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DRWO4.0

Guidelines for application, modification and replication of the I4.0 transformation model (O3.2)

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Danube Region Wood Industry Transformation

Table of Contents

Table of Figures

Introduction

The objective of the DRWO4.0 project is to support the improvement of the forest-based industry through the adoption of Industry 4.0 principles, strengthening its competitiveness, resilience and sustainability. The forest-based sector plays a strategically important role in Europe, particularly for rural development, employment and the bioeconomy, yet it is increasingly exposed to pressures such as climate change, supply chain disruptions, regulatory requirements and shifting market demand. In this context, digitalisation and Industry 4.0 technologies are no longer viewed solely as efficiency-enhancing tools, but as essential enablers of resilience, traceability, circularity and value creation across forest-based value chains. Technologies such as IoT, data analytics, digital twins and interoperable digital platforms enable better resource utilisation, improved process control and enhanced transparency from forestry operations through to final products. The relevance of Industry 4.0 in the forest-based sector lies in its ability to improve yields, reduce waste and downtime, support predictive maintenance and enable new circular bioeconomy business models. At the same time, digital traceability and data-driven decision-making support compliance with sustainability policies and market expectations, while strengthening supply chain visibility in a fragmented and highly interconnected sector. However, successful transformation requires more than technology deployment alone. It demands a structured approach that connects analysis, implementation and organisational change in a coherent and scalable way. For this reason, DRWO4.0 Transformation Model is supported with this document in adopting a combined methodological approach based on Value Chain Analysis (VCA) and the CULIS methodology.

Target Group and Intended Users

The DRWO4.0 Guidelines for the application, modification and replication of the I4.0 transformation model are designed to support a broad range of stakeholders within the forest-based and wood industry ecosystem. The document addresses both operational actors directly involved in value creation and institutional stakeholders responsible for strategy, coordination and policy development.

Primary Target Group

The primary target group consists of:

- Small and medium-sized enterprises (SMEs) in the forest-based industries (e.g. sawmilling, furniture manufacturing, joinery, engineered wood products)
- Larger industrial companies seeking structured transformation towards Industry 4.0
- Cluster organisations and innovation networks supporting company-level development
- Pilot Environments (PEs) and competence centres facilitating testing and implementation of Lean, Digital and Green solutions

For these actors, the guidelines provide a practical framework for analysing current value chain performance, assessing transformation maturity, defining improvement priorities and implementing structured transformation measures.

Secondary Target Group

The secondary target group includes:

- Policy-makers and public authorities at regional, national and transnational level
- Development agencies and funding bodies
- Research institutions and higher education organisations
- Consultants and transformation facilitators supporting the forest-based sector

For these stakeholders, the guidelines offer a structured reference model that can inform strategy development, support programme design, enable benchmarking across regions and facilitate knowledge transfer.

Intended Use

The guidelines may be used for:

- Company-level transformation planning and implementation
- Structured maturity assessment and gap analysis
- Development of cluster-level or regional transformation roadmaps
- Preparation of funding applications and investment planning
- Policy alignment and evidence-based decision-making

By addressing both operational and strategic stakeholders, the DRWO4.0 transformation model ensures applicability across different organisational levels while maintaining methodological consistency and comparability.

Methodological Framework of the Document

This document outlines the necessary steps for implementing an integrated VCA–CULIS transformation model within the forest-based and wood industry context. The approach begins with a structured analysis phase, followed by targeted transformation actions aligned with identified needs and organisational context.

Value Chain Analysis (VCA)

Value Chain Analysis (VCA) serves as the analytical foundation of the transformation model, providing a systematic approach to understanding how value is created, where inefficiencies occur and which transformation opportunities exist within the forest-based value chain. VCA examines the complete sequence of activities through which materials, information and value flow, from raw material sourcing through processing, manufacturing, distribution and end-of-life management.

Within the DRWO4.0 project, furniture manufacturing (NACE C31) is used as a demonstration and reference case, due to its strong value-added character and relevance across the Danube Region. The VCA methodology itself is sector-neutral and is designed to be applicable to any wood-based subsector (e.g. sawmilling, wood-based panels, joinery, packaging). Sector-specific processes may differ; however, all analyses using the common DRWO4.0 value chain structure to ensure comparability across countries are available on project web site[1].

Within the forest-based sector, VCA enables organisations to map complex interdependencies across forestry operations, sawmilling, secondary processing, and product delivery. It systematically identifies value-adding activities (those that customers are willing to pay for) and non-value-adding activities (those that consume resources without contributing to customer value).

For the purposes of comparability and transnational aggregation within DRWO4.0, all VCA shall be structured and reported using a common reference framework. Regardless of the selected forest-based subsector, VCA results shall be organised according to the following six value chain stages: Inputs, Primary processing, Secondary processing, Distribution and sales, Use phase and End-of-life. This common structure ensures that sector-specific analyses can be consistently compared and synthesised at project and EU level.

This distinction is particularly important in wood processing, where material losses, quality variability and process complexity require careful analysis to optimise operations.

The VCA phase delivers three critical outputs that inform subsequent CULIS implementation:

1. Value chain maps that visualise material flows, information flows and decision points across the complete production system,
2. Flow analysis that identifies bottlenecks, delays and coordination gaps limiting overall performance,
3. Prioritised improvement areas ranked by their impact on throughput, quality, cost and sustainability.

VCA Implementation Approach

VCA implementation follows a structured sequence designed to progressively build understanding and establish transformation priorities. The approach is organised into distinct phases, each with defined objectives, activities and deliverables.

To ensure robust and representative results, VCA implementation should be based on a combination of desk research and structured engagement with relevant stakeholders or representative enterprises. This approach supports an evidence-based assessment of average value chain conditions, rather than isolated firm-level performance.

Phase 0: Preparation and Scope Definition (Duration: 2–4 weeks)

Objective: Establish clear boundaries for the VCA exercise, secure leadership commitment and prepare the analytical framework.

[1] https://interreg-danube.eu/projects/drwo40/library?page=4

Key activities:

- Define value chain scope (which segments, products, and processes will be analysed),
- Establish analytical boundaries (geographical scope, time horizon, organisational units),
- Secure management support and communicate VCA objectives to relevant stakeholders,
- Form cross-functional VCA team with representatives from operations, quality, logistics, IT, and finance,
- Prepare data collection tools and templates (process documentation forms, interview guides, measurement protocols).

Deliverables:

- Transformation scope and objectives document,
- VCA project charter with defined roles, responsibilities and timeline,
- Data collection plan and tools.

This phase ensures that the VCA effort is appropriately scoped and resourced, preventing analysis paralysis while maintaining sufficient depth to identify meaningful improvement opportunities.

Phase 1: Value Chain Mapping (Duration: 3–6 weeks)

Objective: Create comprehensive visual documentation of current state operations, including all processes, flows and decision points across the value chain.

Key activities:

- Document each major process stage (log reception, breakdown, drying, secondary processing, finishing, packaging) including inputs, outputs, cycle times and quality control points.
    - The listed process stages are illustrative examples. Partners are expected to define sector-specific process steps reflecting their selected wood-based subsector and national context.
    - These sector-specific processes shall be mapped and analysed, but must be logically nested under the common DRWO4.0 value chain stages (Inputs to End-of-life) to maintain methodological consistency and comparability across subsectors;
- Map material flows from raw material through all processing stages to finished products and by-product streams;
- Document information flows, identifying where data is generated, how it is transferred, and where it supports decision-making;
- Identify decision points, including who makes decisions and what information is available at each point;
- Record processing times, changeover times, planned maintenance schedules and capacity utilisation rates;
- Document interfaces and handoffs between departments, shifts, or external partners;
- Create visual representations using value stream mapping conventions adapted for wood industry complexity.

Deliverables:

- VCA map showing material and information flows,
- Flow analysis sheet documenting cycle times, waiting times and process dependencies,

- Prioritised improvement areas based on impact and feasibility assessment.

The value chain map provides a shared visual language that facilitates communication between operational staff, management and external transformation partners. It makes visible what is often implicit knowledge held by individual operators, creating a foundation for systematic improvement.

Phase 2: Maturity Assessment

Following the Value Chain Mapping phase, organizations conduct a structured maturity assessment to evaluate current digital and circular capabilities across the value chain. This self-assessment provides a baseline for identifying transformation priorities and measuring progress over time.

Maturity Scoring System (0–3 Scale)

The maturity assessment uses a standardized 0–3 scoring scale to evaluate capabilities at each value chain stage. This scoring approach converts qualitative observations into quantifiable metrics that can guide transformation planning.

