DIGITAL TRANSFORMATION MANAGER

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D4.2.b – Digital Transformation Manager Occupational profile final report

VERSION 2

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WP2 - Skills needs fine-tune

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1 Introduction

The **Digital Transformation Manager (DTM)** is the professional able to properly **guide companies** toward their digital transformation and our project focuses its attention on the specific characteristic of this profile within the furniture sector. The DTM is the professional that will plan, design, guide and check the implementation of the changes needed by furniture companies to transform themselves and adapt to the digital transformation.

1.1 The Digital transformation

The "***Digital transformation***[1] *is the profound and accelerating transformation of business activities, processes, competencies and models to fully leverage on the changes and opportunities of digital technologies and their impact across society in a strategic and prioritized way, with present and future shifts in mind. Digital transformation in the integrated and connected sense requires, among others, the transformation of:*

- *Business activities/functions;*
- *Business processes;*
- *Business models;*
- *Business ecosystems;*
- *Business asset management;*
- *Organisational culture;*
- *Ecosystem and partnership models;*
- *Customer, worker and partner approaches.*

1.2 The EU furniture sector and the digital transformation

The EU furniture industry has been affected by this transformation and, according to different studies, it will be even more affected during next years. A previous project, dealing with this topic, shows us a clear vision and forecast on how the EU furniture sector will be in 2025 due to the digital transformation:

> *By 2025, with a massively **connected and globalised economy**, the wood furniture manufacturing industry will offer **personalised smart products and services** based on **digital manufacturing, logistics and sales systems** supplied by **resource-efficient and sustainable industries** with an immense need for enough **digitization talents and skills** securing a competitive transformation of the industry.*[2]

1.3 The furniture industry and its processes

The previous vision and forecast allow us to state the Digital transformation will affect all processes of the furniture companies across the whole value chain, it will transform the sector companies.

[1] https://www.i-scoop.eu/digital-transformation/#Digital_business_transformation_8211_a_holistic_approach

[2] *For the full report, please, see Annex I or visit:* http://digit-fur.eu/wp-content/uploads/downblue.png

In the following table, you can see a complete structure of the main organizational processes of a typical furniture manufacturing company.

Table 1 – Processes of a typical furniture manufacturing company

PROCESSES	
A1: Plan	
	A11: Design the Management System
	A12: Manage the Government
	A13: Plan the strategy
	A14: Explain the strategy
A2: Provide resources	
	A21: Manage people
	A22: Manage alliances
	A23: Managing the economy and finances
	A24: Managing the infrastructures
	A25: Manage technology and information
	A26: Managing legal aspects
A3: Produce	
	A31: Planning operations
	A32: Design and develop products
	A33: Manage customers
	A34: Produce
	A35: Deliver the products
A4: Check	
	A41: Measure procedures
	A42: Analyse
	A43: Inform
A5: Improve	
	A51: Improvement programme
	A52: Manage the projects
	A53: Manage the challenges

A short description of the first stage processes can help to better understand of the company functioning.

A1 Plan: It includes all those processes that place the actions in the future. This requires to design a process of strategy creation, which will define a set of objectives. It includes as well internal and external management communication, and those that provides functioning guides to other processes.

A2 Provide resources: It includes all those processes that manage the resources intended to the other processes and that have a transversal sense of the organization; They are often called internal processes. We can identify them as these processes are carry out by organizational units, *staf.*

A3 Produce: It includes all those processes that are directly linked with the organizational operation. From initial contacts with customers, passing through

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their design and construction, until the post-sale service. We can identify these processes as they are carried out by final organizational units.

A4 Check: It includes all those processes that analyse the information produced in the operation of the organization. The good use of process Indicators is a key aspect to identify the expected and not-expected relations that exist among them, tools for the analysis and reporting are very useful in this framework. These tools can be included in the concept of BI (Business Intelligence) that, for example, employs utilities of advanced statistics that allow monovariable, bivariable and multivariable analysis, as well as data grouping in dynamic tables and in graphic representation.

A5 Improve: It includes all those processes that, based on the outcomes of the A4 check process, implement the actions for improvement. These improvement decisions and projects can be implemented directly or as objectives of the Plan process (A1). With this, we achieve to close the management cycle or the continuous improvement.

1.4 Design, distribution and manufacture in furniture companies

In the following paragraphs we present a detailed description of the activities of design, distribution and manufacturing of a typical furniture manufacturing company.

1.4.1 Design

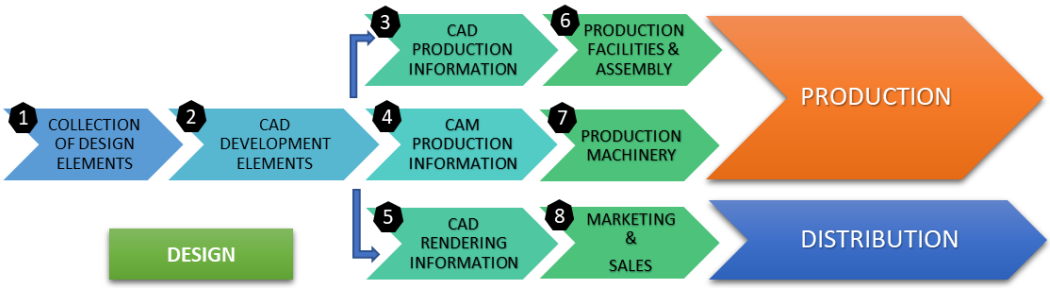

Figure 1 - Design process

1. Companies currently collect information about the products to be produced mainly from distributors. Only big companies have a structured marketing department with their own market research.
2. Companies work on product development using software like AutoCAD and other software mainly in 2D. The designing process, even in 3D, does not always provide the information needed for manufacturing.
3. From the CAD software all the companies obtain information about measures and mockups to be interpreted by production departments. Generally, 2D printed drawings of the components are obtained.
4. Due to the diversity of numerical controls and protocols used by the machine manufacturers, few companies are able to set up CAM machines using directly CAD drawings.
5. Moving from physical photography to photo-quality rendering.
6. More and more CAD information is being used in real time for supporting production and assembly operations.
7. Machine manufacturers are improving machine control software increasing possibilities to import various types of CAD files.

