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Deliverable D2.2 - SILEO Manufacturing Process Map & supply chain SWOT analysis

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Premises

Europe has a long way to go to fully tap the potential of advanced technologies and digitization, and the European lighting and furniture SMEs are on its frontline. The size, scale, and pace of change are greater than ever before, and the COVID-19 has pushed companies over the technology tipping point - and transformed business forever. In just a one- year time, the pandemic has brought about years of change in the way companies do business. Firms have accelerated the digitization of their customer and supply-chain interactions and of their internal operations by three to four years. And the share of digital or digitally enabled products in their portfolios has accelerated by a shocking seven years. Companies have stood up with at least temporary solutions to meet many of the new demands on them, and much more quickly than they had thought possible before the crisis.

However, to ensure that these changes are long-lasting and what's more beneficial to firm growth and competitiveness, SMEs need to reimagine the business ecosystems and internal production processes necessary to deliver outcomes and their role within. And establish partnering as a strategic competency. Failing to do so may lead them to be left behind in the market and the ecosystem of Industry 4.0 and 5.0.

Lighting and furniture SMEs constantly must deal with new business challenges. In addition to technical restrictions and sustainable product policies, it is precisely the increasing individualization of customer needs combined with growing demands on the availability of products that have led to a need for rapid adaptation and business transformation to remain competitive in the market. The global health crisis, and the consequent raw materials and supply chain shortages, must be added as a challenge threatening the stability of business operations.
WP2 goal is to execute a deep analysis of the current manufacturing, logistics, commercialization, and also management processes in the lighting and furniture industry to individuate the main criticalities and bottlenecks that occurred in SMEs, like important hold-ups and limits of the current traditional processes that interrupt the production by delaying or stopping the flow of operations, restricting the information stream, guidance and work instructions, impacting the quantity and quality of the products, and finally always result in reduced performance for SMEs.
The SILEO Manufacturing Process Mapping with the SWOT analysis of target processes, along with the strategic market intelligence analysis tailored for the characteristics of the lighting & furniture sector will help to understand the importance of the green and digital transition, the short-, medium- and long-term gains, and also to detect potential applications of the Advanced Technologies and how they might help SMEs to improve their business and get closer to industry 4.0 – 5.0 concepts.

The fact-finding and executed analysis will be accompanied by SILEO Value Chain Discussion Forums, having local and international dimensions, aimed at identifying key value chain players to support the companies' business activities and make them more resourceful, green, and technologically advanced and to establish a direct dialogue with the policymakers and regional authorities managing industrial policies to sensitize them on the SMEs' challenges.

Task T.2.1 aims at providing a Lighting & Furniture Manufacturing Process Map with supply chain SWOT analysis. This task performs the in-depth analysis and segmentation of manufacturing, logistics, and commercialization processes in the lighting and furniture industry, with particular focus on different SMEs' production typologies and market applications, and all along the whole chain (suppliers of raw material, suppliers of component, external process suppliers). This investigation detected the strengths, weaknesses, opportunities, and threats of the current manufacturing, logistics, and commercialization processes and of

the related supply chain ecosystem. It was examined considering the changing market demands, post-Covid-19 business challenges, sustainability, energy efficiency, materials and components shortages, and external dependencies.

