes capability to plan for career development or further education. Aspects of character such as honesty, punctuality, time management, keeping to and maintaining deadlines that are important in a work environment are also important personal skills.

Entrepreneurial skills require relevant knowledge, skills and expertise in key areas of an enterprise. Important personal qualities will include creativity, grit and drive. The learning outcomes describe incremental development of these skills. The drive to be an entrepreneur is set as personal skills but also requires the requisite of relevant knowledge, cognitive and functional skills.

Ethics and Professionalism

Ethics and values are important at personal, organisational, societal/community and global settings as they guide personal actions, interactions, at work and within the community at large. Awareness/understanding and respect of ethical, social and cultural differences and issues are important in the exercise of professional skills and responsibilities: integrity, professional conduct (professionalism), and standards of conduct such as upholding regulations, laws and codes of good practices or code of professional conduct. A sensitive approach in dealings with other cultures adds value to this learning domain.