8. Marketing and sales departments are increasingly employing photo rendering for the fast generation of catalogues and other sales tools.

1.4.2 Distribution

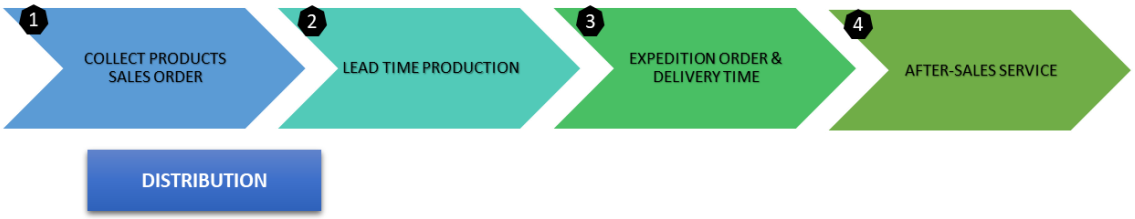

Figure 2 - Distribution process

1. The increasing products customizations required by customers represent a challenge for the orders collection systems, which can play a key difference among small and large enterprises.
2. The reduction of the lead-time is today the key factor to ensure the survival of companies in some market segments.
3. The way in which orders are grouped and delivered defines the delivery time and it differentiates the companies oriented to the final customer service from those working through distributors.
4. Few companies still have direct contacts with the final customer. Usually, they are companies of big dimensions, with brand strategies and direct delivery of KIT type products (DIY, FLAT PACK).

1.4.3 Processes

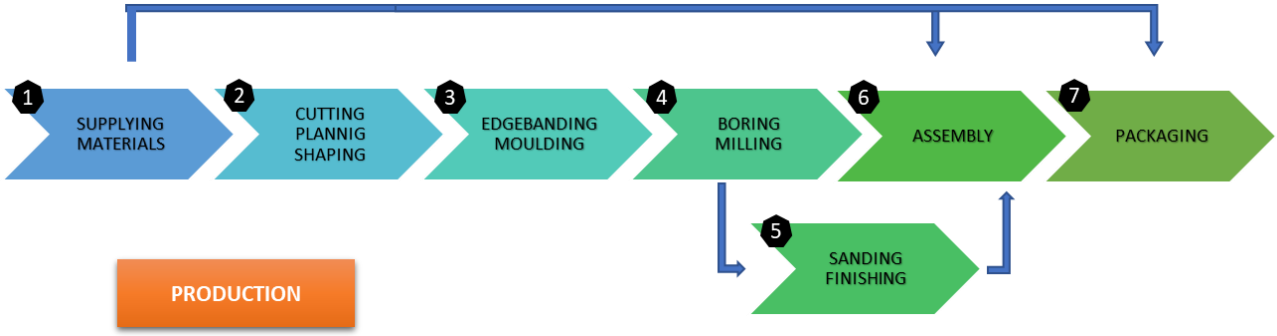

Figure 3- Production process

1. The increasingly complex management of the external suppliers and of their products represents a big difference among small and large enterprises for purchasing logistics
2. This first machining stage serves to give the right dimensions to the parts that will make up the final product.
3. The second machining stage is used to finish the edges of the pieces, either by applying a band, which can be of different materials, or by moulding the piece with a milling cutter in the case of solid wood.
4. The third production stage and usually the last, serves for structural and aesthetic finishing, which will also allow the assembling of the product components. Moreover, it provides the final image of some elements that allow differentiating among products with the same function.

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5. Some articles and components require finishing processes using varnish or paint. These processes require applying several layers with intermediate sanding.
6. After the completion of the components, there is the assembling process. Not all the items are assembled. Sometimes they remain disassembled because of their size or weight.
7. The final process is the packaging. It is intended to protect the set of components of the product (or the product itself) during the transportation to the distributor or to the final customer. It is not always used for advertising or marketing purposes.

2 Digital Transformation Manager occupational profile

The following section contains the definition of the **DTM - Digital Transformation Manager occupational profile** agreed during the discussion at the DITRAMA **Experts workshop** that took place in Brussels on the 27th of June 2019 at the WOODWIZE premises. They were representatives from project partners entities and external experts specifically invited to the event in order to collect their inputs. These external experts, with different backgrounds and expertise, could provide relevant inputs about the draft definition of the Digital Transformation Manager occupational profile and tasks and the design of the related joint curriculum.

Table 2 - Experts that participated to the workshop

ID	Name of the Expert	Organization
1	Albano Vasconcelos	CFPIMM
2	Alexandra De Raeve	HOGENT
3	Almudena Gonzalez Costas	METODO
4	Carlos Godínez	Universidad Politécnica de Cartagena
5	Carlos González	CETEM
6	Chiara Terraneo	FEDERLEGNO
7	Clara Ferraz	CFPIMM
8	David Pavliš	UEA
9	Gregory Pinte	Flanders Make
10	Ioan Cionca	TAPARO
11	Jeroen Doom	WOODWIZE
12	Jeroen Vancraen	Flandres Make
13	Jesús Sanz	CETEM
14	Juan Carlos Martinez	Ceei Burgos
15	Julio Rodrigo	CENFIM
16	Lidia Gurau	UTBv
17	Marc Vens	Distributor Homag in BE
18	Massimiliano Rumignani	AMIC
19	Michel Byvoet	Bivolino
20	Nicolas Sangalli	FEDERLEGNO
21	Nikolas Van Beeck	Van Hoecke NV
22	Peter Verkest	HOGENT
23	Serena Leka	AARHUS
24	Susanna Campogrande	WOOD.BE

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25	Tamas Kiss	Un. Westminster
26	Uwe Kies	innovawood
27	Xavier Pi	Catalan Indutry 4.0 Commission

The Digital Transformation Manager (DTM) designs, implements, maintains and improves the **Digitization strategy** of the company using adequate technologies, tools and methodologies. S/He ensures that the company organization and its products are in compliance with the Digitalization requirements foreseen and defined in the Digitalization strategy of the company. Facilitates a continual improvement in the field of the organization Digitalization, in line with the customer satisfaction. Encourages and guide the company **digitization improvement projects** in the field of Digitization. Reports on the performance in the field of Digital transformation to the top management.