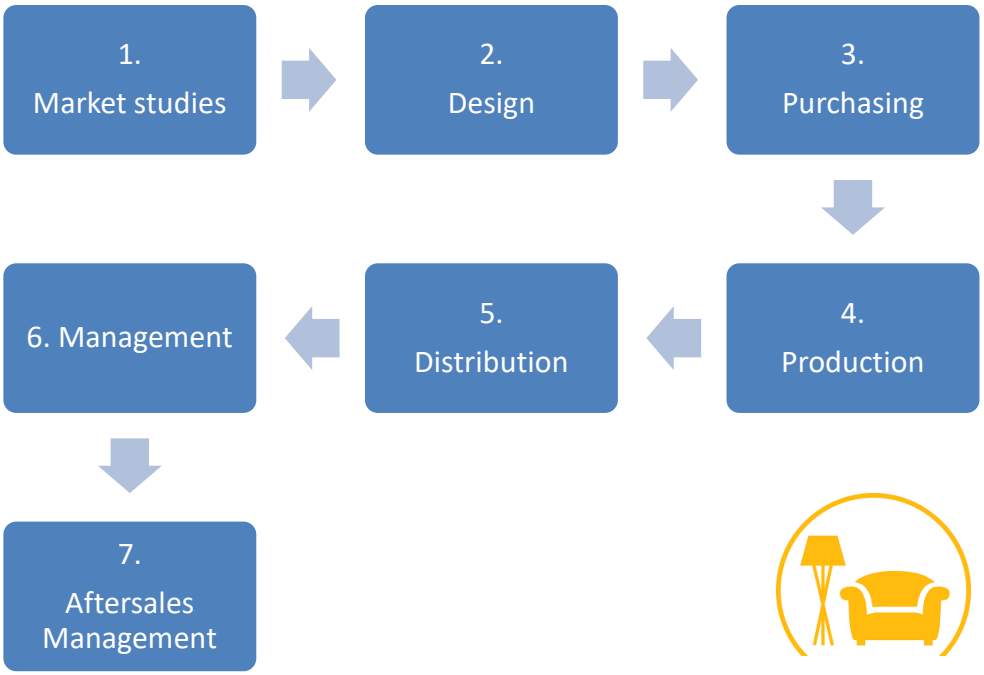
The mapping process was performed by the six project clusters (Cluster Lumière - CL, Catalonian Lighting Cluster CICAT, Rete di Imprese Luce in Veneto - LIV, Cluster Arredo - Arredo, Transylvanian Furniture Cluster - TFC and Building Innovation Cluster - BIC) from France, Italy, Spain, Romania and Austria, with the active involvement of their SME-members, representing lighting and furniture sectors, via customized surveys and live - online interviews. The total 64 SMEs have provided inputs to the SWOT analysis: LIV-20, CL-7, CICAT-7, TFC-10, BIC-10, Arredo-10, 34 lighting companies and 30 furniture companies.

ELCA being an international network of lighting clusters, including three SILEO partners (LIV, CL, CICAT) and not having direct contact with SMEs, supported Cluster Lumière in the data analysis of the collected mapping inputs.

1. Methodology for Manufacturing process map

Lighting and furniture manufacturers do not manufacture all components of the final product they deliver. In fact, they must purchase materials (metal, wood, holster, plastics), glue, tools, electronic and electric components. They also must modify aspects of products (finishes and painting).

After exchanging with the participating Clusters, a first mapping of phases of the manufacturing process was proposed. The successive 7 steps were identified:



Then for each of the 7 phases, we conducted the exercise of identification of sub-phases (Table 1), to facilitate discussions on more specific topics. This was considered as essential to launch a SWOT (Strength, Weaknesses, Opportunities, and Threats) analysis of the activities of the SMEs. This showed that a large majority of the subphases were similar between the Furniture Clusters and the Lighting Clusters.

PHASE	SUB-PHASES
1. Market studies	Market analysis Targets / priorities Strategy International Strategy Branding
2. Design	Ideas / early-design Validation Marketing / R&D Prototype design Optical specifications Electrical specifications Communication specifications Material specifications Prototype design

	Prototype validation Industrialization Manufacturing tools First series Certification
3. Purchasing	Materials Light engines Optical components Power supplies / drivers Electrical connectors / wiring / junctions Communication components Casing Structural components Tools
4. Production	Organisation of assembly line On-site manufacturing (robots / manual) Technology Assembly Quality testing Packaging Transport to storage Duration of manufacturing process Storage of components Storage of final product
5. Distribution	Commercial activities / local agencies Communication Management of orders Delay for delivery Distribution (B2B, B2C) Wholesalers
6. Management	In house human resources External human resources Purchasing / rental of equipment Subcontracting Consumer Relationship Management
7. Aftersales Management	Spare parts management Customer Feed Back Management Satisfaction Survey Warrantees Product maintenance

Table 1. Phases a sub-phase of the furniture and lighting industry processes.

Then the proposed exercises consisted of bringing a critical analysis of these steps and identify the critical steps for which there is a need for change of the process. This is why a SWOT analysis appeared attractive.

2. SWOT Analysis

SWOT analysis means to identify for the activities of the SMEs, Strengths, Weaknesses, Opportunities, and Threats. The proposed SWOT analysis was performed to identify key points of attention: they are tasks, which are affected, or will be affected, by the evolution of the context, and the technology.
The SWOT analysis allowed companies to identify tasks which require some level of changes or adaptation.

It was proposed to invite European SMEs member of the participating Cluster organizations to conduct a SWOT analysis to identify domains where major improvement of their activities could be achieved, leading to reduction of risks, and strengthening of their activities.

Since the context is changing rapidly, the SMEs were invited to bring their views on issues such as:

- Threats and opportunities related to the development of digital technologies (communication, machinery, controls, etc.)
- Threats and opportunities related to more constraints concerning the environment (energy efficiency, higher transportation costs, use of local materials, recyclability, etc.)

