

Measuring circularity, sustainability and resilience: new tools and perspectives

Alessandro Creazza & Andrea Urbinati
LIUC – Università Cattaneo

Castellanza, 22 September 2023 «LRN Italy Forum 2023»

Measuring resilience and sustainability

- “Measuring” is becoming a buzzword today - but why is measurement so important?
→ *because it can help to better understand our world and what we do.*
- Supply Chain resilience and sustainability are current topics that have gained the interest of academic and industrial discussions
- However, **mixed interpretations exist** on resilience and sustainability and on the interrelationships between them
- These mixed messages derive from a **lack of clarity**:
 - Some authors regard sustainability as a driver of resilience
 - others instead state that resilience is an antecedent of sustainability
- Is there a way to make some clarity?
- One possible way can be to try and be as specific as possible: by **jointly measuring sustainability and resilience in an integrative framework**
 - assessing the weight of these concepts and their dimensions
 - evaluating the interrelationships between them



Research framework

- We decided to tackle the measurement problem by **developing a composite indicator** that we named “RESIST-I” (“Resilience and Sustainability - Index”)
- We took the guidelines for Constructing Composite Indicators of the OECD and the Joint Research Centre of the EU Commission, JRC-EU (OECD/JRC, 2008).

Research phases	Composite indicators building	Advisory board contributions
1.Scoping and framing	1. Conceptual framework	-Framework, indicators, and survey questionnaire validation
	2. Selection of indicators	
2.Survey and data treatment	3. Data treatment	-Validation of the survey sampling and data treatment
	4. Normalisation	
	5. Weighting	
3.Composite building	6. Aggregation	-Validation of indicators grouping, sub-pillars, pillars, and sub-indices
	7. Statistical coherence	
	8. Robustness and sensitivity	
4.Results: Analysis and benchmarking	9. Data sensemaking	-Results validation and insights for future research

Scoping and framing: resilience

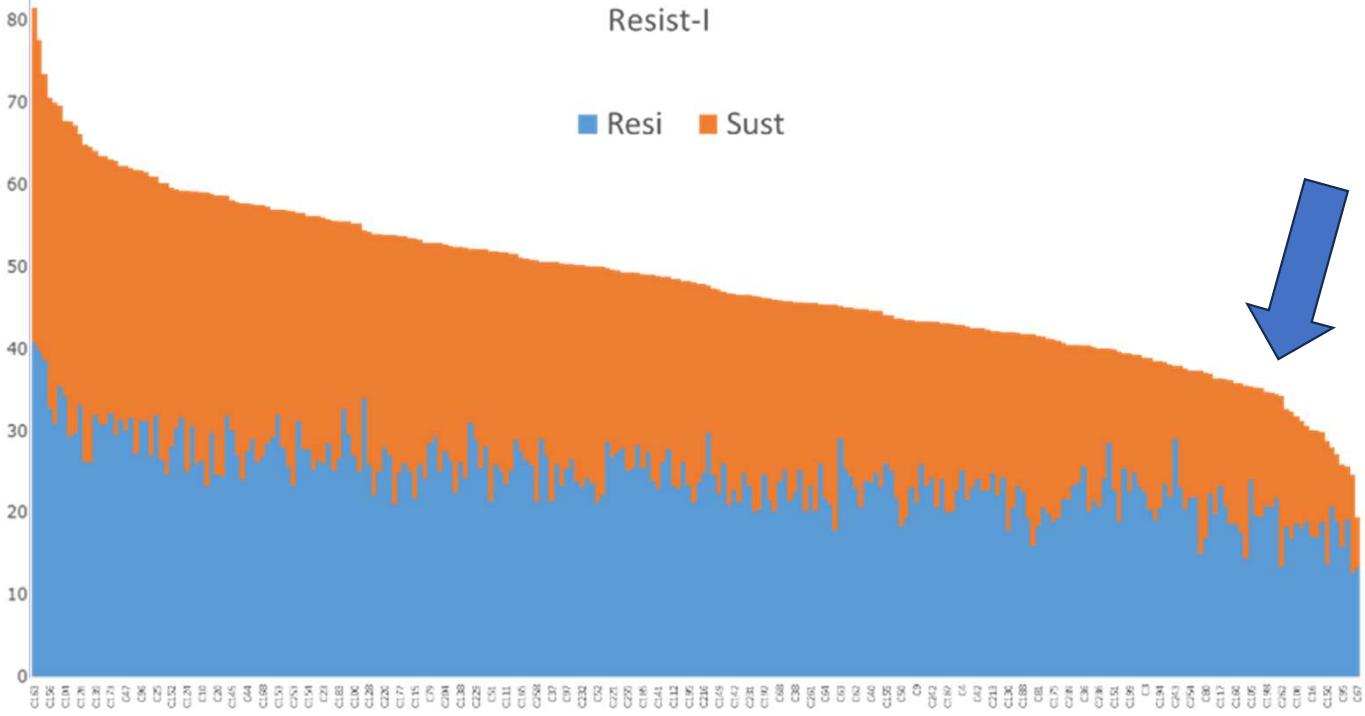
PILLAR	SUB-PILLAR	INDICATOR
Agility	Adaptability & Velocity	Transportation & Warehousing Flexibility
		Transportation Mode Flexibility
		Workforce Flexibility
	Responsiveness & Recovery	Production Volumes Flexibility
		Use of Small Minimum Batch Size from Supplier
	Flexibility in Sourcing & Order Fulfilment	Use of Small Minimum Batch Size toward Customers
Production Systems Flexibility		
Redundancy	Inventory Mgmt & Dispersion	Supply Base Flexibility
		Safety Stock Implementation
	Capacity	SC Density
		Production Capacity Saturation
	Supply Base	Use of Dual/Multiple Sourcing for Raw Materials
		Use of Dual/Multiple Sourcing for Finished Products
Use of carriers Multisourcing		
Adaptive Risk management	Security & Robustness	Use of Logistics Multisourcing
		Data Storage Backup System
	Risk Mgmt Culture & Business Continuity	Suppliers Financial Robustness
		Risk Metrics Use
	Reliability	Business Continuity Plans
Collaboration	Visibility & Collaboration Practices	Presence of Nodes in High-Risk Areas
		External Stocks and Downstream Demand Visibility
	Communication & ICT Skills	Collaborative Forecasting Level
		SC Information Sharing Quality
		Collaborative Communication Level