2.1 Occupational profile tasks

Plan

Priority tasks:

a) Plans and designs the Digitalization strategy of the company, in line with the company overall strategy.

b) Plans the human, economic, infrastructural and technological resources of the Digitalization department required for the successfully implementation of the strategy.

Secondary tasks:

c) Identifies and design the processes of the Digitalization department.

d) Identifies and analyses the context in the field of Digitization in which the company operates.

Do

Priority tasks:

e) Ensures the successful implementation of the Digitalization strategy.

f) Coordinates the activities related with the company Digitalization strategy.

Secondary tasks:

g) Supports the overall implementation of the company strategic, structural, processes, revision and improvement systems.

h) Participates to the Top Management meetings and Informs Top Management about the status of the implementation of the Digitalization strategy and about opportunities for improvement.

i) Executes all those general tasks assigned by the company.

Check

Priority tasks:

j) Designs the list of reports (and KPIs) for monitoring, measurement, analysis and evaluation of the digitization performance of the company.

k) Coordinates the auditing activities in the field of Digitization, including the assessment of the digitization maturity level, of the company.

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l) Coordinates and supervises the investigation of new technologies, solutions, tools and methodologies in the field of Digitalization.

Secondary tasks:

m) Leads the revision activities of the Digitalization department.

n) S/he is held accountable for the Digitalization department activities.

o) Ensures that the company and the products meet the legal requirements of Digitalization and those voluntarily adopted by the company.

p) Ensures that the Digitalization strategy is in line with the company customer satisfaction policy; covers all company processes and all its products/services; is the appropriate one for the sector technological trends and advances.

q) Ensures that the processes identified in the Digitalization field are generating and providing the expected outputs and results.

r) Ensures that the integrity and security of the Digitization system is maintained when changes are planned and implemented.

Act

Priority tasks:

s) Drives innovative / transformative / disruptive **improvement projects** in the field of Digitization, including corrective actions, within the Digitalization department and the company.

t) Identifies opportunities for improvement, including nonconformities, of the Digitalization department and of the part of the company management system related to Digitization and to the implementation of its strategy.

The following table shows the correlation of tasks and needed skills by the DTM - Digital Transformation Manager.

Table 3 - Correlation of tasks and skills needed by the DTM – Digital Transformation Manager

Correlation of tasks and needed skills by the Digital Transformation Manager	**TECHNICAL SKILLS**											**NOT-TECHNICAL SKILLS**					
	Industrial internet of things	**Cybersecurity**	**Technical general competences**	**Horizontal and vertical system integration**	**Cloud computing**	**Simulation**	**Big data analytics**	**Additive manufacturing**	**Augmented reality**	**Autonomous robots**	**Blockchain**	**Innovation**	**Communication**	**Management and entrepreneurship**	**Emotional intelligence**	**Quality, risk and safety**	**Ethics**
Plan																	
Priority tasks:																	
a) Plans and designs the Digitalization strategy of the company, in line with the company overall strategy.	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
b) Plans the human, economic, infrastructural and technological resources of the Digitalization department required for the successfully implementation of the strategy.	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x
Secondary tasks:																	
c) Identifies and design the processes of the Digitalization department.			x											x		x	
d) Identifies and analyses the context in the field of Digitization in which the company operates.	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x
Do																	
Priority tasks:																	
e) Ensures the successful implementation of the Digitalization strategy.	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
f) Coordinates the activities related with the company Digitalization strategy.	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Secondary tasks:																	
g) Supports the overall implementation of the company strategic, structural, processes, revision and improvement systems.			x										x	x	x	x	x
h) Participates to the Top Management meetings and Informs Top Management about the status of the implementation of the Digitalization strategy and about opportunities for improvement.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
i) Executes all those general tasks assigned by the company.			x										x	x	x	x	x
Check																	
Priority tasks:																	
j) Designs the list of reports (and KPIs) for monitoring, measurement, analysis and evaluation of the digitization performance of the company.	x	x	x	x	x	x	x	x	x	x	x			x		x	
k) Coordinates the auditing activities in the field of Digitization, including the assessment of the digitization maturity level, of the company.	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
l) Coordinates and supervises the investigation of new technologies, solutions, tools and methodologies in the field of Digitalization.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Secondary tasks:																	
m) Leads the revision activities of the Digitalization department.	x	x	x	x	x	x	x	x	x	x	x			x		x	x
n) S/he is held accountable for the Digitalization department activities.	x	x	x	x	x	x	x	x	x	x	x			x		x	x
o) Ensures that the company and the products meet the legal requirements of Digitalization and those voluntarily adopted by the company.	x	x	x	x	x	x	x	x	x	x	x			x		x	x
p) Ensures that the Digitalization strategy is in line with the company customer satisfaction policy; covers all company processes and all its products/services; is the appropriate one for the sector technological trends and advances.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
q) Ensures that the processes identified in the Digitalization field are generating and providing the expected outputs and results.	x	x	x	x	x	x	x	x	x	x	x			x		x	
r) Ensures that the integrity and security of the Digitization system is maintained when changes are planned and implemented.	x	x	x	x	x	x	x	x	x	x	x			x		x	
Act																	
Priority tasks:																	
s) Drives innovative / transformative / disruptive **improvement projects** in the field of Digitization, including corrective actions, within the Digitalization department and the company.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
t) Identifies opportunities for improvement, including nonconformities, of the Digitalization department and of the part of the company management system related to Digitization and to the implementation of its strategy.	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x

3 Relevant skills for the DTM

In this section we present those skills that previous studies and survey results identify as the most needed by the DTM for the successful implementation of the company digitization strategy.

3.1 Some considerations about skills

CEDEFOP delivered a common accepted definition of the key concepts when talking about skills in VET.

Skill *is usually used to refer to a level of performance, in terms of accuracy and speed of performing particular tasks (skilled performance). […] Skill has been defined as: goal-directed, well-organised behaviour that is acquired through practice and performed with economy of effort*[3].