In this deliverable, we present the methodology, the results of the SWOT analysis and the comparison between the situation today and the possible direction for going more digital and greener.
All participating Clusters involved some of their members (at least 10 per Cluster) in a task aimed to determine areas that require improvement, request more supply independence and resilience, specific collaboration actors, and revision of the business model.

The task has been performed by the project clusters, with the active involvement of their SME members via customized surveys and live auctions. The SILEO Manufacturing Process Map along with the SWOT analysis aimed at giving a clear view of current practices which is the actual start of EU lighting and furniture SMEs' transformation process towards green and resilient factories of the future. The analysis of results has been shared among target SMEs. The tables proposed above have been used as a canvas in exchanges between cluster organisations and their members.

Methodology:

1) Part of the task was conducted through an online survey: sending questionnaires to Cluster members.
2) Part of the task was also conducted during specific meetings where participants were invited to fill the tables together, leading to possible debates.

It was agreed during a cross-work package meeting (WP2 and WP3) that participants should be given, when answering the survey, the list of possible “Advanced Technologies” which will be addressed by vouchers offered to companies. However, it was also agreed to complete the initial list supplied by the draft version of deliverable D3.1 with processes “outside the only manufacturing phase”.

3. Guidelines for conducting the SWOT Analysis

The principle is that each company willing to participate in the exercise should try to bring information in some boxes of the proposed table. The figure below suggests the steps. Each company then send the results to the Cluster organizing the exercise.

Figure: Companies are invited to fill part of this templates, following the 7 proposed steps.

The proposal was that the companies do not have to fill all the boxes of the proposed tables, but to fill boxes where key points need to be addressed. This depends on the SME activity. In this phase we communicated the list of identified “innovative technologies” presented in deliverable D3.1 to ease the identification of technologies.

During the exercise, it was also expected that participants identify some missing “innovative technologies” or more generally “innovative processes”. This task was considered as a first possible identification of opportunities for possible distribution of “vouchers “within the SILEO project.
Each participant had to contribute to filling its own table. Clusters have been responsible for gathering the inputs and produce a global table which will be used to manage the voucher scheme, and possibly identify priorities.

4. Processing of results I - The situation today: start line for transformation process

The 5 participating regional clusters (Cluster Lumière, ARREDO, LIV, Biz-up, TFC) have all invited their members in the proposed SWOT analysis. At least 10 SME companies per Cluster have actively contributed to the exercise.

The results were provided in the form of the proposed excel files. For reasons of confidentiality, the excel files filled by each participant remained within Cluster organizations and were not shared between Cluster Members or between Cluster organization.

This mapping gave a good understanding of the present strengths and weaknesses of the European industry of furniture and lighting.

4.1. Strenghts

	**STRENGHTS**
Quality	A significant fraction of the European SMEs propose products qualified has “high quality products” and this make them attractive both for professional and non-professional clients. This concerns the choice of materials, the adjustments, the durability should be considered as a major asset to protect and consolidate.
Innovation	This concerns both attractive design and functionalities. This makes the European products attractive of the market, with significant potential for export.
Customization	SMEs seem to be focusing slightly more on B2B approach, having clients in the domain of hospitality, restaurants, workplaces, education buildings, health care, urban equipment, etc. These specific markets allow the SME to customize their solutions in relation to specific needs of these markets.
Durability	It is a complement to the perception of quality. It allows justifying some prices, which can appear higher than on the global market. In addition, for some companies it leads to potential warrantees and strengthening after-sales services.
New technologies	Some lighting companies are already quite advanced in 3D modelization and use of new communication technologies. But this is very uneven.
Customer relationship	Some companies have established excellent relationships with clients, allowing loyalty. The possibility to directly link the manufacturer to the final client facilitates exchanges (quality assurance) It also allows us to develop a long-term relationship which is essential for the SME.
Branding	Some European SMEs have powerful brands. They are known in Europe and other part of the word. This is an asset and needs to be at least protected or strengthened.
Visibility	Some SMEs are visible of fairs and propose attractive and well-designed booths.

4.2. Weaknesses

	WEAKNESSES
Branding	Some companies expressed also that their Brand is not enough known for the European market as well as the rest of the world. This may require development of a better identity.
Internationalization	Some companies feel uncomfortable addressing new international markets, for logistics issues or certification barriers (safety, electric standards, lighting, etc.).
Time to deliver	Some businesses are missed for excessive delivery time. This delivery time may be related to the slowness of the manufacturing process, the slowness of the distribution chain, or the difficulty of quickly adapting products to the demand.
Storage issues	Storage of strategic components is often difficult to achieve (electronic components for instance, due to scarcity). There are issues related to minimum storage capacity of product components as well as final products to reduce delivery time.
Standardization	Some SMEs are confused about the variety of standards leading to the difficulty to use the most appropriate one, or to develop compatibility with many of them. This concerns software as well as connectors.
Insufficient technology push	Some SMEs already master some high-tech solutions, but this is too much ahead of the market demand: there is a need to better involve clients.
Insufficient offer concerning renewable energy solutions	Some lighting companies want to integrate more solar solutions for autonomous products.