Scoping and framing: sustainability

PILLAR	SUB-PILLAR	INDICATOR	
Environmental Sourcing	Suppliers Env. Certification & Green Procurement	Certified Suppliers Share Green Procurement Consideration	
	Env. Supply Visibility	Second-tier Environmental Sustainability Assessment	
Sustainable Supply Chain and Logistics Practices	SC Design & Transportation Mode	Modal Transportation Suppliers Dispersion	
	Energy Use	Renewable Energy Use in Production and Storage facilities	
	Waste Recyclability & Reuse, Recycling and Remanufacturing	Production Wastes Quality Recycling, Remanufacturing and Reuse	
	Waste Production & Water Use	Total Waste Production Total Water Use	
Environmental Commitment	Company's Commitment & Packaging Recyclability	Packaging Recyclability Environmental Roles Diffusion Environmental Impact Self-Assessment	
	Env. Certification Use & Environmental Relevance in SCM	Environmental Impact in SCM Performance Evaluation	
Socially Responsible Sourcing	Socially Responsible Procurement & Soc. Supply Visibility	Certified Suppliers Share Second-tier Social Sustainability Assessment	
Internal Supply Chain	Working Conditions & Employees Satisfaction	Employees Satisfaction Measurement Health and Safety Practices Implementation	
	Equity, Diversity and Inclusion & Gender Equality	Gender Equality Employment Inclusivity, Equity and Diversity Practices	
	Social Sust. Relevance in SCM	Social Impact in SCM Performance Evaluation	
External Stakeholders	Community Involvement Initiatives	Community Initiatives	
Financial Management	Profitability & Growth	EBITDA Margin EBITDA Margin Growth Revenue Growth	
		SC Finance	NWC/Turnover
		Short & Long Term Solvency	Current Ratio D/E