Scoring Scale:

Score	Maturity Level	Typical Characteristics
0 – None	No evidence of capability	Manual processes only, no digital tools or automated systems in place
1 – Basic	Initial awareness or isolated adoption	Individual digital tools used (e.g., standalone CNC machine, basic digital files), but not integrated
2 – Developing	Partial implementation, not systematic	At least 50% of production processes digitally connected to ERP/MES system (e.g., ERP with partial CAD connection), selected automation, inconsistent application
3 – Advanced	Fully implemented and integrated	Smart manufacturing systems, digital twins, full traceability, systematic circular economy practices

Figure 1 Value chain stage evaluation scoring scale

How to Conduct Self-Assessment

Step 1: Assemble Assessment Team

Form a cross-functional team including representatives from:

- Production/operations

- Quality management
- Logistics/supply chain
- IT/digital systems
- Management

Step 2: Review Value Chain Stages

Using your value chain map from Phase 1, identify the relevant stages for your organization. The standard forest-based value chain stages are:

- Inputs (raw material sourcing and logistics)
- Primary Processing (sawmilling, breakdown operations)
- Secondary Processing (further processing, component manufacturing)
- Distribution & Sales
- Use Phase
- End of Life (recycling, reuse, disposal)

Step 3: Assess Each Value Driver

For each value chain stage, evaluate the following value drivers using the 0–3 scale:

1. Digital Automation – Integration of digital systems (ERP, CNC, CAD/CAM)
2. Quality Control & Traceability – Digital monitoring, tracking and quality management systems
3. Logistics & Distribution Digitalization – Digital planning, tracking and coordination of material flows
4. Sustainability & Circularity – Systems for material efficiency, waste reduction, circular economy practices
5. Data Analytics & Decision Support – Use of data for process optimization and decision-making

Step 4: Assess Current and Potential Maturity

For each value driver at each stage, assign two scores:

- Current score (0–3): Where you are today
- Potential score (0–3): Where you could realistically be within 3–5 years with focused investment

Step 5: Calculate Gap Analysis

The gap between current and potential scores indicates improvement priority:

- Large gap (1.5–3.0): High improvement potential, priority transformation area
- Medium gap (0.5–1.4): Incremental improvement opportunity
- Small gap (0–0.4): Maintain current level, low priority for investment

A detailed guide for the self-assessment can be found in Annex 1.

Phase 3: Flow Analysis and Bottleneck Identification (Duration: 2–3 weeks)

Objective: Analyse value chain maps to systematically identify constraints, inefficiencies, waste sources and improvement opportunities.

Key activities:

- Identify physical bottlenecks that constrain overall throughput (e.g., drying kiln capacity, planning line speed);
- Assess information delays where lack of data availability or delayed transfer impacts decision quality;
- Detect quality generation points (where defects originate) and quality detection points (where defects are discovered);
- Map waste sources by category: material waste (offcuts, reject products), time waste (waiting, motion), energy waste;
- Analyse batch sizes and inventory levels to determine whether batching strategies create unnecessary delays or quality risks;
- Evaluate coordination effectiveness between production stages, departments and shifts;
- Prioritise identified issues by impact on throughput, quality, cost, customer satisfaction and sustainability.

Deliverables:

- Bottleneck analysis report identifying primary system constraints,
- Waste quantification summary with estimates of material, time and energy losses,
- Flow analysis sheet with prioritised improvement areas ranked by impact and implementation feasibility,
- List distinguishing quick wins (immediate improvements requiring limited investment) from strategic improvements (longer-term initiatives requiring significant change).

This analytical phase translates visual maps into actionable insights. By systematically identifying where value is created and where it is lost, organisations can make evidence-based decisions about where to focus transformation efforts.

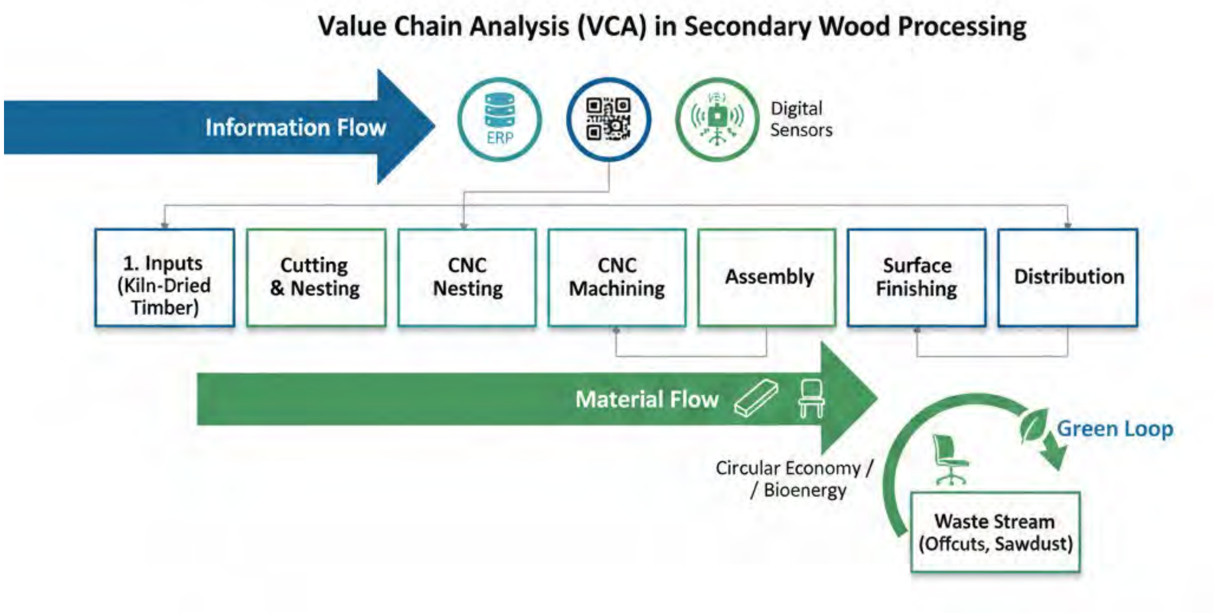


Figure 2 Value Chain Analysis in Secondary Wood Processing

VCA Outcomes and Linkage to CULIS

The VCA phase produces a clear picture of current state performance and a prioritised list of transformation opportunities. These findings directly inform the selection and design of CULIS pillar activities:

- Lean opportunities are identified where process stability, waste reduction, or flow optimisation would address bottlenecks and inefficiencies,
- Digital opportunities emerge were better data availability, system integration, or automation would improve decision-making or throughput,
- Green opportunities are highlighted were material efficiency, energy optimisation, or circular economy practices would reduce environmental impact while improving operational performance.

The transition from VCA to CULIS shifts from analytical understanding to transformation implementation. VCA answers the question "What should we improve?"; CULIS provides the framework for "How should we improve it?". Initially, the CULIS methodology was implemented for the DRWO4.0 Baseline Status Assessment Report[2] available on the project website.

Together, they form an integrated approach that connects diagnosis with intervention in a structured, evidence-based manner. Within the DRWO4.0 methodology, Value Chain Analysis and the CULIS pillar assessments serve complementary but distinct purposes.

VCA provides a value chain-level diagnosis by identifying where value is created, constrained, or lost across stages and activities. The following CULIS pillar assessments focus on organisational readiness and capability to implement targeted Lean, Digital, and Green transformation measures. These analytical layers should be interpreted sequentially and not merged into a single scoring system.

CULIS/VCA Transformation model Flowchart

The CULIS/VCA Transformation Model Flowchart illustrates the logical structure and phased progression of the transformation approach adopted within the DRWO4.0 framework. The flowchart provides an overview of how analytical assessment, structured transformation design, and implementation activities are systematically connected to support the Industry 4.0 transition in the forest-based industry.

The model begins with a preparation phase, which establishes the strategic context, scope and organisational alignment required for transformation. This is followed by analytical phases, including Value Chain Analysis and Maturity Assessment, which enable a structured evaluation of current performance, identification of development gaps, and assessment of transformation potential across the value chain.

Based on the results of these analyses, the transformation is translated into concrete improvement actions through the design of CULIS pillars. The CULIS framework serves as the central implementation

[2] https://interreg-danube.eu/projects/drwo40/library?page=1

mechanism, integrating Lean, Digital and Green transformation pillars in a coordinated manner. These pillars are applied selectively and may partially overlap, reflecting the specific characteristics and priorities of wood-processing activities. Lean transformation focuses on process stability and flow, Digital transformation enhances data availability and system integration, while Green transformation addresses resource efficiency, circularity and sustainability objectives.

The flowchart further illustrates that implementation is supported by continuous measurement, monitoring, and scaling activities. This ensures that transformation progress is systematically tracked, successful initiatives are expanded, and achieved improvements are sustained over time. The model concludes with structured reporting and consolidation of results, providing a foundation for informed decision-making, knowledge transfer and further development within the Industry 4.0 transformation journey.

Flowchart for the CULIS/VCA Transformation Model

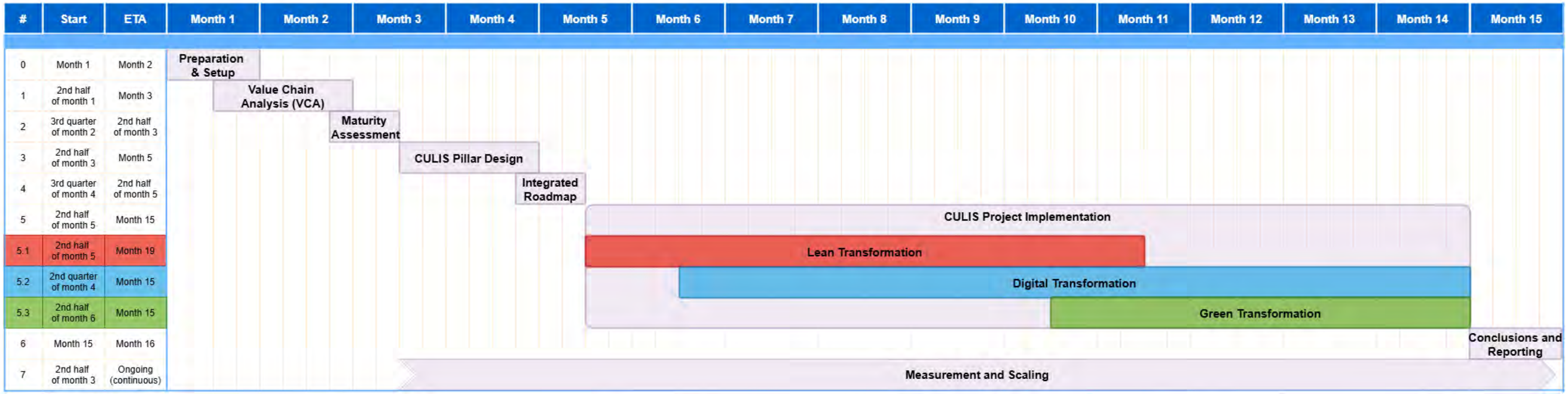


Figure 3 Flowchart for the CULIS/VCA Transformation Model

CULIS methodology

Building on the insights generated through Value Chain Analysis, the CULIS methodology is applied as a transformation framework that translates analytical findings into practical improvement measures. CULIS integrates three complementary pillars Lean, Digital and Green, allowing organisations to selectively apply those elements that directly address identified challenges. In this way, process optimisation, digital enablement and sustainable resource management are aligned within a single, coherent approach.