4.3. Threats

	THREATS
Staff training	Staff may be insufficiently trained to master new tools, new technologies.
Regulatory / certification context is changing	This may lead to products becoming obsolete.
Costs	Increase of costs of components, increase of competition.
Risks	Product not in phase with demand, prototypes not meeting expectations. Quality control becomes essential. Failures are more and more expensive.
Customer feedback management	This is becoming strategic, and competitors may already manage this well.
Innovative solutions copied by competitors	This requires linking innovation with branding and rapid increase of sales.

4.4. Start line for transformation process

The results of the analysis conducted by 64 SMEs in the field of furniture and lighting manufacturers demonstrate common status and discrepancies:

- On one hand they consider that they propose high quality products on the market with sometimes powerful brands allowing both to benefit from loyal clients and to attract international customers.
- On the other hand, the changing context (regulation, standards, electric components) require them to continuously train staff and invest in new production technology, as well as make strategic decisions.

Also, they are two key constraints for their development: competition is growing due to globalization, but simultaneously they are clients pushing for local production (greener concern). This second aspect could be in fact a very important opportunity to take.

The results dealing with exercise on opportunities were very abundant. They required a review of the potential new innovative technologies and services available. This is why we bring the details in the section 5, 6 and 7 below.

5. Identification of possible innovative technologies or approaches

The table 2 below shows the document which was partly elaborated by participants and partly by the Cluster organizations. It was used during interviews of SMEs and exchange meetings.

PHASE	SOME TECHNOLOGIES[1] AND ISSUES IDENTIFIED BEFORE AND DURING THE EXCHANGES:
1. Market studies Sub-phases: ✓ Market analysis ✓ Targets / priorities ✓ Strategy ✓ International Strategy ✓ Branding	3D Visualization & product digitalization Image Scripting technologies WebAR Sharing experiences of lighting solutions Videoconferencing Experiences on Lighting fairs Social Commerce Machine Learning
2. Design Sub-phases: ✓ Ideas / early-design ✓ Validation Marketing / R&D ✓ Prototype design ✓ Optical specifications ✓ Electrical specifications ✓ Communication specifications	3D Visualization & product digitalization Image Scripting technologies WebAR Bim Objects CAD Virtual Reality Big Data

[1] *The identified technologies are described and analysed in the SILEO Deliverable D3.1 SILEO Scouting Report of Advanced Technologies & Infrastructure providers for lighting & furniture industry.*

✓ material specifications ✓ Prototype design ✓ Prototype validation ✓ Industrialization ✓ Manufacturing tools ✓ First series ✓ Certification	Insertion of communication components - LiFi Wireless control and management of luminaries Use of biosourced materials Use of recycled materials End of life management of materials / reduction of waste Life cycle analysis Labels Cyber Security Cloud computing Miniaturisation Colour control solutions / multi chips
3. Purchasing Sub-phases: ✓ Light engines ✓ Control components ✓ Mechanical components ✓ Wooden materials ✓ Metallic materials ✓ Other materials ✓ Hardware ✓ Tooling	New materials New manufacturing process (i.e., 3D printing) New manufacturing process 24V 48 DC and POE EnOcean, LiFi, Bluetooth, Zigbee New production solutions New LED modules & standardization (i.e., Zhaga)
4. Production Sub-phases: ✓ Organisation of assembly line ✓ On-site manufacturing ✓ Assembly ✓ Quality testing ✓ Packaging ✓ Transport to storage ✓ Duration of manufacturing process ✓ Storage of components ✓ Storage of final product	3D printing Additive manufacturing (difference with 3D printing)? Industrial IoT Laser Cutting Robotics / automation Computer Numerical control
5. Distribution Sub-phases: ✓ Commercial activities / local agencies ✓ Communication ✓ Management of orders ✓ Delay for delivery ✓ Internet distribution ✓ Wholesalers	Automated Warehouse Cantilever rack system Computer aided warehouse management system Multi-directional trucks in Warehouse Transportation management systems (TMS) Internet of things Geolocalization of luminaries to ease maintenance Distribution through the internet (e-commerce) Packaging / waste management
6. Management Sub-phases: ✓ In house human resources ✓ Sharing manufacturing with other players ✓ External human resources ✓ CRM software ✓ Purchase / rental of equipment ✓ Subcontracting	Sharing manufacturing with other players CRM software

✓ Consumer Relationship Management	
7. Aftersales Management Sub-phases: ✓ Spare parts management ✓ Customer Feedback Management ✓ Satisfaction Survey	On-site performance / management assessment

Table 2: Some technologies and issues identified before and during the exchanges. This table was used during the SWOT analysis phase, to facilitate exchanges with SMEs.