Knowledge *includes theory and concepts, as well as tacit knowledge gained as a result of the experience of performing certain tasks. Understanding refers to more holistic knowledge of processes and contexts and may be distinguished as know-why, as opposed to know-that. Know-how is often associated with tacit knowledge and know-that with propositional knowledge, reflected in the distinction between declarative knowledge (knowing what), and procedural knowledge (knowing how)* [4].

In this framework, we can see that Knowledge refers to what one professional needs to know to be able to carry out the tasks of a specific occupation/job, while skills refer to what one professional needs to be able to implement/do in order to carry out the tasks of that specific job.

Competence*, in turn, can be defined as one's capability to handle certain situations successfully or complete a job. Competence can thus be considered an umbrella term for being equipped with the relevant knowledge and skills to be able to carry out the tasks and duties of a certain job (using the term 'competence' in this way is also in line with the approach of the e-Competence Framework (e-CF)* [5]*).*

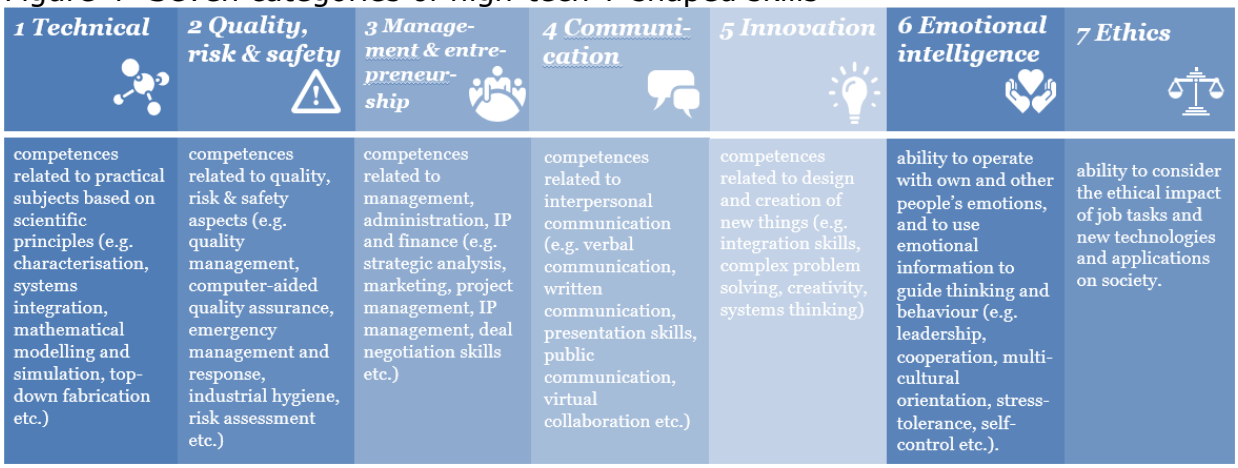
Current literature highlights the importance of **high-tech T-shaped skills** for any successful implementation of Digitalization strategies in manufacturing companies. High-tech T-shaped skills refer to the combination of generalist skills in different/several domains and specialised skills in one precise domain, specifically related to a specialized sphere of work or knowledge, in this case: Digitalization[6].

[3] Pag 7 – Typology of knowledge, skillsand competences https://www.cedefop.europa.eu/files/3048_en.pdf
[4] Pag 7 – Ibid.
[5] Pag 215 - Skills for smart industrial specialisation and digital transformation – Interim report https://publications.europa.eu/en/publication-detail/-/publication/1939a3ea-e955-11e8-b690-01aa75ed71a1/language-en/format-PDF
[6] Pag 216 – Ibid.

Hereafter, we identify seven categories of skills relevant to digital transformation. Looking at the above-mentioned high-tech T-shaped skills, they are relevant both as crosscutting skills and as specialized (technical: Digitalization) skills:

1. Technical skills (Digitalization);
2. Skills related to quality, risk and safety skills;
3. Management, leadership and entrepreneurial skills;
4. Communication skills;
5. Innovations skills;
6. Emotional intelligence skills.
7. Ethics

Figure 4- Seven categories of high-tech T-shaped skills[7]



3.2 Survey results

The following parts specifically present the outcomes of the survey explicitly implemented by the DITRAMA partnership to identify those technical and not-technical skills needed by Digital Transformation Manager to successfully implement the digital transformation in a furniture manufacturing company.

3.2.1 Survey results - Technical competences

This section presents the results of the survey in relation to the importance of the technical competences for the digital transformation of furniture industry. These skills related to KETs areas can be categorized into production technologies, digital technologies, cyber technologies and knowledge domains.

Survey respondents consider that the most important are (from the most important to the less important).

1. **Industrial internet of things**: The network communication technology providing the necessary connectivity to have access to all relevant data is referred to as the Industrial Internet of Things.
2. **Cybersecurity**: Cyber threats can hit any part of the manufacturing chain as well as the actual smart products itself.

[7] Pag 221 – Ibid.

3. **Technical general competences**: Competences related to practical subjects based on scientific principles (e.g. characterization, systems integration, mathematical modelling and simulation, top-down fabrication, etc.)
4. **Horizontal and vertical system integration**: The accumulated effect of the convergence of the new digital technologies accelerating the impact of the digital transformation.
5. **Cloud computing**: Cloud computing is a shared pool of configurable computer system resources and higher-level services that can be rapidly provisioned with minimal effort.
6. **Simulation**: Accurate predictions of how elements behave.
7. **Big data analytics**: The extraction of new information from massive amounts of data using machine learning software algorithms.
8. **Additive manufacturing**: Additive manufacturing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object (3D printing).
9. **Augmented reality**: A live indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video or graphics on top of the real world.
10. **Autonomous robots**: Autonomous robots and machines that are able to make their own decisions on how to operate in a particular situation.
11. **Blockchain**: system in which a record of transactions made in bitcoin or another cryptocurrency are maintained across several computers that are linked in a peer-to-peer network. This system is used by companies to offer the traceability of their products throughout the production chain.

