

# EMBEDDING ECO-INNOVATIONS IN WOOD-PROCESSING COMPANIES

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What makes companies able — and willing — to embed eco-innovation?

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# WOOD IS RENEWABLE.

*But is a wood product automatically sustainable?*

## CLIMATE

Can we rely on the same raw material?

heat · drought · disturbance · supply uncertainty

## REGULATION

Can we prove where it came from?

origin · legality · traceability · product data

## MARKET

Will customers actually choose sustainability?

price · quality · design · convenience · trust

**Three pressures. One challenge: how can firms respond?**

Estimated disturbance-related timber volume in 34 European countries averaged  $\approx 16\%$  of mean annual harvest, 2001–2019.

Sources: Patacca et al. (2023); Hoeben et al. (2023).

# WE WANT SUSTAINABLE FURNITURE...

But what shapes purchase intentions — and product replacement?

## FAST FURNITURE?

Low cost

Trend-driven

Short use cycles

Replacement-oriented

VS.

## CIRCULAR FURNITURE

Durable

Repairable

Reusable

Designed for longer life

Positive sustainability attitudes ≠ proven sustainable purchasing behaviour

Affordability · perceived quality/design · behavioural control · credible product information

# WHAT DOES ECO-INNOVATION LOOK LIKE IN PRACTICE?

*Concrete examples from wood and furniture applications*

## PRODUCT

Modelled LCA case:  
Eco-designed wooden  
bunk bed

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15.1% below selected  
traditional-furniture  
benchmark

## PROCESS

Measured single-factory  
case:  
Resource-efficient  
cleaner production

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lower material intensity  
and emissions

## CIRCULAR

Technical feasibility:  
Recovered timber →  
secondary lumber /  
experimental CLT

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not yet evidence of  
routine industrial use

## DIGITAL

Short-term proof of  
concept:  
Sensor- and AI-assisted  
energy management

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short-duration workshop  
trial

These examples illustrate different levels of evidence — not equivalent sector-wide effects.

# THE PRESSURES ARE SIMILAR.

*Why do firms respond differently?*

Previous Research



Determinants of eco-innovation

## INTERNAL

Can we change?  
capabilities · resources · routines

## EXTERNAL

Why should / must we change?  
pressure · opportunity · context

Literature-derived determinants informed the questionnaire.  
Questionnaire pretested with 10 wood-processing companies.

*Main empirical data collection follows in the next research stage.*

# CAN THE COMPANY ACTUALLY CHANGE?

Literature-derived internal capability domains

## LEADERSHIP

commitment · environmental culture

## PEOPLE

skills · knowledge

## INNOVATION

R&D · technology · digital capability

## OPERATIONS

environmental management · resource efficiency

## RESOURCES

finance · investment capacity

Technology must be integrated with organisational capability.

# WHY SHOULD — OR MUST — THE COMPANY CHANGE?

Literature-derived external conditions

## REGULATION

requirements · incentives

## MARKET

customers · sustainable  
demand

## COMPETITION

differentiation · new  
markets

## COLLABORATION

suppliers · universities ·  
research

## TECHNOLOGY & SOCIETY

new opportunities ·  
stakeholder expectations

An external condition may enable or constrain eco-innovation depending on firm capabilities and context.

# TRACEABILITY IS BECOMING A BUSINESS CAPABILITY

*Regulation: driver or burden?*

## EUDR

**Where does the wood come from?**

origin · legality · due diligence · traceability

## ESPR

**How sustainable is the product?**

durability · repairability · resource efficiency

## DPP

**(under ESPR)**

**Can product information travel with the product?**

data · transparency · traceability

**External requirement → data + skills + technology + supplier coordination → internal capability**

Legal qualifiers: EUDR 30 Dec 2026 (large/medium + EUTR-covered micro/small); 30 Jun 2027 (other micro/small). ESPR furniture priority = future rule development. DPP only via product-specific delegated acts.