Some brief outline of the most interested technologies highlighted by the SILEO lighting and furniture clusters and their SMEs:

WebAR

Augmented reality (AR) sounds like something out of a science fiction film that takes place several years, or even decades, in the future. But the truth is it is here today, and it can help lighting and furniture companies access the advanced form of visual communication to meet and exceed consumer expectations, driving furniture industry growth and revenue. When put to use in the lighting - furniture industry, WebAR helps solving two important problems— getting products to market in time, and effectively communicating the worth and utility of a complicated and expensive product in B2B. It's also a truly unique sales tool that allows a customer to easily visualize how a product will fit within their own home. This is achieved with digital models of products that can be placed within real environments using AR technology. Imagining how a lamp, a couch, or a table looks within client's own home would simplifier and support a decision on purchasing the product.

BIM objects

BIM, or building information modelling is a sophisticated technology specially designed to enable companies to complete projects in less time, with minimal or no flaws, and in a more cost-effective manner.

By implementing BIM, companies can streamline projects by essentially utilizing data files that have been developed with specific parameters that greatly enhance and improve the modelling projects. Building these models from scratch allows for intuitive objects to be created — an intelligent object that allows for precise calculation with minimal effort, and increased flexibility in lighting and furniture project.

Many furniture-lighting manufacturers already utilize BIM to maximize their product reach and subsequently advance their position in the furniture market. For furniture sellers, BIM can be utilized in conjunction with product digitization to better appeal to customers and increase engagement. Regardless of the initial incentive, the ultimate outcome is the same — BIM is a technology trend in the lighting and furniture industry that will continue to gain ground along the path to digital transformation.

ImageScripting

The furniture and lighting have long struggled with a particular consumer pain point — how to get customers to buy products online from an e-commerce webshop when they'd rather be able to see and touch the product in person? The solution is ImageScripting, and it is one of the primary technology trends in the furniture-lighting industry that is successfully driving online revenue. ImageScripting technology can be used to produce photorealistic images of each furniture product that enables a product to be showcased online in stunning detail. Consumers viewing the products online can zoom in and out without any loss of quality or

clarity, rotate images at any angle, and see each piece in a multitude of colors and styles. Portions of the image can even be dissolved in order to reveal hidden components and features.

CAD packages & virtual prototyping

CAD (computer-aided design) was once a technology relegated to architects and similar fields, aiding in the development of rather uninteresting and ultra-technical digital models. But today, CAD has completely integrated with the digital realm and can be used to design amazingly creative and interactive 3D visualizations of a multitude of products. But much more than just a tool for creating digital images, CAD also offers increased value in the presentation of those products in a variety of settings, complete with enhanced lighting, visually stunning textures, and a complete range of styles. This technology has not only paved the way for today's digital transformation but has also grown along with newly developed technologies, serving as both a foundation and pivotal role in future projects. Digitizing the design process allows for CAD data to be available to whoever needs it, driving process stability and speed – especially for made-to-order models where variability has the potential to wreak havoc on production processes. Virtual prototyping increases production speed, reduces models with costly errors, limits physical prototypes and allows for quick changes, and can ultimately reduce your product development from weeks to days.

3D printing

Over the last several years the world has seen 3D printing shake up a number of industries. It seems as if there's nothing one can't have printed these days, and now this technology is changing the world of furniture, too. Lamps, chairs, tables and decorative hardware are now being printed, and it's quickly changing how companies produce pieces as well as increasing the options available to consumers. One part of the furniture and lighting business that has traditionally required significant time and financial investment is the design process. Prototypes have to be made, models tested and pieces reworked to reach a final product. 3D printing streamlines, simplifies and reduces the cost of designing furniture. Being able to create lightweight furniture prototypes quickly and inexpensively with 3D printing enables designers to test their creations more thoroughly and maximize the beneficial features in the finished product. This technology allows furniture and lighting design firms to increase their bottom lines, waste significantly less resources and energy and make production much more efficient.