3.2.2 Survey results – Not-Technical competences

This section presents the results of the survey in relation to the importance of the Not-Technical competences for the digital transformation of furniture industry.

Survey respondents consider that the most important are (from the most important to the less important).

1. **Innovation:** The interdisciplinary nature of KETs asks for competences such as having a design mind-set, taking risks with approaches and solutions that have never been applied or attempted before.
2. **Communication:** As manufacturing processes involve large number of workers from a variety of cultural backgrounds, KET workers need to be able to interact with each other and understand each other's terminologies and goals.
3. **Management and entrepreneurship**: Three distinctive sub-categories of competences can be distinguished within Management & Entrepreneurship category at the individual level, namely, business development, operational management, and entrepreneurship-related competences. Business development is necessary to capitalize on KETs market potential, and require an individual to have knowledge of strategy, building competitive advantage, the application of state-of-the-art application, and tools and techniques, concepts for the management of new products, and supply

chain management when dealing with complex and risky global supply chains.

4. **Emotional intelligence**: Emotional intelligence is a key ingredient for any successful interdisciplinary team, especially if cultural or other barriers need to be bridged. Emotional intelligence skills include the individual's ability to control own behaviour, and include, among others, persistence, passion and enthusiasm, attention to detail, adaptability, self-discipline etc. Emotional intelligence also includes social skills, including the ability to manage the emotions of others, including friendliness, leadership, integrity, multi-cultural orientation.
5. **Quality, risk and safety**: KETs are envisaged to become widely used and highly impactful, requiring KETs producers to ensure the quality of KETs and to consider risk and safety issues. While companies typically hire dedicated quality assurance specialists, upholding quality and safety is a responsibility of all individuals within a company, necessitating basic quality assurance skills. Furthermore, working with KETs might entail safety risks, making safety skill a prerequisite for future workers.
6. **Ethics**: Given the substantial social and environmental impact that KETs and digital technologies might entail, leaders and professionals need to be aware of the consequences that their actions can have. Skills related to ethics include having basic human values, empathic concern, perspective taking, moral behaviour, moral cognition and moral judgement.

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Annex I

This Annex presents the **expected scenario of the EU Wood Furniture Industry in 2025**. The content is based on the outcomes of the DIGIT-FUR project. www.digit-fur.eu

1. Introduction

1.1 European Wood Furniture Industry in 2025

In order to be able to forecast the furniture sector scenario in 2025 to secure the EU innovation and competitiveness a necessary step was to get a clear overview of the ongoing and forward-looking evolution of the European furniture manufacturing industry and eco-system in general. To achieve this, the study adopted a holistic lens to identify and understand the industry in the context of the drivers that will influence the future, not only of the production and consumption system themselves, but of the broad European furniture industry sector in 2025. The work done, that is both the process itself as well as in the formulation of this report, has been adopted from a similar but more general manufacturing industry study on *How standards will facilitate new production systems in the context of EU innovation and competitiveness in 2025?* made by the European Commission[8].

The vision of the European Furniture Industry in 2025 has been based on the analysis of the importance and impact of societal changes, technology developments, economic trends, the environment and policy drivers of the furniture industry. The vision has been developed using review of existing research and literature on current and future trends of furniture manufacturing, at both European and global level, combined with a Delphi survey including an online questionnaire combined with a joint workshop involving experts from the wood furniture industry, experts in European economic trends, in vocational and educational training, in occupational health and safety as well as within industrial digitization.

The concluding summarized view of the European furniture industrial eco-system, its interlinkages and dynamics is described through a functional view rather than a classic sectorial view, equivalent to the one used in the foresight study already mentioned above. This method is believed more illustrative in terms of the identification of future, potentially disrupting, wood furniture industry scenarios, where novel digitization technologies are transforming the classic well-known landscape into a completely new rapidly changing marketplace.

[8] JRC Foresight Study on "How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025?", European Commission, 2014 (http://publications.jrc.ec.europa.eu/repository/bitstream/JRC93699/jrc_27ap15_2rep_web.pdf).

2. The Vision

A clear and understandable **European wood furniture industry vision** has been made to help grasp the critical elements in a 2025 timeframe. This vision is a view into how the future can offer to Europe an even stronger wood furniture manufacturing industry with increased competitiveness on the global market. Moreover, it can be used as a tool to stimulate strategic thinking about future strategic investments and to support the preparation of next reports foreseen in the framework of the DIGIT-FUR project. The vision statement is:

> *By 2025, with a massively **connected and globalised economy**, the wood furniture manufacturing industry will offer **personalised smart products and services** based on **digital manufacturing, logistics and sales systems** supplied by **resource-efficient and sustainable industries** with an immense need for enough **digitization talents and skills** securing a competitive transformation of the industry.*

The next sections describe the status and the industrial landscape responses for each of the five key elements of the vision statement above.

2.1 A Connected and Globalised Economy

In 2025, the world economy will be even more connected and globalised, with the global market expanded to include more mature economies like the BRICS countries (Brazil, Russia, India, China and South Africa). The **growing global population** will create new market opportunities, but also increase the fight for market share. New industrial players from emerging and newly emerged industrial economies will fight for their role and compete with well-established companies from industrialised countries like those within the EU. A truly global market place result in potentially millions of new customers for products and services across the globe, but in order to gain from this it is necessary to be able to address a significant regional diversity in consumer demands. The winners will have increased their global **market analysis capabilities** significantly.

In order to maintain a competitive advantage companies will be offering **mass customisation** as an answer to the customer requirements. Companies will still seek to maintain the cost-efficiency of mass production by integrating the highest degree of flexibility in individual customisation and differentiating the product/service at the latest possible point in the production chain. Individualized production costs will continue to decrease, with wood furniture add-on materials being manufactured using ultrafast 3D printing and hybrid machines combining additive and machining directly in the production phase, allowing customization to be done at very early stages in the supply chain. Companies with **agile product lines** will be highly competitive by leveraging proximity to local markets and deliver highly personalized products with minimum lead-time. Consumers appreciate instant gratification and are often willing to pay for it. This kind of agility is of particular interest for manufacturers in countries with well-developed local markets and high labour costs and can be implemented in large as well as small and medium sized enterprises (SME's).