**ESPR** — *Ecodesign for Sustainable Products Regulation*

**DPP** — *Digital Product Passport*

**EUTR** — *EU Timber Regulation*

Sources: European Commission EUDR page; ESPR Working Plan 2025–2030; Regulation (EU) 2024/1781.

# AI: ECO-INNOVATION ENABLER — OR JUST MORE TECHNOLOGY?

## REPORTED / POTENTIAL APPLICATIONS

- Energy monitoring
- Material optimisation
- Quality control
- Predictive maintenance
- Traceability
- Decision support

## BUT REQUIRES

- Skills
- Reliable data
- Investment
- Integration
- Management commitment

Technology can enable eco-innovation. It does not guarantee environmental benefit.

# WHEN PRESSURE MEETS CAPABILITY

A literature-derived framework to be tested

EXTERNAL PRESSURES &  
OPPORTUNITIES

Climate · Regulation · Market · Competition · Technology

INTERACTION / ALIGNMENT

INTERNAL CAPABILITY

Leadership · People · R&D · Finance · Technology · Management

EMBEDDED ECO-INNOVATION

Product · Process · Circular · Digital · Organisational

Potential benefits: resource efficiency · adaptation · circularity · sustainability · competitiveness

Sources: Authors' synthesis based on reviewed literature; Mammadov (2026).

*Borrowing a famous line: “Winter is coming.”*

## THREE WAYS COMPANIES MAY RESPOND TO CHANGE

### COMPANIES THAT ANTICIPATE CHANGE

*Winter is coming.*

**Are we prepared? — Yes.**

### COMPANIES THAT REACT TO CHANGE

*Winter is here.*

**We are not prepared — but we will act.**

### COMPANIES THAT ARE STILL WONDERING WHAT’S GOING ON

*Is it cold outside?*

**Maybe winter is already here...**

**Pressure creates the reason to act. Capability shapes the response.**

**Acknowledgements:** This work was supported by the Slovak Research and Development Agency under the Contract no. APVV-23-0022.



Thank You for your attention !!!!!



# KEY REFERENCES — SCIENTIFIC SOURCES

*Clickable links for manual verification*

[Patacca et al. \(2023\) — European forest disturbances](#)

[Hoeben et al. \(2023\) — resilience in wood-based value chains](#)

[Furmston & Braithwaite \(2025\) — fast furniture as emerging concept](#)

[Xu et al. \(2020\) — authentic green furniture purchase intention](#)

[Cai et al. \(2017\) — eco-label credibility and green furniture](#)

[Harju & Lahtinen \(2021\) — quality perceptions of wooden interiors](#)

[Coloma-Jimenez et al. \(2022\) — eco-designed bunk bed LCA](#)

[Jawjit et al. \(2024\) — cleaner production in rubberwood](#)

[Bohm et al. \(2025\) — salvaged rafters / secondary lumber](#)

[Llana et al. \(2022\) — CLT from recovered European oak](#)

[Molinaro & Orzes \(2022\) — Industry 4.0 in wood sector](#)

[Sahoo et al. \(2024\) — Industry 4.0, integration, eco-product innovation](#)

[Haddouche et al. \(2026; online 2025\) — short-term AI-assisted energy-management proof of concept](#)

[Harsanto et al. \(2026\) — institutional environment and SOI](#)

[Mammadov \(2026\) — contingent EI–firm performance link](#)

Blue items are clickable in PowerPoint. Source list is limited to references used directly in the deck.

# KEY REFERENCES— EU SOURCES & SUPPORTING LITERATURE

*Use official sources for legal claims*

## Official EU sources

[European Commission — EUDR current implementation page](#)

[ESPR Working Plan 2025–2030 — EUR-Lex](#)

[Regulation \(EU\) 2024/1781 — EUR-Lex](#)

## Additional sectoral sources available for backup

[Wulf et al. \(2024\) — circular economy and digitalisation in furniture](#)

[Shahsavari et al. \(2020\) — WTP for eco-friendly furniture](#)

[Sellitto et al. \(2020\) — green innovation in furniture cluster](#)

### Evidence and citation rules for the revised deck

- empirical numbers only from original/publisher sources
- legal dates only from official EU sources
- fast furniture treated as an emerging concept
- performance outcomes labelled as potential / contingent
- case, model, laboratory, survey and conceptual evidence labelled separately

Official legal claims should be rechecked immediately before the conference.