6. Results of SWOT Analysis: Opportunities per phase

6.1. Market studies

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
Market analysis Targets / priorities	Identify new markets, new applications		Big data and machine learning for market analysis	digital twin to test in very early stage, broader product range, increase speed and efficiency	Access to free statistic information: The National Institute of Statistics Romania Websites and social media	technologies to analyze markets to find out new and unexplored market shares
Market analysis Targets / priorities		Big Data for market analysis			Externalisation of this stage	advanced technologies for market study to monitor the changes of the market trends

Market analysis Targets / priorities						new strategies to strengthen company presence on the market
Strategy	Artificial Intelligence to speed up response to request by customers		Social commerce	all the technologies cause costs at the first stage, technologies can bring the strategic advantages		
International Strategy	Virtual Reality: build shared experiences to test digital prototypes in realistic conditions			technology is the same all over the world		
International Strategy	Need to adapt products to specific geographical zones, and specific weather conditions.		Big data and machine learning for new international strategy			
Branding		BigData, AI, VR among other technologies for export/import and international markets follow up.	Use of a mix of technologies: 3D AR, digitalization, social commerce, image scripting technology	not handmade, create customized products for an own brand	Common branding at TFC level	more efficient brand promotion in target countries
Branding						improvement of brand perception

6.2. Design

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
Ideas / early-design	Identify solutions with benefits in Life Cycle Analysis to provide product with a real benefit on the environment	3D printing, VR, AI, IoT, Robotics, image scripting tech for design and ideas creativity	Automatic design by AI	Use of 3D visualisation	Collaboration with universities, the minimalism trend in furniture products	introduction new technologies as BIM objects, WebAR
Ideas / early-design	Luminaire control from mobile phones	Connectivity IoT and cyber Security	3D visualization (preview)			
Ideas / early-design	Strategic design of off-grid luminaires (system optimization)		Social commerce for defining new products /trends			

Ideas / early-design	Facial recognition algorithms, to identify reponse of customers to new lighting solutions					
Validation Marketing / R&D			Submission of new design to potential customers by AI and/or social commerce	Digital tools, technical difficulties, Use of VR		
Prototype design	Optimization of solar solutions (source, battery, controller)	3D printing, VR, AR, AI, and image scripting tech for prototyping and innovation	Prototyping by VR	AI can find own solutions; very early stage brings advantage in time	Design, Prototyping and Development Laboratory of the Transylvanian Furniture Cluster	introduction of BIM technology
Prototype design	Improve making of digital twins of luminaires to reduce cost of prototypes and reinforce confidence in European luminaries.	Machine learning for new designs and materials	Prototyping by 3D visualization	digital prototype with 3D visualisation --> cost reduction, less waste, and materials		
Prototype design		Big Data for info collection of all the ideas generated	Prototyping by 3D CAD modeling	expenx		
Prototype design	Assistance for precise optical simulation of materials, reflectors, surfaces, etc. to develop more efficient products		Prototyping by 3D printing	Use of biobased and organic materials		
Prototype design	Investigate boxing and components in bio-source materials, and identify products with benefits in Life Cycle analysis			spare parts management, what can you do if something breaks down		
Prototype design	Facial recognition algorithms, to identify reponse of customers to new lighting solutions					
Prototype design						
Optical specifications	To develop new industrialization solutions such as new molds with digital simulations, to decrease energy and CO2		Integration of optical specifications in BIM objects			

Optical specifications			Optical specifications by 3D CAD modeling			
Electrical specifications			Electrical specifications by 3D CAD modeling			
Communication specifications	Control through 5G network	IoT and Connectivity				
Communication specifications	Control through Bluetooth Mesh					
Material specifications			3D printing	AI helps to find new material specifications		
Prototype validation	Acceleration of time from design to prototype to final product / Digital twin / early test and validation	BigData and Analytics for patents and trademarks monitoring	3D printing			
Industrialization	Need to integrate lighting solutions in other global solutions (communication, HVAC, acoustics, etc.)	VR, AR, IoT, Machine learning for production processes	3D visualization for industrialization			new technologies to improve and speed up industrialization
Industrialization						introduction of new manufacturing techniques
Manufacturing tools			3D visualization support for manufacturing tooling	use them for designing the products, to do early prototypes for further developments; limits in flexibility; expensive software solutions		
First serie		3D printing, VR and AR		3D Printing helps to create very fast and cheap first series, digital twin helps to create it even before; depend to technology		
Certification	Need clear validation process. Boosting activities in geographical zones.	VR and AR for checking and testing, sensors for inspection before				improvement of the company effort in certification field

		certification, BigData.				
Certification						introduction of new advanced materials in production processes to meet certification criteria
Certification						implementing tests processes to receive certifications