Rapidly developing **digital tools** will unlock the opportunities of mass-customization for consumers. Online tools can enable the customisation of a specific furniture, where the elements of the particular design can be added to the production schedule right after the customer has placed the order. This kind of manufacturing-on-demand model helps control costs and decrease stocks. Depending on the individual design, the logistics chain can put

the parts together for shipping. For the most mature companies, this digital transformation is facilitating a **true global production and distribution** system.

By 2025, the wood furniture manufacturing industry will be in the middle of a new era in manufacturing, the **digital manufacturing era**. Manufacturing companies will need to be highly agile. Networked enterprises use information and analytics as skilfully as they employ talent and machinery that can deliver high valued products. We talk about an actual **digital transformation of the industry**.

2.2 Personalised Smart Products and Services

A demanding customer base will drive a much more aggressive type of consumer requirements for **personalised products and services**. This will be a key driver for the wood furniture industry. To comply with this customisation, manufacturing companies and service providers will work closely together to build consumer-driven solutions of combined products and services. The customization and diversification of products require companies to rely on artisanal skills and/or very deep technical expertise, e.g. in the processing of different materials like wood/plastics/glass or building the best data analytics algorithms. An increased number of **niche industries** will emerge, often in very technical and specialised areas. These niche industries will work in loose alliances with other companies to help produce the personalised products and services that consumers will increasingly require. They will be extremely important, also for established companies, since they will drive the transformational change in processes and hence become a target for mergers and acquisition. Niche companies is one of the main driving forces of Industry 4.0, also with respect to the wood furniture industry.

To be able to benefit from these new opportunities, companies will have to change the business model into a true global digitised business model. Think of it this way: the competitive furniture manufacturing business model changes from having a focus of relentless cost optimisation to a much stronger focus on how to become best in **manufacturing personalized products**. Over time, service-type functions will play a more and more important role for the companies since they are an excellent ad-on for the implementation of personalised consumer products. **Smart products**, with embedded digitisation capabilities based on powerful single board computers, are everywhere enabling the ad-on services. By 2025 furniture product ownership is no longer the only dominant market driver; consumers increasingly require "bundled" products with embedded **digital services**. The ability to offer a complete **ecosystem**, e.g. with data from different business sectors, as an integral part of the development. Products will offer more competitive services and thereby products. The concept of the **API economy**, where products embed a customer interface that allows software components to interact, is another example of a new business model enabler technology that is being pushed forward by the accelerating performance/cost increase of technologies like cloud computing and open hardware/software. Smart furniture's will be flexible in their functionality and meet the required personalisation demand of the customer. Additionally, it opens up for a more **holistic design** thinking, taking into account the entire life cycle of products and services. This holistic approach, addresses all aspects of products and services, from consumer requirements to their environmental impact and cost. Consumers can be much more closely involved in the design and prototyping of products and services. New practices, including **social and open innovation**, will be implemented to maximise consumer input and innovation. Many companies will become more specialised, focusing on one particular part of the value chain, working in collaboration with other companies to develop products.

Besides the digitisation technologies materials will remain the critical factor for the competitiveness of any advanced furniture manufacturing company. The scarcity of many

important materials will continue to push the development of new **advanced materials**. New wood-based materials will arise, new ways of doing wood and surface treatment as well as bonding technologies (e.g. in combination with polymer chemistry) will also arise. This makes fields like wood chemistry and material emission key knowledges and related skills. Materials will be optimised with respect to characteristics like increased functionality, lower weight, a lower environmental burden, and greater energy efficiency. Materials engineering will improve productivity, ease material recycling and reuse, and open the path towards efficient manufacturing processes. Even smart, **multifunctional materials**, able to change properties according to the environment (e.g. temperature, pH, light, magnetic field, etc.) will become increasingly available, and will permit the development of new, advanced and environmentally friendly products. Discoveries arising from nano-scale technological breakthroughs will underpin these developments. The development and characterisation of new, advanced materials will continue to facilitate advanced manufacturing processes, such as additive manufacturing combining different materials creating products not previously possible.

2.3 Digital Manufacturing, Logistics and Sales Systems

One thing we know for sure: the factory of the future will be **a smart factory** with plenty of embedded machine intelligence. This is already today happening in many industries, e.g. within shoe manufacturing. Building on top of the basic automation of the factories of the past, the smart factory will integrate digital technology into every part of the manufacturing, logistics and sales processes. Fully connected, flexible and hyper-efficient, the new manufacturing model will make use of the constant acceleration in price/performance of a number of digital technology domains. A fully implemented digital smart factory will, for the winners, **reduce the time from design to production** dramatically, satisfying the consumers service need in relation to customisation and fast delivery. Additionally, the digital smart factory will have **distributed and agile production and supply chains** that are geographically spread around the world, connected by advanced digital communication infrastructures. Systems will be based on an intelligent and reliable communications infrastructure where data are kept private and secure. Large companies will build their own system, and make it a competitive edge, while smaller SME's will buy this as a service. It will be a competitive edge to have the best **logistic systems** to produce and distribute products.

The one single technology that is driving the entire digital transformation, is the **evolution of electronics**. By 2025 the exponential price/performance improvements we have seen for the last 50 years have continued and we can expect price/performance reductions with a factor of around at least 15-20 compared to today for area's like computational power, network connectivity and data produced. A set of **digital enabling technologies** benefit dramatically from this and therefore drive the transformative digitisation agenda, for the wood furniture manufacturing industry, too.

Smart electronic **sensors**, as e.g. radio tags, have continued to rapidly decrease in size as well as in price. Billions of these small electronic components are collecting information, connected via what is referred to as the Internet-of-Things. For example, the RFID technology allows washing machines to automatically adapt their washing programmes to the clothes introduced. In the same way, the RFID technology could be used in a wardrobe to suggest to you which specific clothes to wear in relation to the weather or to your agenda. Robots will separate waste depending on the composition of the objects, and sensors will monitor sensitive infrastructures to assure their structural integrity. As a result, processes are easier and much smarter monitored.