Through the sequential application of VCA and CULIS, this document provides a structured pathway from understanding value creation and system constraints to implementing focused, context-appropriate transformation measures across the wood and forest-based industry.

CULIS Pillar design and integrated Roadmap

Following the completion of the VCA, the identified improvement areas are translated into clearly defined transformation focus areas for the wood industry. Rather than applying all transformation concepts uniformly, the approach focuses on selecting and prioritising relevant Lean, Digital and Green elements based on the specific challenges and characteristics of wood-processing activities. Lean measures typically address process stability, material flow and standardisation, while Digital and Green elements focus on process visibility, data-driven coordination, resource efficiency and sustainable use of wood-based materials.

Based on these defined focus areas, an integrated transformation roadmap is developed to structure implementation in a coherent and feasible manner. The roadmap aligns Lean, Digital, and Green initiatives across production, logistics and supporting functions, considering interdependencies between processes and resource constraints typical of the wood industry. In this way, analytical insights are converted into a coordinated set of transformation actions that support consistent progress toward improved efficiency, resilience and long-term sustainability.

CULIS Pillar questionnaire

Annex 2 contains the questionnaires for the assessment of stakeholders' potential for transformation into Smart factories, based on key elements of Industry 4.0. The questionnaire should be answered by a team of company employees. The team should include those people who know the processes, goals, development direction and strategy of the company best, as well as people from the company's management.

Each question can be answered with a score of 1-5. For each question, descriptions of grades 1, 3 and 5 are given, to facilitate the evaluation of the grade of one's own company. If the estimated score is between the described scores 1 and 3 (or 3 and 5), it is possible to give a score of 2 (or 4) (it is not mandatory that all scores are 1, 3 or 5).

The company's readiness for transformation into a Smart factory is calculated as the average of readiness for three transformations according to the CULIS methodology: Lean, Digital and Green transformation.

The grade of readiness for each transformation is calculated as the average of the grades of all questions for that type of transformation, and the overall readiness as the average of the grades of three transformations.

A detailed questionnaires for the self-assessment can be found in Annex 2.

Pilot implementation: Lean pillar

Lean implementation pillar represents the initial phase of transformation in which processes are optimised, waste is eliminated and a stable foundation is established for the further development of the organisation. It is focused on people, value streams and continuous improvement, delivering fast and measurable results such as increased productivity, shorter process times and cost reduction. Since Lean can be applied in any environment that contains processes, its success depends on the size of the organisation, its culture, the level of waste and the objectives to be achieved:

Figure 4 Lean excerpt (CULIS methodology)

As illustrated by the CULIS methodology excerpt in *Figure 2*, the emphasis is placed on key Lean tools that form the basis of every successful transformation:

- Value Stream Mapping
- 5S systems and visual management
- Standardisation
- Quality management
- Kaizen approach (continuous improvement).

When applied together, Lean tools create an environment in which processes become clear, stable and predictable. The effects are reflected not only in waste reduction, but also in higher employee engagement, improved communication and faster problem-solving. Lean therefore operates not only at a technical level, but gradually transforms the organisational mindset, from a focus on individual tasks to an understanding of the entire value stream. This shift in perspective enables improvements to be viewed not as isolated activities, but as a continuous process that naturally leads the organisation toward greater efficiency and long-term sustainable growth.

Value Stream Mapping (VSM)

Value Stream Mapping is a core Lean tool used to analyse how value is created along a process, from the initial customer order to the final delivery of the product. It enables a comprehensive visualisation of material and information flows, including process times, waiting times, inventories and key decision points.

Within the Lean Transformation, VSM typically represents the starting point of pilot implementation, as it provides a fact-based overview of current operations and allows processes to be analysed as an integrated system rather than as isolated activities. This holistic perspective supports informed decision-making and the prioritisation of improvement actions.

The VSM methodology generally follows a structured sequence:

1) Selection of a representative product or product family
2) Development of a current-state map that describes existing process conditions
3) Analysis of the current state, including the identification of waste and inefficiencies ("Kaizen flashes")
4) Design of a future-state map that defines an improved process flow
5) Definition of Lean performance metrics and an implementation plan.

In the wood industry, VSM is particularly relevant due to the presence of complex material flows, batch-oriented production and frequent handovers between processing stages such as cutting, machining, assembly and finishing. Mapping the end-to-end process often reveals excessive work-in-progress, long waiting times and unclear information flows between production planning and shop-floor execution. The future-state VSM establishes a clear target condition, defining expected material flow, acceptable buffers and relevant performance indicators for pilot implementation.

Implementation: A representative product or product family is selected and a cross-functional team conducts Value Stream Mapping workshops to document the current-state process from customer order to delivery. Process steps, material and information flows, cycle times, inventories and waiting times are recorded directly on-site. Based on the analysis of identified inefficiencies ("Kaizen flashes"), a future-state VSM is developed, defining improved flow, target performance indicators and a structured implementation plan.

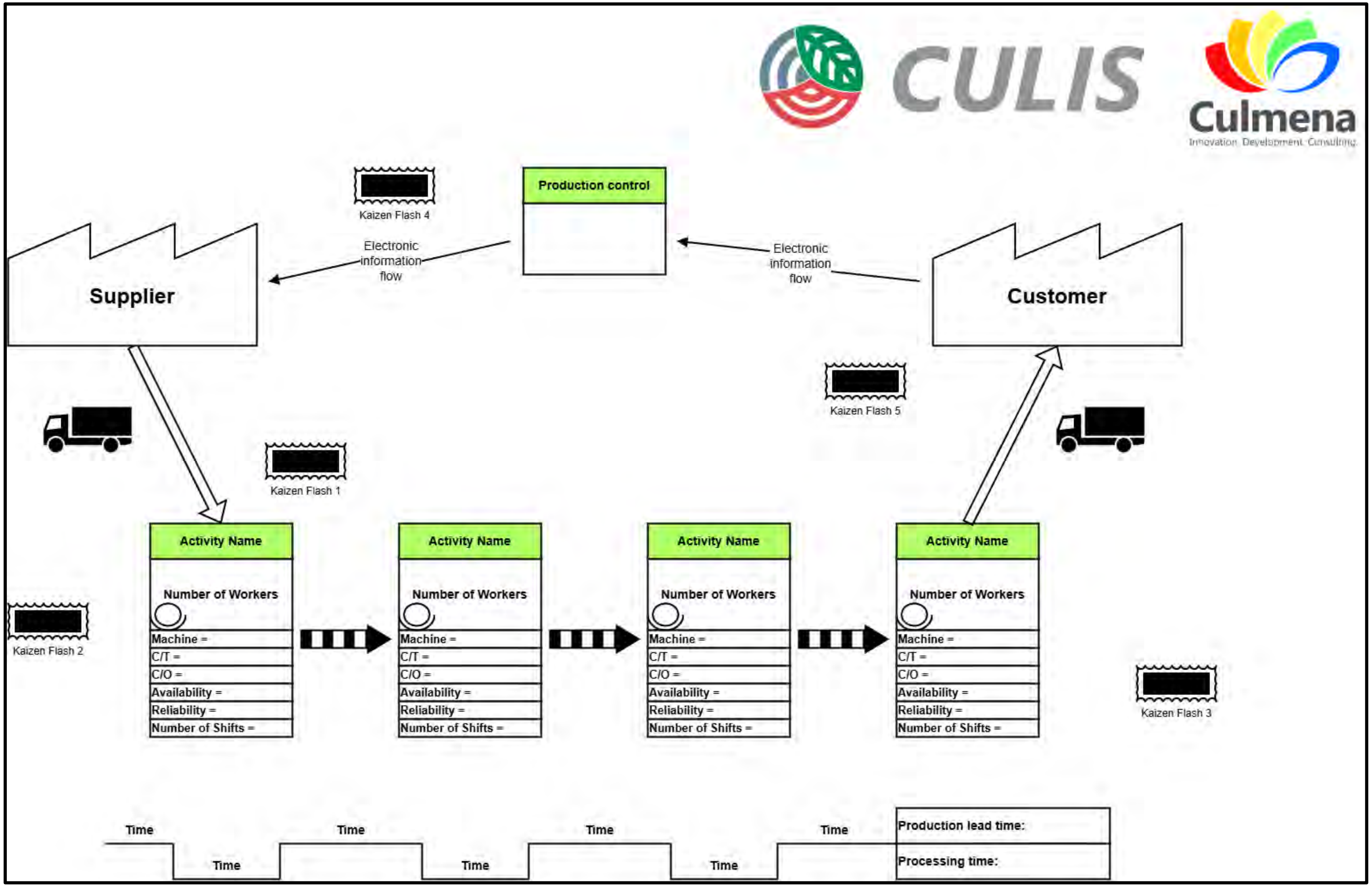


Figure 5 AS IS VSM chart exam

5S and Visual Management

5S and Visual Management are foundational Lean tools aimed at creating organised, transparent and disciplined workplaces. Their primary objective is to eliminate waste associated with searching, unnecessary motion, unclear standards and hidden process problems.