6.3. Purchasing

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
General		in all purchasing: BigData and AI (for similar products). AI and Machine learning for automatization of purchasing software				
Light engines		3D printing				
Optical components		3D printing				
Power supplies / drivers		IoT , Cyber Security				
Electrical connectors / wiring / junctions			Integration of major standards: zigbee, InOcean, Lora, Casambi			
Communication components	Need to be independent from Google and other major players when using web-based tools			digital twin helps in communication as you can send it around the world		
Casing		3D Printing and sensors				
Structural components			Warehouse digitalization and 3D visualization to manage purchasing process		Varied offer on the market, 3D Printing	introduction 3D printing
Structural components						introduction 3D scanner
Raw materials		3D printing		Circular economy and reuse of materials		new materials introduction

Finishing materials (paint)		Robotics and VR/AR for customization and previsualization of the final product		online configuration can be used to define the finish by customers		internal management of the process: introduction of the related technologies needed
Finishing materials (paint)						robotics
Finishing materials (upholstery, textile						internal management of the process: introduction of the related technologies needed (laser cutting)
packing components						introduction of new and more sustainable materials

6.4. Production

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
Organisation of assembly line		IoT, Machine learning, VR/AR for improvement assembly line, image scripting tech,	Warehouse digitalization and to improve assembly line	automated production data	Smart furniture, inter-sectional collaboration	technologies to optimize logistic processes
On-site manufacturing	Need improvement of data management	IoT, Machine learning, VR/AR, robotics, cybersecurity for improvement manufacturing process	Use of new technologies: 3D printing, 3D laser cutting, CNC	production of less waste through digitalization of production process, use of rest of wood material for heating, production of own energy supply; Well educated workforce is needed; Efficiency, more precise, broader product range	The whole market is well developed, we have access to new manufacturing technologies	

Assembly	Need to standardize connectors and protocols	IoT, Machine learning, VR/AR, robotics, cybersecurity for improving assembly processes		robots are precise and work 24/7 in same quality; Skilled workers and cost of further education; increased safety due to new technologies for the workers	Access to low-cost energy resources or stable prices in the future	
Quality testing		sensors, IoT and robotics	Iot for in-line testing	due to consistent quality easier checks are possible		implementing new tests to high quality of the products
Quality testing						more detailed study of the materials used
Packaging	Improve life cycle analysis	Tracking Sensors, BigData, IoT and cybersecurity for data management	Automation/Robotics for automatic packaging.			Robotic technologies for automatic packaging, to speed up the process
Packaging		Robotics for production packaging assembly step	3D laser cutting for customized packages			
Transport to storage		Tracking Sensors, BigData, IoT and cybersecurity for data management	Use of robotics for storage			
Duration of manufacturing process		Robotics and machine learning	Use of robotics to reduce manufacturing process	robots and machines can do dangerous and dirty jobs; increased productivity		new advanced technology implementation for speeding up production
Duration of manufacturing process						CNC machine's introduction (if not applied yet)
Storage of components		Tracking Sensors, BigData, IoT and cybersecurity for data management,	Automated Warehouse for storage	no storage needed as the products can be produced on demand		technologies for the optimization of the flows

		robotincs for in/out stocks AR/VR and image scripting tech for communication				
Storage of final product			Automated Warehouse for storage			technologies for the organization of the warehouse: asset tracking software

6.5. Distribution

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
Commercial activities / local agencies		AR/VR and image scripting tech for communication		Use of 3D visualization; Use of electrical vehicles	Strategic geographical position in relation with our connections with local agencies and direct consumers	
Communication			Use of chatbot for automatic communication	Use of VR and of digital twin		new and advanced communication strategies to implement
Management of orders		Machine learning for periodic orders	Automated warehouse and computer management system		Digital instruments	
Delay for delivery		machine learning for production priority modifications and adaptations	Use of cloud computing and automated warehouse for reduce of delivery delay	produce on demand, size		
Internet distribution	Investigate which products, which services can be sold on internet for which target of customers				Access to training courses and materials for personnel in marketing and sales	e-commerce improvement
Wholesalers						

6.6. Management

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
In house human resources	Wish to obtain assistance from temporary workers with specific training	VR/AR for better communication		one-man company --> low-tech	Access to training courses and materials for personnel provided by Transylvanian Furniture Cluster	technological software for the improvement of the internal office flows management
External human resources	Facilitate external human resources	VR/AR for better communication				internal management of the production processes outsourced at the moment
Purchase / rental of equipment		3D printing equipment, maintenance planning		low cost of several digital products (3D printing and visualisation)		
Subcontracting	Indity best skilled subcontractors					
Consumer Relationship Management		BigData and Analysis	Extensive use of CRM		Integration of innovative learning experiences, such as VR, Innovation management practices	CRM software implementation (if not applied yet)