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Massive digital connectivity of everything is currently happening. By 2025 the **Internet-of-Things** is a reality, enabled by **standardized interoperable technologies** like mobile internet, **cloud computing** and advanced low-cost hardware communication technologies like photonics. Social networks and open innovation tools play an important role in the sharing and the generation of knowledge, with the next generation of Internet offering increased functionality and intelligent searching.

Data and **data analytics** has become the new oil that furniture manufacturers can use to better understand and optimise all stages of the value chain from design to distribution, including supply chain management, the production processes and marketing. Additionally, **ubiquitous computing** using low-cost high-performance single board computers generates collections of huge complex data sets everywhere. To process these types of data new **artificial intelligence** algorithms have been developed that facilitates capture, storage, search, sharing, transfer, analysis, and visualisation. This has allowed new information to be used by anyone that have the necessary software intelligence to greatly improve services and thereby the products.

From the nature of the wood furniture business, the **product design** itself is of course a very critical part. By 2025, for the smart factories who are producing smart products, the design phase and the manufacturing phase will have melted into one single highly integrated process. Digital **simulation** of the furniture product as well as the entire manufacturing process, called **digital twin**, will offer better, faster and more cost-effective products as well as manufacturing processes. Accurate predictions of how elements will behave will reduce errors and cut costs. Integrating simulation into manufacturing from start to finish will help unleash the full potential of advanced manufacturing processes like additive and hybrid manufacturing.

Augmented and mixed reality as a live indirect view of a physical, real-world environment whose elements are presented with a digital overlay by computer-generated sensory input such as sound, video or graphics, are an integrated element throughout the entire manufacturing process. It is used all the way from the design, development and manufacturing phases to marketing and sale, even for smart product customer training as a new way of visualizing products. Examples such as **virtual rooms** for the proper configuration of a product, by the customer, will be widely used by companies of all sizes. By 2025 the core underlying technologies, like computer processing power, will enable mixed reality visualizations so good they hardly can be differentiated from the real world.

The manufacturing chain of the smart furniture factory will be highly automated. Not only digitisation technologies but also mechanics and advanced materials has matured advanced flexible cost-efficient **collaborative robots**. They are designed to interact directly with humans as an integrated part of the manufacturing process in a safe, flexible and easy way, offering massive efficiency improvements of the manufacturing business of every size, also for SME's. Robots can have health and safety benefits in removing the need for workers to operate in hazardous or unsafe environments. They can also prevent heavy and repetitive labour that may result in musculoskeletal disorders. However, through robots and automation new occupational risks and safety matters may arise and will need to be properly identified and tackled. **Embedded metrology** with the measurement of parts within the production process itself is everywhere. It is more accurate and requires far less human interferences in the line of production. Fully automated, fully integrated measuring and monitoring technology has the potential to bring automated manufacturing quality control to the factory of the future.

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The accumulated effect of the **convergence** of all these technologies accelerates the impact of the digital transformation beyond imagination. They all contribute to the process of improving product and service quality, safety, sustainability and reduce cost and waste. Moreover, the creation of **Building Information Models (BIMs)** for each product will allow the information and technical characteristics travelling in an electronic file format (model) with the product itself and this information can be used by dynamic software of building modelling in 3D and in real time to support decision-making regarding a building or other built asset. The required improvements in ways of securing **technology interoperability** has been made and they are fully rolled out in the furniture industry by 2025. For the fully digitised factory, these technologies facilitate an optimised holistic structuring of the complete value chain. It is possible to efficiently operate a more **complex value chain,** globally distributed, minimising supply chain risks and the environmental impact, while maximising the savings based on a dedicated focus on the regional political situation and specific market segments. Companies will rely more and more on asset-tracking software enabling the real-time monitoring of materials and products. The use of such tools will assure good process reliability, short delivery times, reduction of stocks and low costs.

With the level of information exploding, by 2025, **knowledge management** has become a crucial task for any wood furniture manufacturer, in terms of not only operating the digital factory to provide mass customisation, but also when producing smart products and creating tighter customer relationships. Large companies will build and operate their own cloud systems with secure **data storage**, providing them with a competitive advantage e.g. towards how they utilise personalised information about their customers. It is a big task to do this properly, as it is necessary to do it through an integrated approach to identify, capture, create, evaluate, store, retrieve and share all a company's knowledge assets. Therefore, most SME's will not build their own knowledge management systems, but buy specific services using more generic components provided by external data service providers. The top digital wood furniture manufacturing companies will by 2025 have implemented new knowledge-management schemes across the organisation and managed to minimize the barriers between workers, technicians, engineers, designers, big data experts, managers and executives.

2.4 Resource-Efficient and Sustainable Industries

Wood furniture manufacturing, being an industry producing high volume products of large physical size, will increasingly have to focus on the **use of resources and energy from sustainable sources**, completely similar to quite different manufacturing industries like e.g. automotive, wind turbines and even large-scale electronics. The increasing concern of climate change, among other environmental impacts as well as the lack of available natural sustainable resources call for new ways of addressing the challenges of being able to produce enough in a sustainable way. Both factors will have considerable impact on all manufacturing industries, including wood furniture, both in terms of cost of materials and cost of certain types of energy, but also due to a rising environmental and societal concern.

The wood furniture industry is already today, from an eco-sustainability standpoint of view, well on the way. On one hand, the primary material used in our production, wood, helps by itself to raise awareness of the sustainable agenda. On the other hand, the market is increasingly aware of the sustainability concerns and the impact of products on health of users and workers. This has led companies to focus on two different development paths within sustainability. The first on the **design of increasingly eco-friendly products**, using and researching the use of recycled, recyclable, safe materials with lower environmental impacts, making the products more circular. The second concerns

companies and their production phases: many companies are already relatively **eco-sustainable within the production chain**, improving the quality of work, using renewable energy and waste disposal so that it can be recovered. However, furniture manufacturing companies will increasingly be forced to focus on saving energy, minimising waste, recycling and reusing products and their parts, as well as increasingly put their attention on the increasing demand for green and circular energy-efficiently produced products.