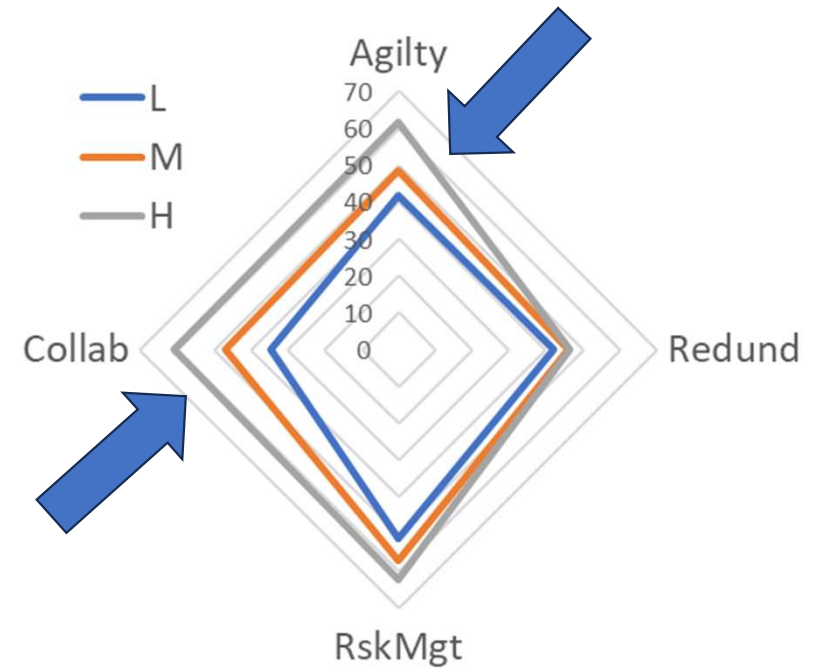
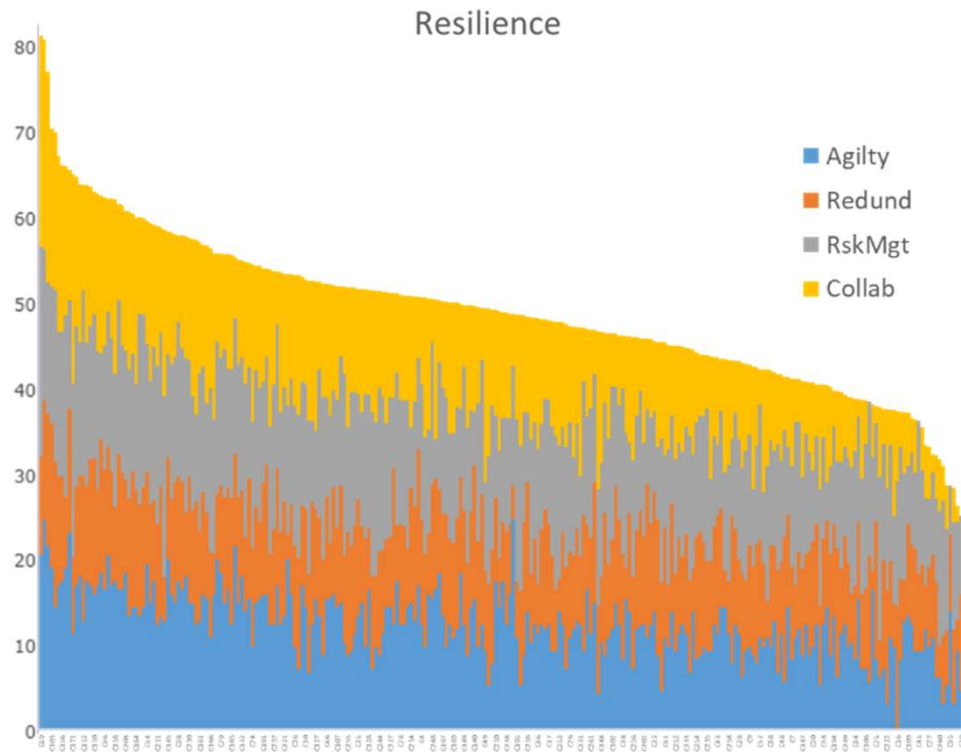
Results: supply chain resilience and sustainability

The survey was administered to a sample of companies obtained from the Orbis database (focusing on firms in Italy operating in the manufacturing, retail, and energy-supply sectors). We obtained **262 full valid responses**.