6.7. Aftersales Management

Subphases/Cluster	LUMIERE	CICAT	LIV	BIC	TFC	ARREDO
Spare parts management	Preventive maintenance using Artificial Intelligence	AI for spare parts and maintenance. VR/AR for maintenance or preventive maintenance	Cloud computing for aftersales management			
Customer Feed Back Management	Improving monitoring of clients / possible failures	Monitoring platform (cybersecurity and IoT)	Customer self-service portal with intelligent chatbot for after-sales support			

Satisfaction Survey		BigData and Analytics	Customer self-service portal with intelligent chatbot for after-sales support		Digital instruments for feedback collection	web based survey implementation

7. Processing of results II - Identification of possible directions for going greener and more digital

The major finding of the work so far is that we need to approach the potential of innovation in manufacturing of furniture and lighting equipment in a rather *holistic* way.

This means that there are many niches where significant opportunities exist. Some of them are difficult to implement, others may be easier. There are some "the low hanging fruits" to identify.

Opportunities related to digitalization and to greener manufacturing are high. It appears they are considered as important for the development of the SMEs of our cluster.

More particularly, looking at the phases mentioned earlier, it appeared that there are recent progresses and opportunities to change processes before the production phase, during the production, and afterward.

7.1 Digitalization

Digitalization: underlined: possible « low hanging fruits "due to availability of solutions today.	
Before manufacturing	Digital marketing, Use of artificial intelligence to optimize designs. Building of digital twins for testing (high Quality 3D rendering) Testing and communicating with VR Quick prototyping (3D printing) Digital Co-design involving clients leading to customized solutions. Purchase of components through internet Integrate smart products allowing more efficient operation (commissioning, installation, management, servicing, etc.) Investigate alternative communication protocols. Improve user interfaces (UX) Provide efficient training through digital tools.
During manufacturing	Management of components and materials 3D printing, Digital machinery Improve interfaces. Training of staff with new tools
After manufacturing	Assist engineers and architects with digital catalogs.

(or in parallel)	Build compatibility with BIM files. Develop sales through the internet, Distribute products through shared or owned digital platforms. Organize (ad share delivery) from digital platforms. Build digital link with customers. Manage aftersales activities with digital tools. Develop remote commissioning / maintenance / predictive maintenance. Use tracking sensors.

7.2 Going Green

Going Green: underlined: possible « low hanging fruits "due to availability of solutions today	
Before manufacturing	Eco-design Adapt product to climatic zones. Anticipate consequences of climate changes Green design with minimum resources Use locally produced materials. Use of bio-sourced materials Use of recycled materials Use of highly efficient durable lighting sources
During manufacturing	Reduce waste. Recycle waste internally. Recycle waste externally. Use recycled products. Use bio-sourced material. Use more efficient machinery. Training staff Minimize packaging. Use packaging in recycled material.
After manufacturing (or in parallel)	Optimise storage (minimize storage capacity) Optimise delivery / transportation. Simplify distribution channels to reduce transportation costs. Recycle products at the end of life. Propose product upgrade on site.

Conclusion

It is profoundly evident that the furniture industry is undergoing a major transition due to the adaption of digitization and other technological advancements. In the race of digitization, the furniture and lighting industry has also been vigilant enough to integrate digital means and methods to sophisticate and improvise the customer experience. The companies strongly commit to embrace new technologies to keep up with the customer expectations and ever-changing trends and behaviours.

If one looks at the number of comments and suggestions by SMEs which were interviewed, it appears that the highest interest for innovative solutions concern the design phase: it is the phase where digitalization can improve the process: accelerate prototype developments, testing, validation with customers, etc.). It is also the phase where strategic decisions can be made to make greener products.

Then the manufacturing process needs to be able to transform the digital data to the manufacturing equipment (laser cutting, 3D printing, assembly, etc) and maintain the concern for reduction of waste.

The majority of targeted SMEs are aligned towards thinking that digital transformation will be the key to their survival and business growth in the next 3-5 years.

Apparently, going green is a key issue on marketing, design (selection of materials, efficiency, durability), production (reduction of waste, efficiency of process) and on-site activities (recycling, end of life management, maintenance, aftersales management, etc.).

The solutions identified above by our SMEs concerning possible opportunities related to both digitalization and “greenification” are a help for the various other tasks planned in the SILEO project. This should be useful when managing the SILEO vouchers schemes (consultancy, training, etc.).

SMEs, and in particular small companies which are dominant in the European furniture and lighting industry, have recognized that change is inevitable, and taken the necessary steps to adapt to those changes in order to stay relevant, competitive, and continue to drive revenue.