The 5S methodology establishes a structured approach to workplace organisation through the following steps:

1) Sort – removal of unnecessary items
2) Set in Order – organisation of necessary items for efficient access
3) Shine – cleaning and inspection of the workplace
4) Standardise – definition and documentation of workplace standards
5) Sustain – maintenance of discipline through routines and audits

Visual Management complements 5S by making standards, performance and deviations visible through visual cues such as labels, colour coding, boards and signals. Together, these tools enhance transparency, safety and process stability.

In woodworking environments, where tools, materials and dust are inherent to operations, 5S and Visual Management significantly improve working conditions and operational efficiency. Standardised tool locations and clearly marked material flow paths reduce confusion and prevent damage to semi-finished products. Visual boards displaying daily targets, quality alerts and improvement actions support structured communication and rapid response to deviations during pilot implementation.

Implementation: A company-wide 5S implementation plan is developed, including pilot areas, rollout phases and audit routines. 5S activities are executed at department level, supported by employee training and practical simulations. Visual Management elements such as 5S boards, visual standards, labels and colour-coded markings are introduced to make workplace organisation, performance and deviations clearly visible. Regular audits ensure the sustainability of the implemented standards.

5S Area:	Group 1

CATEGORY	CRITERIA	AUDIT PERIOD											
Sorting	**Difference between what is needed and what is not needed**	1	2	3	4	5	6	7	8	9	10	11	12
Sort and remove all unnecessary items.	Procedures are defined to identify unnecessary items.												
	There is unnecessary equipment (tools and accessories), mismatched items (storage space), containers, etc.												
	There are unnecessary items on walls / notice boards.												
	Hallways, stairways, boxes, equipment, etc. are free of additional items.												
	There is unnecessary inventory, spare parts, and materials (drawers / cabinets / work surfaces / storage areas).												
Setting in Order	**A place for everything and everything in its place**	1	2	3	4	5	6	7	8	9	10	11	12
Uses labels, lines, signs, and colours to clearly distinguish good from poor conditions.	All items have a clearly defined location.												
	Shared drawers, cabinets, work surfaces, and storage areas are clearly labelled and well organised.												
	Personal drawers, cabinets, work surfaces, and storage areas are clearly labelled and/or well organised.												
	All items are placed in their appropriate locations.												
	Aisles, workstations, and the locations of equipment and devices are identified.												
Shine (Cleaning)	**Routine discipline maintains a clean and organised workplace**		2	3	4	5	6	7	8	9	10	11	12
Cleaning is a method of inspection, look for hidden defects.	Equipment, computers, work surfaces, and storage areas are clean.												
	Waste and recyclable materials are collected and disposed of appropriately.												
	Emails and paper documents are archived on a daily basis.												
	Shared areas are cleaned and maintained regularly.												
	Are lines, labels, and signs clean and in good condition?												
Standardisation	**Prevents the occurrence of abnormal conditions in the workplace**	1	2	3	4	5	6	7	8	9	10	11	12
Standardise rules so that 5S becomes a habit.	Are notice boards used, and are they well organised, up to date, and clean?												
	Defined cleaning and organising tasks have been developed and assigned to work areas.												
	Employees are trained and understand 5S procedures.												
	5S standards are clearly displayed.												
	Visual management tools clearly identify completed work.												
Sustain	**Adhere to the rules (self-discipline)**	1	2	3	4	5	6	7	8	9	10	11	12
Sustainable plans are developed to ensure accountability.	Everyone is involved in improvement activities.												
	Are standardised cleaning and working procedures followed?												
	Do employees have access to tools that support the 5S programme?												
	5S documentation and instructions are up to date.												
	5S audits are carried out regularly.												

SCORING SYSTEM

Measure / # of Problems	Rating / Points
High – 5 or more	1
3-4	2
2	3
1	4
Low – None	5

DATA SUMMARY

Average score	Sorting	Setting in Order	Shine (Cleaning)	Standardisation	Sustain	Overall average score
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
Average	0	0	0	0	0	

Inspected area:

Date:

Auditor: Signature:

Comments

Figure 6 5S audit form

Standardisation

Standardisation refers to the definition and documentation of the best-known method for performing a task or process. It is a critical element of Lean Transformation, as sustainable improvement is only possible when processes are stable and repeatable.

Rather than limiting flexibility, standardisation provides a clear baseline from which improvements can be systematically developed and evaluated.

Standardisation activities typically include:

- Identification and analysis of process activities
- Definition of work sequences and responsibilities
- Establishment of performance and quality criteria
- Balancing of workloads at workstations
- Definition of Lean performance metrics and targets

Standards are regularly reviewed and updated as part of continuous improvement activities.

In wood manufacturing, process variability is often influenced by differences in operator practices, material characteristics and environmental conditions. By standardising activities such as machining setup, sanding procedures or assembly sequences, organisations can significantly reduce variation and defect rates. Standardisation also supports training, onboarding and cross-functional flexibility by providing clear and accessible process documentation.

Implementation: Key processes and activities are analysed and documented in collaboration with operators and supervisors. Standard Operating Procedures (SOPs) are developed, defining work sequences, responsibilities, quality criteria and performance targets. Workstations are balanced based on workload analysis, and Lean metrics are assigned to each standardised process. Standards are communicated through visual instructions and regularly reviewed as part of continuous improvement activities.

STANDARD OPERATING PROCEDURE (SOP) CULIS

SOP title:		Purpose - Describe the purpose of procedure:	
SOP number:			
Department:		Scope - Define where and when this SOP applies:	
Version:			
Effective date:		Responsibilities - Who is responsible for this procedure?	
Prepared by:			
Approved by:		Required Tools/Materials:	

Procedure steps:

Step	Description	Responsible
1		
2		
3		
4		

Procedure steps:

Procedure steps:

Procedure steps:

Version	Date	Description of change	Author

Figure 7 Standard operating procedure form

Quality

Within Lean Transformation, quality management focuses on preventing defects by embedding quality into processes rather than relying solely on end-of-line inspection. The objective is to achieve consistent quality performance in an efficient and sustainable manner.

Lean quality management integrates process-oriented thinking, statistical methods and continuous improvement principles. Key elements include:

- Process-oriented quality management systems
- Use of statistical tools to monitor and control variation
- Application of Total Quality Management (TQM) principles
- Process scoping and alignment using tools such as SIPOC
- Advanced approaches such as Lean Six Sigma for defect reduction.

Digital technologies increasingly support quality management through real-time monitoring, improved traceability and data-driven analysis.

In the wood industry, quality challenges are often linked to natural material variability, moisture content and surface characteristics. By applying process-based quality management, organisations can identify critical quality parameters and control them more effectively. For example, combining SIPOC analysis with basic statistical monitoring enables a clear linkage between input variables (e.g. material properties) and output quality. Over time, Lean Six Sigma methods and digital quality tools further enhance process stability, consistency and transparency.

Implementation: Selected products and processes are defined as quality focus areas. The existing quality management approach is documented and analysed using a process-oriented perspective. Key quality indicators are selected, and statistical monitoring methods are introduced to track process variation. Continuous improvement mechanisms are applied to address identified deviations. Where applicable, Lean Six Sigma methods and digital quality tools are implemented to improve traceability, manage non-conformities and support data-driven quality management.

Kaizen

Kaizen represents the principle of continuous improvement through structured, incremental changes involving employees at all organisational levels. Instead of relying exclusively on large-scale transformation projects, Kaizen embeds systematic problem-solving into daily operations.

Within the pilot Lean Transformation, Kaizen ensures that improvement activities continue beyond initial process redesign and are sustained over time. It provides a practical mechanism for translating identified gaps into concrete improvement actions.

A structured Kaizen system typically includes:

- Clearly defined roles and responsibilities (e.g. Kaizen manager, facilitators, team members)
- Systematic identification and prioritisation of problems
- Application of simple analytical tools such as the 5 Whys method and Ishikawa diagrams
- Execution of Kaizen workshops or improvement events
- Measurement, evaluation and follow-up of achieved results

In wood-processing environments, Kaizen is commonly applied to address recurring operational issues such as rework, material damage, quality deviations or inefficient changeovers. For example, a Kaizen workshop may focus on reducing rework in surface finishing by analysing root causes related to material preparation, environmental conditions or operator methods. Over time, Kaizen supports the development of a continuous improvement culture, in which employees actively contribute improvement ideas and management provides the structure required for their implementation.