# BACKUP — INTERNAL DETERMINANTS (1/2)

Literature-derived determinants operationalised in the questionnaire; questionnaire pretested with 10 firms

| Determinant                                      | Potential enabling role reported in the literature        | Potential limitation                 |
|--------------------------------------------------|-----------------------------------------------------------|--------------------------------------|
| Environmental leadership & management commitment | Strategic orientation; organisational support             | Weak commitment slows implementation |
| Environmental culture                            | Awareness; employee involvement; long-term sustainability | Time-consuming to build              |
| Human resources & employee skills                | Ideas; implementation; knowledge transfer                 | Skills shortages; training costs     |
| R&D                                              | New products, technologies and processes                  | Requires long-term investment        |

Conceptual synthesis; not results from the ten-company pretest or main survey.

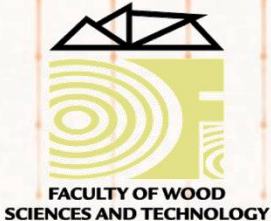


# BACKUP—INTERNAL DETERMINANTS (2/2)

Literature-derived determinants operationalised in the questionnaire; questionnaire pretested with 10 firms

| Determinant                      | Potential enabling role reported in the literature | Potential limitation                       |
|----------------------------------|----------------------------------------------------|--------------------------------------------|
| Technological capabilities       | Cleaner technologies; resource-efficient processes | Modernisation cost; obsolescence           |
| Environmental management systems | Structured improvement; credibility                | Administrative burden; certification costs |
| Resource & energy efficiency     | Lower operating cost and environmental impact      | Delayed payback                            |
| Financial capacity               | Investment and risk management                     | Financial constraints limit action         |

Conceptual synthesis; not results from the ten-company pretest or main survey.

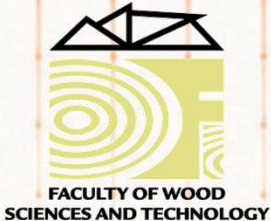


# BACKUP — EXTERNAL DETERMINANTS (1/2)

Literature-derived external determinants operationalised in the questionnaire; questionnaire pretested with 10 firms

| Determinant                            | Potential enabling role reported in the literature                  | Potential limitation                      |
|----------------------------------------|---------------------------------------------------------------------|-------------------------------------------|
| Environmental regulation & legislation | May create compliance pressure, standards and innovation incentives | Uncertainty and compliance costs          |
| Market demand for sustainable products | New opportunities; differentiation                                  | Demand varies across segments             |
| Customer environmental awareness       | May increase demand for environmentally preferable products         | Limited willingness to pay premium        |
| Government incentives & subsidies      | Lower investment risk; technology adoption                          | Dependence on public funding              |
| Supplier collaboration                 | Access to materials and knowledge                                   | Coordination problems; partner dependence |

Conceptual synthesis; not results from the ten-company pretest or main survey.



# BACKUP—EXTERNAL DETERMINANTS (2/2)

Literature-derived external determinants operationalised in the questionnaire; questionnaire pretested with 10 firms

| Determinant                          | Potential enabling role reported in the literature | Potential limitation                       |
|--------------------------------------|----------------------------------------------------|--------------------------------------------|
| Universities and research institutes | Knowledge transfer; technology development         | Different academic/business priorities     |
| Industry competition                 | May encourage innovation and differentiation       | Pressure can reduce available resources    |
| Technological opportunities          | New environmental technologies                     | Performance uncertainty                    |
| New market expansion                 | Profit and diversification potential               | Requires adaptation and investment         |
| Stakeholder / societal pressure      | Reputation and environmental responsibility        | Rising expectations and compliance demands |

Conceptual synthesis; not results from the ten-company pretest or main survey.