Energy- and resource-efficient business models are needed for factories to achieve the *triple-zero* objectives: zero waste, zero net energy cost and zero environmental impact. This **circular economy** kind of business model will be driven by market costs, societal demands, and a regulatory push, and by 2025 also by the consumers that will require more environmentally friendly furniture. In some parts of the wood furniture industry this shift is already happening, e.g. with re-cycling of materials (e.g. particle boards), reusing some parts (e.g. contract and office furniture subsectors), implementation of take-back schemes (e.g. in France) and the formalised use of eco-systems to produce more sustainable products. They will also invest in technologies to manage the disassembly and de-manufacturing of materials, parts, products and even factories, as well as the recovery of trace elements, so as to foster end-of-life reuse, remanufacturing and recycling. This will be part of the marketing strategy to gain a commercial advantage (e.g. sustainable packaging and remanufacturing). As life-cycle and **sustainability-by-design** approaches increasingly impact the value chains, materials will circulate among different industries and value chains. This circulation will be enabled by a range of advanced technologies including the reuse, remanufacturing and recycling of secondary materials, parts and products. The furniture industry must **close its material cycles** and take responsibility of its products during the whole life-cycle. The sector should be prepared and already develop take-back schemes, repair services and enhance the reuse and recycling of furniture materials.

Environmental and social pressures will contribute to the changes in furniture manufacturing. **Corporate social and environmental responsibility** will become a core element of the company strategy, with reporting and accounting requiring companies to set environmental and social rules. Costumers will increasingly choose products on the basis of their social and environmental impact rather than on price alone. This will be driven by an increased awareness of the ethical issues surrounding sustainable products. Consumers will be better informed thanks to the widespread use of social networks, which results in a new social ranking of products and services.

As natural resources become scarcer, suppliers will need to be more **technologically advanced and specialised** as they seek to extract the remaining key natural resources. The evolution will continue and companies will invest in the development of new **replacement materials**. Research inside or among companies in the field of sustainability will be done aiming at innovations in the materials used, in products and in internal processes. Companies will increasingly consider Nature and its ecosystems to innovate new sustainable products and services. In particular, the use of organic materials and non-toxic, non-harmful synthetic materials, which can be used endlessly in different cycles, will help to achieve a waste-free manufacturing system that can protect and even enrich ecosystems.

The continued transformation to more and more **sustainable energy supplies** supports this effect. The rapidly declining cost of electrical energy production from sustainable sources (especially solar but also wind), combined with the smart electrical power grid, enables factories to optimise their consumption as well as their cost of energy. This is mostly true for large manufacturers, an example is the design and use of the heat or waste

from the manufacturing process itself that can be embedded as a source of energy, enhancing the energy balance and making them **energy self-sufficient and carbon neutral.** Cheap new electric **energy storage technologies**, like e.g. redox flow batteries, will enable factories to adjust energy flows according to their off-the-grid needs.

2.5 Digitization Talents and Skills

The wood furniture manufacturing industry is dominated by SME's. In e.g. Spain and Belgium, more than 90% of the companies have less than 20 employees. These small companies, in general, lack skilled digitisation employees in order to be able to adapt to the coming highly impacting changes. By 2025 the furniture industry will embrace high value characteristics in their products: smart products with embedded ICT, sustainable products from an environmental point of view, as already described. In order to be able to compete in this market, SME's need to have access to **the furniture manufacturing industry new types of needed skills and knowledge**. This will imply new occupational risks and safety matters that will need to be properly identified and tackled. The furniture manufacturing industry needs to secure digitization professionals, design engineers, environmental engineers as well as other profiles like strategists that can read and map the digitization changes and how they will influence the market and business case of the individual company/industry. General engineers and tech-oriented managers will also be essential to achieve business/ICT alignment and convert data into strategic insights. The wood furniture manufacturing industry will compete with completely different industries about this.

High level of customization and personalized design will increase the demand **for highly skilled digitisation personnel** dramatically. This will not only be evident when supporting the design and the manufacturing process, but also when analysing the large amount of data collected from various systems along the value chain. Big data analytics and its influence on the planning and manufacturing process, distribution and marketing will further increase. It will raise the demand for such **highly skilled digitization individuals**. Also building smart products contributes to an increase in this demand. The furniture manufacturing industry should already today initiate processes to **set up strategic partnerships** with strong ICT universities and companies from other well-established digitization domains. The race is on and within the ability to attract digitization skills the competitor is not found in the classic furniture industry, but in principle any other industrial domain affected by the digital transformation (agriculture, energy, production, finance, healthcare etc.). **Securing the right skills and best talents may be the biggest challenge of all.**

Advanced manufacturing systems will be shared by product designers, so talent is needed to design, build and run manufacturing facilities as well as for sales. This can be done at independent geographical locations. Companies will consider human resources globally and factories will move where skills and talents are located.

The classic relationship between **employer and employee will diminish** and eventually disappear. By 2025 there will be a more flexible relationship with some kind of the right talent at the right place at the right time. Specialised digitization co-workers will be independent subcontractors, who will work together with SME's on project-based contracts/internships. Larger companies will employ these specialists under long-term contracts.

Companies will develop **internal training** schemes or apprenticeship programmes to fill their specific workforce needs and grow their talents. They will increasingly **collaborate with educational partners, universities, research centres** and other partners to offer

work study programmes with recognised degrees to younger talented recruits. **Collaborative platforms** and more strategic stronger links among companies and universities and other educational partners support this, also for SME's. With a collaborative and open approach among the sector stakeholders, it will be easier to secure a competitive future. Small and micro companies require a specific and permanent support to properly exploit the digitization transformation of the sector and to properly exploit the new technologies and possibilities offered by this. **Local and international technological centres** are key entities for facilitating the success of these companies by providing specific support and the related services, as, in relation to higher and larger research institutions, they are closer to the practical and daily needs of these kinds of companies.

To safeguard knowhow and develop new and useful knowledges for companies the creation of **vocational training centres** is born from the collaboration between companies and aimed at providing adequate training to respond to the new needs of companies in the sector.

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