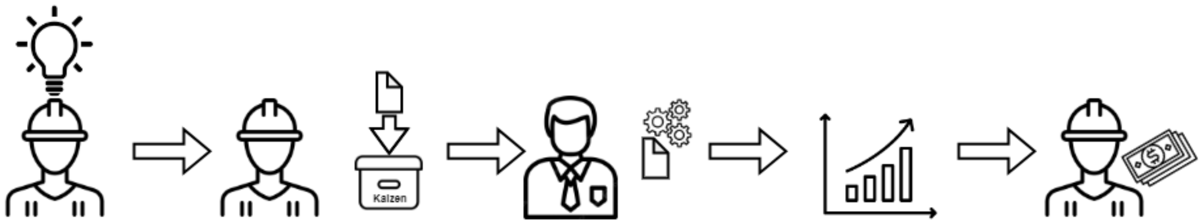
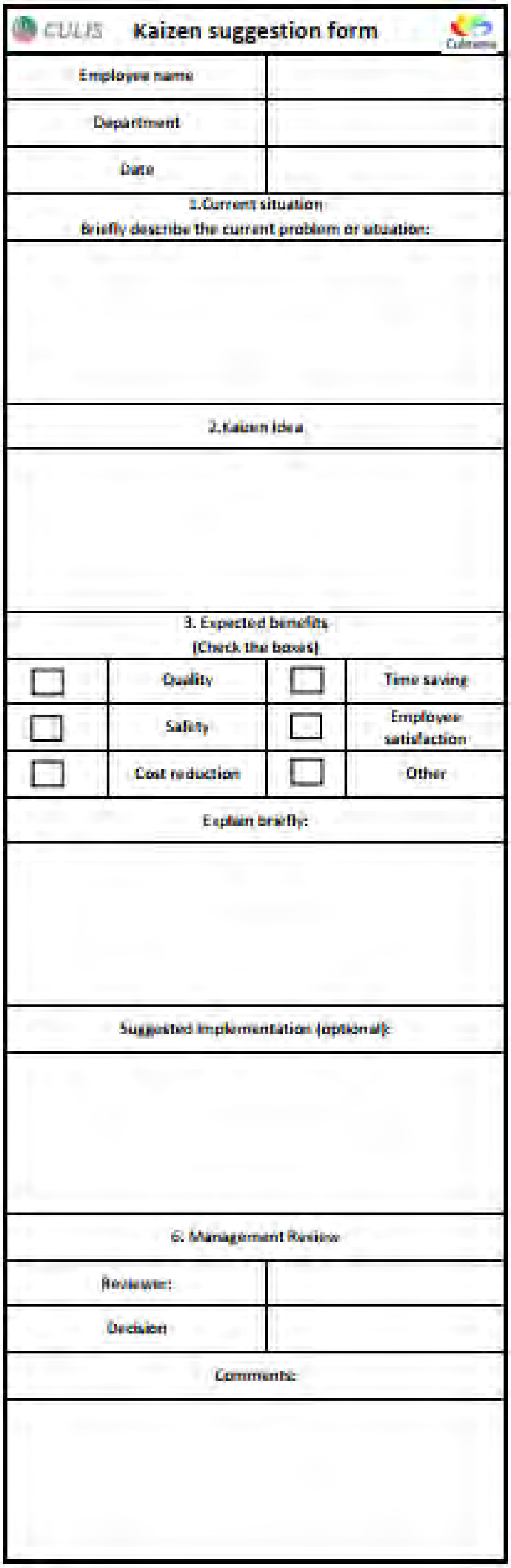


Figure 8 Kaizen suggestion box infographic

Implementation: A structured Kaizen system is established by appointing a Kaizen manager and defining clear roles and responsibilities. Operational problems are systematically collected, prioritised and analysed using standard Lean problem-solving tools. Kaizen workshops are conducted to address selected issues, with defined actions, responsibilities and deadlines. Achieved improvements are measured using predefined indicators and integrated into regular operational routines.


Kaizen suggestion form

Employee name	
Department	
Date	

1.Current situation
Briefly describe the current problem or situation:

2.Kaizen idea

3. Expected benefits
(Check the boxes)

☐	Quality	☐	Time saving
☐	Safety	☐	Employee satisfaction
☐	Cost reduction	☐	Other

Explain briefly:

Suggested implementation (optional):

6. Management Review

Reviewer:	
Decision	

Comments:

Figure 9 Kaizen form suggestion

Pilot implementation: Digitalization pillar

The Digital pillar supports the gradual expansion of digitalisation across organisational processes as they become clearer and more stable through ongoing improvement efforts. Rather than introducing digital tools as isolated solutions, digital capabilities are progressively embedded into everyday operations in line with process maturity and organisational readiness. This approach enables increasing levels of process visibility, data consistency, and system connectivity across the value chain, allowing the extent of digital support within core processes to be meaningfully observed and assessed over time:

Figure 10 Digitalisation excerpt (CULIS methodology)

Smart and Connected products

QR / RFID product identification

Implementation: Each wood element (boards, beams, CLT panels) is assigned a QR or RFID tag linked to a central database containing dimensions, moisture content, batch number, certifications, and production status.

Digital product passport

Implementation: A digital product data sheet is generated from ERP or BIM systems and made available to customers or construction sites, particularly for prefabricated and engineered wood products.

Digitization of Manufacturing, Services and public administration

Digital work orders (paperless production)

Implementation: Work orders are provided to operators via tablets or terminals at machines, including operations, tolerances, and drawings, with real-time status feedback to the ERP system.

ERP-supported documentation workflows

Implementation: CE documentation, delivery notes, and certificates are automatically generated based on production and order data.

Optimal use of resources

Cutting and nesting optimisation software

Implementation: Software tools optimise cutting patterns for boards and logs to minimise waste and improve material yield.

Energy and material monitoring systems

Implementation: Energy consumption of machines and drying kilns is measured and linked to production output for performance and efficiency analysis.

Digital knowledge and skills

Digital SOPs and work instructions

Implementation: Visual and multimedia work instructions are made available at workstations to support machine setup and operational tasks.

Internal production and maintenance knowledge base

Implementation: A shared digital platform stores common issues, solutions, and machine settings, accessible to operators and maintenance staff.

Robotization and automatization

CNC machining centres

Implementation: Automated cutting, drilling, and milling operations are performed using CAD/CAM data directly transferred to CNC machines.

Automated material handling systems

Implementation: Conveyors, manipulators, or robotic systems are used to transport and stack wood elements between production stages.

Digital standardisation and legal regulation

Digital traceability systems

Implementation: Materials are tracked from incoming raw wood to finished products, ensuring traceability and certification compliance.

Digital compliance management tools

Implementation: Standards, audits, and certifications (EN, ISO, FSC) are managed digitally, with automated reporting and reminders.

Cyber security

Industrial network segmentation

Implementation: CNC, PLC, and industrial networks are separated from office IT systems to reduce cybersecurity risks.

Secure data backup and access control

Implementation: Production programs and machine configurations are regularly backed up, with controlled access to critical systems.

Pilot implementation: Green pillar

The Green Transformation pillar is implemented alongside Lean and Digital initiatives, ensuring that operational improvements and digital capabilities support sustainability objectives in the wood industry. Lean reduces waste and stabilises processes, while digital tools enable measurement and optimisation of energy and resource use. Within this framework, the Green pillar addresses the following key sustainability focus areas aligned with the EU regulation (EU Taxonomy Regulation, CSRD regulation, etc):

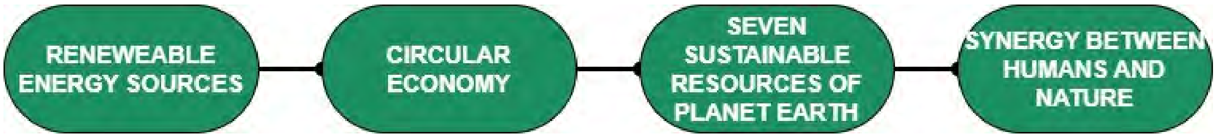


Figure 11 Green excerpt (CULIS methodology)

Renewable Energy Sources

Biomass energy systems (wood waste utilisation)

Implementation: Wood residues (chips, sawdust, bark) are used as fuel for biomass boilers to supply heat for drying kilns and production facilities.

Solar PV systems for auxiliary energy demand

Implementation: Solar panels are installed on factory roofs to cover part of electricity demand for lighting, offices, and auxiliary equipment.

Circular Economy

By-product reuse and material cascading systems

Implementation: Production waste streams are classified and reused internally (e.g. offcuts for secondary products) or externally (pellets, panels, bioenergy).

Closed-loop material tracking

Implementation: Digital tracking links material input, waste generation, and reuse options to support circular material flows across production stages.

Seven Sustainable Resources of Planet Earth (water, soil, biomass, air, solar, wind, geothermal)

Water and air management systems

Implementation: Closed-loop water systems and air filtration units reduce freshwater use and airborne emissions in sanding and cutting operations.

Biomass and energy flow monitoring

Implementation: Biomass input and energy conversion efficiency are monitored to optimise the use of renewable natural resources.

Synergy Between Humans and Nature

Environmental impact monitoring and reporting tools

Implementation: Emissions, energy use, and material efficiency indicators are monitored and reported to support transparent environmental management.

Eco-design and sustainable product development tools

Implementation: Product design integrates material efficiency, durability, and recyclability criteria to reduce environmental impact over the product lifecycle.

SMART KPI

Successful transformation requires systematic monitoring of progress and results. Without clearly, and Time-bound, enabling clear performance tracking and informed defined performance indicators, it is not possible to objectively evaluate the effectiveness of implemented measures. SMART KPIs provide a structured approach to defining indicators that are:

$$[\boldsymbol{S}pecific] + [\boldsymbol{M}esurable] + [\boldsymbol{A}chieveable] + [\boldsymbol{R}elevant] + [\boldsymbol{T}ime - bound] = \boldsymbol{SMART}\ KPI$$

Each transformation phase includes development KPIs to track progress and implementation, as well as maintenance KPIs to sustain achieved improvements. Dedicated KPIs are defined for each phase to ensure continuous progress and long-term stability.