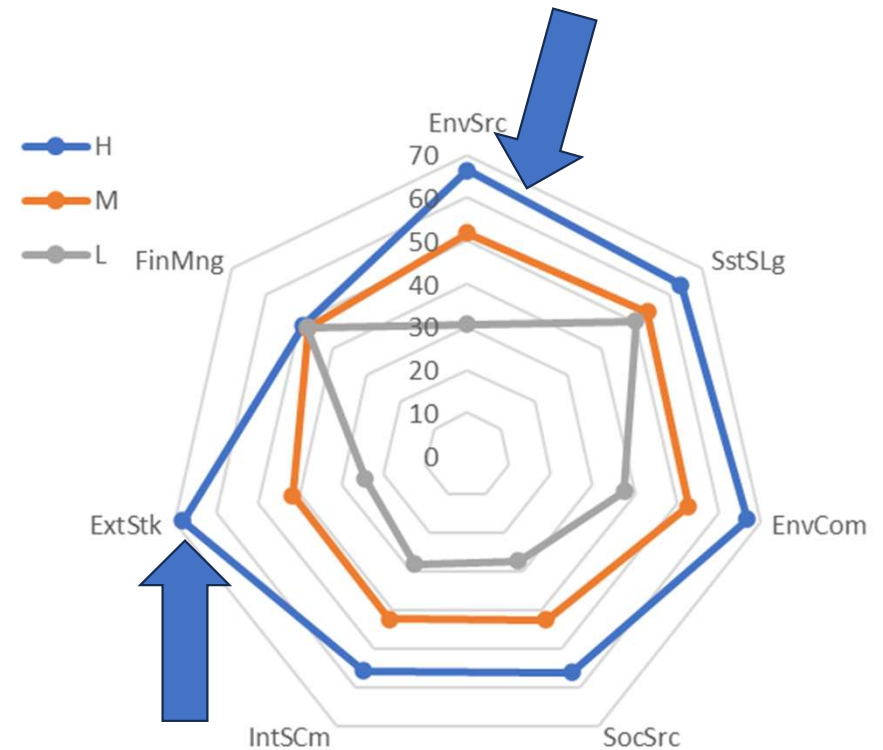
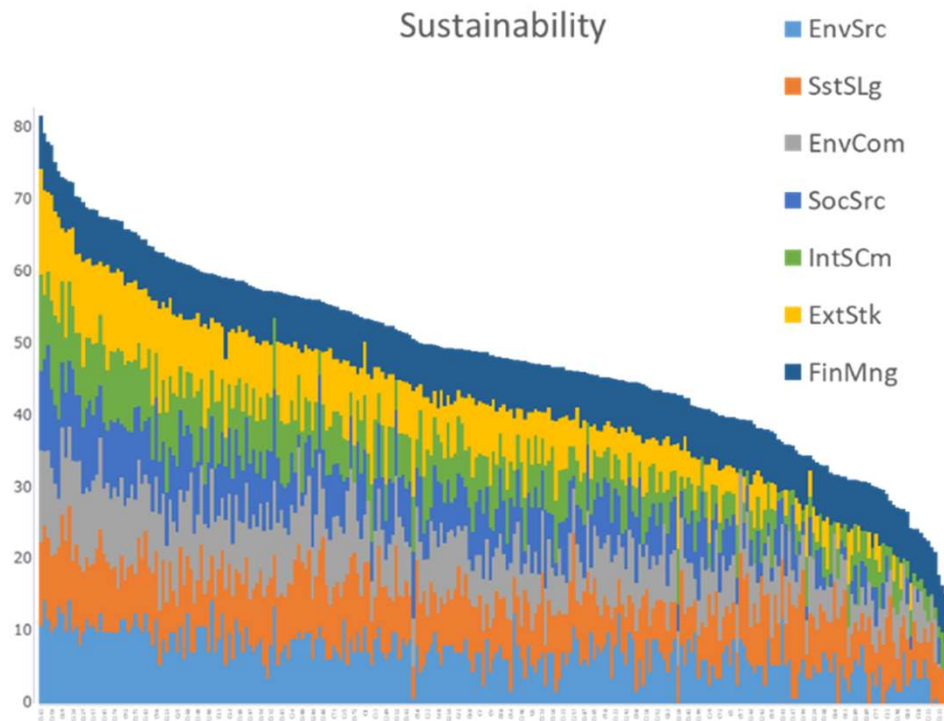
Firms with **lower scores in the overall index** also have a **lower contribution of supply chain sustainability**, showing that sustainability is less developed compared to resilience in terms of performance.