Lean Pillar KPI

KPIs focused on process stability, efficiency improvements, waste reduction and the achievement and sustainability of operational performance targets:

	KPI	Specific	Measurable	Achievable [1-5]	Relevant	Time-bound
Development KPI	Process Lead Time Reduction	Reduction of total lead time for a defined production process	[%] change compared to baseline	5/5	Directly impacts productivity and delivery performance	Measured monthly or quarterly
	Waste reduction rate	Reduction of identified Lean waste (scrap, waiting, motion)	[%] reduction per waste category	5/5	Reduces operational cost and inefficiencies	Tracked per implementation phase
	Standardised Process Coverage	Share of processes with defined work standards	[%] of standardised processes	4/5	Gradually implemented across operations	Targeted per transformation phase

Maintenance KPI	Process Stability index	Variability of cycle time versus defined standard	Deviation from standard cycle time	4/5	Ensures repeatability and reliability	Continuously monitored
	5S Audit Compliance	Compliance with defined 5S criteria	[%] Audit score	4/5	Supports safety, efficiency, and discipline	Audited monthly
	Recurring Issue Rate	Number of repeated problems within a process	Count per defined time period	4/5	Indicates effectiveness of corrective actions	Reviewed quarterly

Figure 12 LEAN Pillar KPIs

Digital Pillar KPI

KPIs measuring the development and sustained use of digital capabilities, process visibility, data availability, and system integration across the organisation:

	KPI	Specific	Measurable	Achievable [1-5]	Relevant	Time-bound
Development KPI	Digital Process Coverage	Processes monitored or supported by digital systems	[%] of total processes	3/5	Increases transparency and control	Annual improvement targets
	Real-Time Data Availability	Availability of key operational data in real time	[%] of real-time accessible data	4/5	Supports faster and better decisions	Defined per system rollout phase
	System Integration Level	Number of integrated digital systems	Count of system-to-system connections	3/5	Reduces data silos and manual work	Milestone-based
Maintenance KPI	Data Accuracy Rate	Accuracy of digitally collected data	[%] of validated data entries	4/5	Critical for reliable decision-making	Continuously monitored
	Digital Tool Usage Rate	Actual use of implemented digital tools	[%] of active users	3/5	Indicates digital adoption and maturity	Monitored monthly
	System Downtime	Time digital systems are unavailable	Total downtime hours per month	5/5	Directly impacts operational continuity	Measured monthly

Figure 13 Digital Pillar KPIs

Green Pillar KPI

KPIs tracking the achievement and long-term maintenance of sustainability objectives related to resource efficiency, energy use, emissions reduction and circular practice:

	KPI	Specific	Measurable	Achievable [1-5]	Relevant	Time-bound
Development KPI	Energy Consumption per Unit of Output	Energy used per produced unit	kWh per m^3 / unit	4/5	Direct cost and sustainability impact	Measured monthly and annually
	Material Utilisation Rate	Share of usable output from input material	[%] of material utilisation	3/5	Reduces waste and raw material demand	Tracked per batch or quarter
	Share of Renewable Energy	Portion of energy from renewable sources	[%] of total energy consumption	3/5	Reduces emissions and dependency	Annual targets
Maintenance KPI	CO_2 Emissions per Unit of Output	Emissions generated per produced unit	kg CO_2 per unit	3/5	Regulatory and market relevance	Reported annually
	Waste Recycling / Reuse Rate	Share of waste recycled or reused	[%] of total waste	3/5	Core circular economy indicator	Reviewed quarterly
	Environmental Compliance Rate	Compliance with environmental requirements	[%] of fulfilled obligations	4/5	Reduces legal and reputational risk	Verified through annual audits

Figure 14 Green Pillar KPIs

Conclusion

This document outlines the necessary steps for implementing an integrated Value Chain Analysis–CULIS methodology-based transformation model within the forest-based and wood industry context. The approach begins with a structured analysis phase, followed by targeted transformation actions aligned with identified needs and the specific organisational, technological and market conditions of companies operating along forest-based value chains. By combining value chain thinking with a systemic, maturity-oriented transformation methodology, the Model and the Guidelines support companies in translating strategic objectives into concrete, actionable Industry 4.0 initiatives. It establishes a coherent pathway that connects analytical diagnosis with practical implementation across Lean, Digital and Green transformation dimensions.

The proposed methodology provides a coherent and replicable framework that enables organisations to prioritise investments, manage complexity and reduce risks associated with digital transformation. It supports the alignment of technological solutions with business processes, sustainability goals and workforce capabilities, while fostering transparency, traceability and resilience across interconnected value chains. Importantly, the model is scalable and adaptable, making it suitable for enterprises of different sizes and levels of digital maturity, as well as for diverse regional and value chain contexts within the forest-based sector.

The strength of the presented approach lies in its systemic perspective. Rather than promoting isolated technological solutions, the guidelines emphasise the interdependence between process stability, digital enablement and sustainable resource management. This integrated logic ensures that digitalisation efforts are grounded in stable and transparent processes, while sustainability objectives are supported by measurable data and continuous improvement mechanisms.

Further, the guidelines are designed to be applicable across diverse organisational contexts and wood-based subsectors. While furniture manufacturing serves as a reference case, the methodological structure is sector-neutral and can be adapted to sawmilling, secondary processing, engineered wood products and other forest-based value chains. At the same time, the use of common value chain stages, maturity assessment criteria and KPI structures ensures comparability of results across regions and supports aggregation at transnational and policy levels.

The Guidelines are designed to be usable by organisations with limited prior experience in structured transformation methodologies. The analysis and self-assessment phases do not require highly specialised internal expertise and should not be postponed due to capacity constraints or concerns about complexity. These tools enable non-expert users to structure inputs, identify patterns and generate evidence-based insights, either independently or with complementary support from external experts, consultants or innovation intermediaries. If needed, a wide range of digital and AI-based tools available today can support personnel in conducting value chain mapping, data analysis and maturity assessments in an efficient and user-friendly manner.

By explicitly addressing application, modification and replication, the guidelines support both company-level implementation and broader uptake by clusters, innovation networks and public authorities. They enable organisations to assess their current maturity, identify priority transformation areas and implement targeted improvement measures in a structured and evidence-based manner. At a strategic level, the results generated through this model provide a robust foundation for policy development, programme design and the alignment of regional and national support instruments.

In conclusion, the DRWO4.0 transformation model and its accompanying guidelines offer a practical, scalable and future-oriented approach to strengthening the competitiveness, resilience and sustainability of the forest-based and wood industry in the Danube Region and beyond. By fostering continuous improvement, digital integration and responsible resource use, the model contributes to the long-term transition of the sector towards smart, circular and climate-resilient industrial systems.

Annex 1

Self-Assessment Template

Use the following template to document your maturity assessment results.

Value Chain Stage:

Value Driver	Current Score (0-3)	Potential Score (0-3)	Gap (Δ)	Evidence / Notes
Digital Automation				

Quality Control & Traceability				
Logistics & Distribution Digitalization				
Sustainability & Circularity				
Data Analytics & Decision Support				

Stage Average Current Score: ____ (sum of current scores ÷ number of drivers assessed)

Stage Average Potential Score: ____ (sum of potential scores ÷ number of drivers assessed)

Overall Stage Gap: ____ (potential - current)

Example: Maturity Assessment for Secondary Processing

This example illustrates how a furniture manufacturer might assess their secondary processing stage:

Value Driver	Current Score (0-3)	Potential Score (0-3)	Gap (Δ)	Evidence / Notes
Digital Automation	1.5	3	+1.5	CNC machines used but not integrated with ERP; CAD files transferred manually
Quality Control & Traceability	1	2.5	+1.5	Visual inspection only; no digital quality records or batch tracking
Logistics & Distribution Digitalization	2	2.5	+0.5	Basic warehouse management system; room for optimization
Sustainability & Circularity	1	3	+2	Offcuts not systematically tracked or reused; no material efficiency monitoring
Data Analytics & Decision Support	0.5	2.5	+2	Production data collected but not analysed; no dashboards or KPIs

Stage Average Current: 1.2
Stage Average Potential: 2.7
Overall Stage Gap: +1.5 (High priority for transformation)

Interpretation: This stage shows significant improvement potential, particularly in sustainability /circularity and data analytics. The organization should prioritise:

1. Integrating CNC machines with ERP systems
2. Implementing digital quality tracking and traceability
3. Establishing material efficiency monitoring and offcut reuse systems
4. Developing production dashboards and KPIs.

Guiding Questions for Self-Assessment

Use these questions to support scoring decisions:

Digital Automation

- Do you use CAD/CAM software? Is it integrated with production machines?
- Do you have an ERP system? What processes does it cover?
- Are production orders transferred digitally to machines, or manually?
- Do you use automated material handling or robotics?

Quality Control & Traceability

- How do you measure and record product quality (manual inspection vs. digital sensors)?
- Can you trace a finished product back to its raw material batch?
- Do you use statistical process control or quality management systems?
- Are quality data available in real-time for decision-making?

Logistics & Distribution Digitalization

- Do you use digital tools to plan material purchasing and inventory?
- Can you track material location and status throughout production?
- Do you use digital systems for delivery planning and customer communication?
- Are logistics processes integrated between suppliers, production, and customers?

Sustainability & Circularity

- Do you measure material efficiency and waste generation systematically?
- Are by-products and waste streams tracked and reused or sold?
- Do you monitor energy consumption at process level?
- Do you have systems to support product reuse, refurbishment, or recycling?

Data Analytics & Decision Support

- What production data do you collect (machine utilization, cycle times, yields)?
- Do you analyse data to identify improvement opportunities?
- Do you use dashboards or KPIs for operational decisions?
- Do you apply predictive analytics or simulation tools?

Interpreting Assessment Results

After completing the self-assessment for all relevant value chain stages, synthesize findings:

1. Identify Priority Transformation Areas

Stages with the largest gaps (1.5 or higher) represent the highest potential for improvement and should be prioritized in transformation planning.

2. Recognize Quick Wins

Value drivers with moderate gaps (0.5–1.4) may offer opportunities for rapid improvement with limited investment.

3. Acknowledge Strengths

Areas with small gaps (below 0.5) indicate strong current performance that should be maintained and potentially expanded to other stages.

4. Link to CULIS Pillars

Map identified gaps to appropriate CULIS transformation pillars:

- Large gaps in automation and integration → Digital Pillar actions
- Large gaps in waste and material efficiency → Lean and Green Pillar actions
- Large gaps in process stability → Lean Pillar actions
- Large gaps in circularity and resource use → Green Pillar actions

5. Validate with Stakeholders

Share assessment results with:

- Operational staff to confirm accuracy of current state
- Management to align on transformation priorities and resource allocation
- Technology providers to explore solution options
- Peer companies or industry associations to benchmark results

Self-Assessment Documentation Template

Use this structure to document your complete maturity assessment:

Company Information

- Organization name: _______________
- Subsector: _______________ (e.g., furniture, sawmilling, panels, joinery)
- Number of employees: _______________
- Assessment date: _______________
- Assessment team members: _______________

Summary of Assessment Results

Value Chain Stage	Current Average	Potential Average	Gap	Priority Level
Inputs				
Primary Processing				
Secondary Processing				
Distribution & Sales				
Use Phase				
End of Life				

Overall Current Maturity: _____ (average across all stages)
Overall Potential Maturity: _____ (average across all stages)
Overall Transformation Potential: _____ (potential - current)

Top 3 Transformation Priorities

Based on gap analysis, list the three highest-priority improvement areas:

1. Priority Area: ________________
   Current Gap: _____
   Rationale: ________________
   Recommended CULIS Pillar(s): ________________
2. Priority Area: ________________
   Current Gap: _____
   Rationale: ________________
   Recommended CULIS Pillar(s): ________________
3. Priority Area: ________________
   Current Gap: _____
   Rationale: ________________
   Recommended CULIS Pillar(s): ________________

Key Opportunities

List 3 significant opportunities for digital and circular transformation:

1. ____
2. ____
3. ____

Key Challenges

List 3 main barriers to transformation (e.g., investment capacity, skills, standards):

1. ____
2. ____
3. ____

Next Steps

Based on this assessment:

- Which CULIS pillar(s) will you focus on first?
- What resources (funding, training, expertise) are needed?
- What is your realistic timeline for initial implementation?
- Who will lead the transformation initiative?

Annex 2

Lean Pillar questionnaire

QUESTION			
Has the company ever held a Lean workshop, implementation of Lean or any Lean tool?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No Lean implementation has been done	Partial Lean implementation has been done (or some Lean tools)	Lean implementation was carried out
Rating of the company for the given question			

QUESTION			
How familiar is the company's management and the company in general with the Lean methodology?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Company management is not familiar with the concept of Lean management	Company management is familiar with the concept of Lean management	The management of the company is familiar with the concept of Lean management and implements it in the company
Rating of the company for the given question			

QUESTION			
Did the employees undergo training where they were introduced to the Lean methodology and its tools?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Employees did not undergo Lean training	Employees have not undergone Lean training, but it is planned	Employees have undergone Lean training
Rating of the company for the given question			

QUESTION			
Do and to what extent do employees have the skills necessary to implement Lean methodology in their daily work?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Employees do not have the skills necessary to implement Lean tools in business	Employees have some skills needed to implement Lean tools in business	Employees have the skills necessary to implement Lean tools in business
Rating of the company for the given question			

QUESTION			
Does the company have a process optimization department or, if not, at least certain practices?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	There is no business process optimization department in the company	There is no business process optimization department, but there are certain practices	There is a department for optimizing business processes in the company
Rating of the company for the given question			

QUESTION

Which Lean tools do the management and workers of the company know? Which of them do they use in their daily work?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Employees and management do not know Lean tools	Employees and management know at least 3 Lean tools	Employees and management know at least 5 Lean tools
Rating of the company for the given question			

QUESTION			
Are certain Lean tools applied in the company's daily work?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Lean tools are not applied in the company	At least 3 lean tools are used in the company	At least 5 lean tools are applied in the company
Rating of the company for the given question			

QUESTION			
Does management encourage employees to solve problems in the workplace? In what way is it done, how actively?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Management does not encourage solving problems at work	Management encourages individuals to solve their own problems	Management encourages employees to solve problems in groups
Rating of the company for the given question			

QUESTION			
Is there a culture of continuous improvement in the company? Is the continuous improvement strategy clearly communicated to employees?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	A culture of continuous improvement does not exist	A culture of continuous improvement exists, but employees are not involved in it	Employees are part of a culture of continuous improvement and actively participate in it by making suggestions for improvement
Rating of the company for the given question			

QUESTION
Are Key Performance Indicators defined in the company and to what extent? In which departments and in which not? What are the KPIs?

ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No KPIs have been defined in the company	Certain KPIs are defined	All KPIs are clearly defined
Rating of the company for the given question			

QUESTION			
How does the company carry out planning?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Planning is done manually and reactively	Planning is carried out in Excel, and the processes are not ready for the introduction of planning tools	Planning is carried out using planning tools
Rating of the company for the given question			

QUESTION			
What is the quality of the supplier's goods (%)? In what percentage of cases do suppliers deliver goods on time?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Quality and on-time delivery > 50%	Quality and on-time delivery > 75%	Quality and on-time delivery > 95%
Rating of the company for the given question			

QUESTION			
Is the operation of the production facility monitored and in what way?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Production data is not tracked	Production data is tracked via standard forms, but this data is not analyzed	Production data is monitored through standard forms and regularly analyzed
Rating of the company for the given question			

QUESTION			
In your opinion, is there a problem in the exchange of information and information flows?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	In the processes, there are many errors in	Good communication and availability of information	There are no problems in the exchange of

	communication and information exchange, information is not available on time	has been established in the processes, but errors still occur that affect the quality of the process	information, all information is always available on time
Rating of the company for the given question			

QUESTION			
Are there KPIs for monitoring information flows?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No KPIs have been defined in the company	Certain KPIs are defined	All KPIs are clearly defined
Rating of the company for the given question			

QUESTION			
Are company leaders actively involved in company processes and change processes?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Company leaders do not spend time in the company and are not involved in day-to-day activities	Company leaders are involved in the work of the company, but do not encourage change and keep their distance	Company leaders are actively involved in the work and show by example why change is important
Rating of the company for the given question			

QUESTION			
Are the responsibilities of employees in the change process defined?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Responsibilities of employees in the change process are not defined	Responsibilities are defined but not assigned or adhered to	Responsibilities are clearly defined and distributed
Rating of the company for the given question			

QUESTION			
Do employees understand the company's goals and how their work contributes to those goals?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The goals set for employees are not precisely defined and clear, employees do not	The goals set for employees are precisely determined, but they are	The goals set for employees are precisely defined and clear,

	understand their importance	not clear, nor is their importance	employees understand their importance
Rating of the company for the given question			

QUESTION			
Are there KPIs for monitoring the realization of goals?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No KPIs have been defined in the company	Certain KPIs are defined	All KPIs are clearly defined
Rating of the company for the given question			

Sum of grades of all questions	
Number of questions answered	
AVERAGE GRADE OF LEAN TRANSFORMATION READINESS	

Digital Pillar questionnaire

QUESTION			
Is the company oriented towards the introduction of new technologies?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company is not oriented towards the implementation of new technologies	The company wants to implement new technologies, but does not know how and where	The company is oriented towards the introduction of new technologies and has defined the places of application and the type of technology
Rating of the company for the given question			

QUESTION			
What is the company's goal in the next few years regarding Industry 4.0?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5

Description	There are no goals for the application of Industry 4.0 technologies	The goal is to apply some practices, if there is a need for them	The goal is to fully utilize the benefits of digital transformation and Industry 4.0
Rating of the company for the given question			

QUESTION			
Why did the company decide to transform into a Smart Factory?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company did not decide to transform itself into a Smart Factory	The decision was imposed by the market	The decision is a consequence of the pursuit of process and product excellence and market growth
Rating of the company for the given question			

QUESTION			
Have certain projects already been launched as part of the digital transformation?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No transformation projects have been launched so far	Certain transformation projects are planned	Transformation projects are regularly implemented
Rating of the company for the given question			

QUESTION			
Are there limiting factors in the implementation of digital transformation?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	There are many limiting factors	There are limiting factors, but they can be overcome	The company has no limiting factors in implementing the transformation
Rating of the company for the given question			

QUESTION			
What is the financing plan for projects related to the transformation into a Smart Factory?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	There is no financial plan	The financial plan is based on own funds	The financial plan is based on own funds, incentives and grants
Rating of the company for the given question			

QUESTION			
Is there a clearly defined and announced digital strategy of the company?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	There is no digital strategy	A digital strategy has been created, but employees are not familiar with it and it is not implemented	A digital strategy has been created, employees are familiar with it and it is being implemented
Rating of the company for the given question			

QUESTION			
Is the collected data necessary for the development of a digital strategy?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No data is collected	The data is partially collected	Data has been collected
Rating of the company for the given question			

QUESTION			
How much has been invested in Industry 4.0, i.e. in its tools and methods, in the last 5 years?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	0 – 50 000 EUR	50 000 – 150 000 EUR	> 150 000 EUR
Rating of the company for the given question			

QUESTION			
What is the employee's attitude towards digital transformation?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Employees have an aversion to digital transformation	Employees want digital transformation, but fear its consequences	Employees accept and want digital transformation
Rating of the company for the given question			

QUESTION			
Do employees have the necessary skills for digital transformation? What proportion of employees have these skills?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Employees do not have the necessary skills	Some of the employees have the necessary skills	Employees have the necessary skills

Rating of the company for the given question	

QUESTION			
Is data collected from machines? How are they collected? What data is collected? How is the collected data entered into the system? Has it been defined what data is to be collected from the machines?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Data is collected manually	Data is collected from sensors and manually analysed	Data is collected from sensors in real time and analysed in software
Rating of the company for the given question			

QUESTION			
Is an ERP system used?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The ERP system is not used	The ERP system is used, but not fully exploited	The ERP system is used and fully exploited
Rating of the company for the given question			

QUESTION			
Has the MES system been implemented?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The MES system has not been implemented	The MES system is in the process of implementation	MES system has been implemented
Rating of the company for the given question			

QUESTION			
How many Industry 4.0 technologies have been implemented in company?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	1-3	4-6	>7
Rating of the company for the given question			

Sum of grades of all questions	
Number of questions answered	
AVERAGE GRADE OF DIGITAL TRANSFORMATION READINESS	

Green Pillar questionnaire

QUESTION			
Is information on waste management provided to customers? Is it done efficiently and transparently?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No information is provided to customers	Information is provided, but not transparently	Information is provided transparently
Rating of the company for the given question			

QUESTION			
Has the company researched related companies and their waste management practices?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	No related companies were investigated	Research has started but not completed	Related companies were investigated
Rating of the company for the given question			

QUESTION

Is the company familiar with the concept of circular economy? Does the company apply the circular economy in its work? To what extent is it applied?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company is not familiar with the concept of circular economy	The company is familiar with the term, but does not apply the circular economy in its work	The company applies circular economy in its work
Rating of the company for the given question			

QUESTION			
Does the company use recycled materials in its products or as energy sources? To what extent?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company does not use recycled materials in its products or as energy sources	The company uses recycled materials in products or as energy sources	The company uses recycled materials in products and as energy sources
Rating of the company for the given question			

QUESTION			
To what extent is paper used to transfer information?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	Paper is used to transfer information	he transmission of information is partially digital	Data transfer is a digital, paper free enterprise
Rating of the company for the given question			

QUESTION			
Regarding the use of resources, is it being reviewed? Does the company consider and explore new possibilities and new ways of using resources, which would reduce their consumption?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company does not consider new ways to reduce the use of resources	The company plans to reduce the use of resources	The company continuously looks for new ways to reduce the use of resources
Rating of the company for the given question			

QUESTION			
How easy is it to recycle the products that the company produces?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5

Description	The products are not suitable for recycling	The products can be recycled, but they are difficult to disassemble	The products are easily disassembled and recyclable
Rating of the company for the given question			

QUESTION			
Does the company monitor its water footprint? Is the company trying to reduce that footprint? Have ways been explored to reduce the water footprint? What actions were taken?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company does not monitor its water footprint	The company monitors its water footprint, but makes no effort to reduce it	The company monitors its water footprint and tries to reduce it
Rating of the company for the given question			

QUESTION			
Does the company monitor its greenhouse gas emissions? Is the company trying to reduce this emission? Have ways been explored to reduce this emission? What actions were taken?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company does not monitor its greenhouse gas emissions	The company monitors its greenhouse gas emissions, but does not try to reduce them	The company monitors its greenhouse gas emissions and tries to reduce them
Rating of the company for the given question			

QUESTION			
Does the company use renewable energy sources? What percentage of energy does the company get from renewable energy sources?			
ASSESSMENT INSTRUCTIONS			
Grade	1	3	5
Description	The company does not use renewable energy sources	The company partly uses renewable energy sources	The company gets most of its energy from renewable energy sources
Rating of the company for the given question			

Sum of grades of all questions	
Number of questions answered	
AVERAGE GRADE OF GREEN TRANSFORMATION READINESS	

Glossary

Automation – Use of machines and control systems to perform production tasks with minimal human intervention.

Big Data Analytics – Analysis of large datasets to identify patterns, optimise processes, and support data-driven decision-making.

Biomass – Wood-based by-products and residues used as renewable energy or secondary raw materials.

Bottleneck - A process stage, resource, or organisational constraint that limits overall value chain throughput, capacity, or performance. Bottlenecks may be physical (equipment capacity), informational (data availability), organisational (approval processes), or skills-related (competency gaps).

CAD/CAM – Digital tools for product design and preparation of manufacturing data for CNC machines.

Capacity Utilisation - The ratio of actual output to maximum possible output within a defined time period, typically expressed as a percentage. Low-capacity utilisation may indicate bottlenecks, quality issues, demand variability, or inefficient scheduling.

Circular Economy – Economic model based on reuse, recycling, and extended use of materials to minimise waste.

CNC (Computer Numerical Control) – Automated machining technology used for cutting, drilling, and shaping wood elements.

CO_2 Emissions – Greenhouse gas emissions generated during production, measured per unit of output.

CULIS Methodology – Integrated transformation framework combining Lean, Digital, and Green pillars.

Cybersecurity – Protection of digital and industrial systems from unauthorised access, disruption, or data loss.

Cycle Time - The time required to complete one unit of production from start to finish within a defined process or operation. Cycle time measurement enables identification of process variability and capacity constraints.

Digital Maturity - The level of integration, automation and data-driven decision-making within organisational processes.

Digital Product Passport – Digital record containing technical, sustainability, and traceability data of a product.

Digital Twin – Virtual representation of a physical process or system used for simulation and optimisation.

Digitalisation – Use of digital technologies to improve process visibility, coordination, and decision-making.

ERP (Enterprise Resource Planning) – Integrated system for managing orders, production, resources, and documentation.

Flow Analysis - Systematic examination of how materials, information, and value move through the value chain. Flow analysis identifies delays, interruptions, non-value-adding activities, and coordination gaps that impact overall performance.

Green Transformation – Integration of sustainability principles into processes, energy use, and resource management.

Industry 4.0 – Transformation of industrial systems through connectivity, automation, data analytics, and smart technologies.

Information Flow - The movement of data and information between value chain stages, including quality measurements, production reports, inventory levels, maintenance records, and customer requirements. Effective information flow enables timely and accurate decision-making.

IoT (Internet of Things) – Network of connected sensors and devices enabling real-time data collection.

Kaizen – Continuous improvement approach based on small, incremental changes.

KPI (Key Performance Indicator) – Metric used to measure progress, performance, and sustainability of improvements.

Lead Time - The total time from order receipt to product delivery, including processing time, waiting time, and transportation time. Lead time reduction is often a primary transformation objective.

Lean – Management philosophy focused on waste reduction, process stability, and value creation.

Material Flow - The physical movement of raw materials, work-in-progress, and finished products through the value chain. Material flow mapping visualises processing stages, storage points, transportation routes, and inventory accumulation points.

Material Utilisation Rate – Share of usable output obtained from input raw material.

MES (Manufacturing Execution System) – System supporting monitoring and control of production operations.

Maturity Model – Framework for assessing current and potential development levels of processes or systems.

Non-Value-Adding Activity - Any activity that consumes resources (time, materials, energy, labour) but does not directly contribute to creating customer value. Examples include unnecessary transportation, waiting time, overprocessing, rework, and excess inventory holding.

Predictive Maintenance – Maintenance approach based on condition monitoring to prevent unplanned downtime.

Process Mapping - Visual documentation of process steps, decision points, inputs, outputs, cycle times, and flow logic. Process maps provide a foundation for identifying improvement opportunities and communicating current state operations to stakeholders.

Process Stability – Ability of a process to operate consistently within defined parameters.

QR / RFID Identification – Technologies used for product and material tracking across production stages.

Renewable Energy – Energy generated from sustainable sources such as biomass or solar power.

Smart Factory - A manufacturing environment where physical processes are digitally interconnected, monitored in real time and optimised through automation, data analytics and integrated IT systems.

SMART KPI – KPI defined as Specific, Measurable, Achievable, Relevant and Time-bound.

Stakeholder Mapping - Identification and documentation of all parties involved in or affected by value chain activities, including raw material suppliers, logistics providers, customers, regulators, certification bodies, and internal departments. Stakeholder mapping clarifies dependencies, information exchanges and communication requirements.

Standardisation – Definition and application of uniform procedures to ensure repeatable process performance.

Sustainability – Balanced management of economic, environmental and social impacts.

Takt Time - The available production time divided by customer demand rate, representing the pace at which products must be completed to meet demand. Takt time provides a reference rhythm for balancing production rates across value chain stages.

Throughput - The rate at which products or materials flow through a process or system, typically measured in units per time period. Throughput is determined by the system bottleneck and reflects actual productive capacity under real operating conditions.

Traceability – Ability to track material and product history from input to final output.

Value-Adding Activity -- Any activity that directly transforms materials or information in a way that customers are willing to pay for. In wood processing, value-adding activities include cutting, drying, planning, surface treatment and assembly operations that change product form, function, or quality.

Value Chain – Sequence of activities through which value is created, from raw materials to end of life.

Value Chain Analysis (VCA) – Method for analysing value creation, flows and improvement opportunities across the value chain.

Value Flow - The progression of value creation through sequential process stages, from raw material with inherent value through transformation activities that add value, to finished products with full customer value. Value flow analysis identifies where value is created, preserved, or destroyed within the system.

Value Stream Mapping (VSM) - A Lean management tool for visualising the material and information flows required to deliver a product or service to a customer. VSM identifies waste, delays, and opportunities for improvement within current state operations, and provides a framework for designing future state improvements.

Waste Reduction – Systematic elimination of non-value-adding activities and material losses.