Results: the pillars of Supply chain resilience



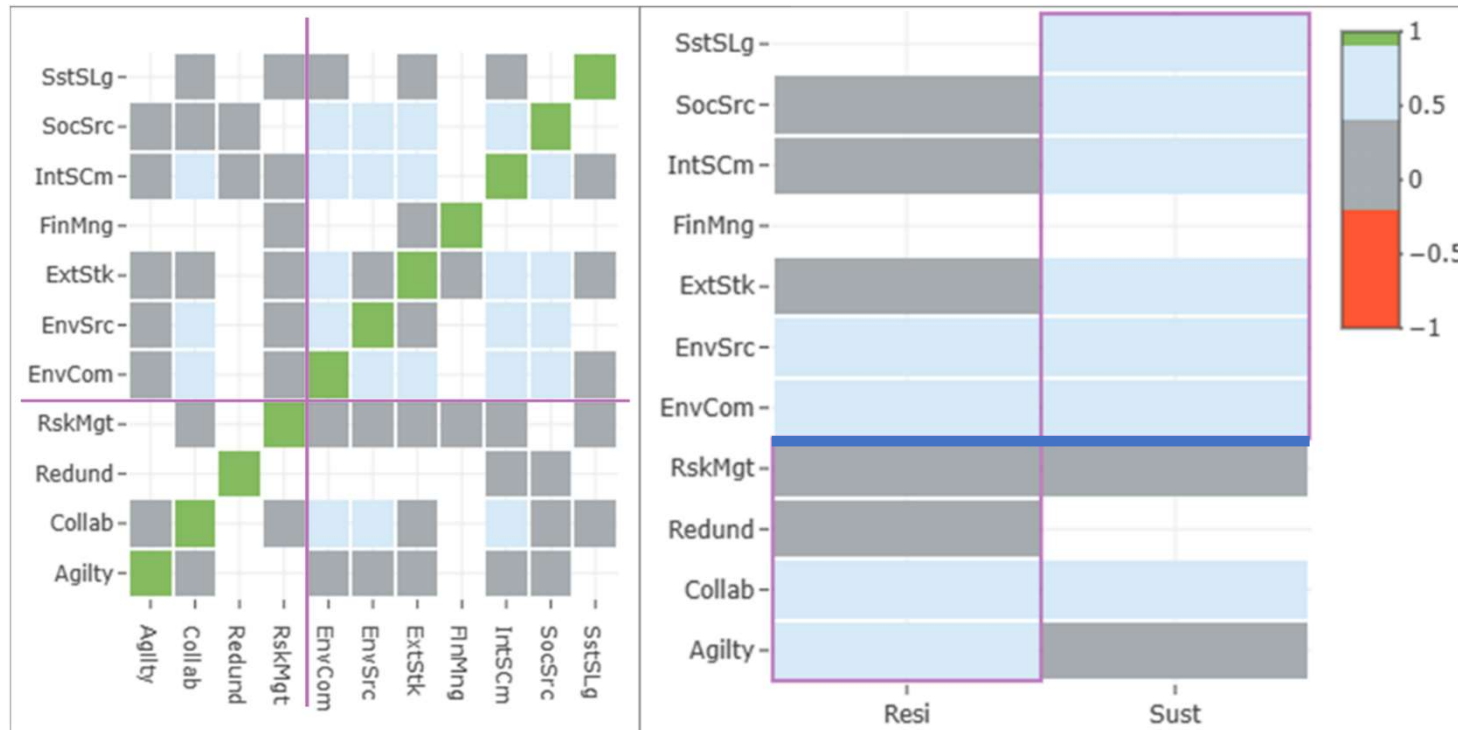
Low-performing companies tend to struggle especially in those areas that require capabilities that go beyond the boundaries of their own organization and that require the development of an external network of collaborations

Results: the pillars of Supply chain sustainability



“External Stakeholders” and “Environmental sourcing” make a difference between firms with low, middle, and high scores. The social sustainability side is acknowledged as a strategic goal for organizations

Results: interrelationships-resilience and sustainability



- The correlations confirm the **strong interrelationship** between Collaboration and the Sustainability sub-index, and between Environmental Sourcing (EnvSrc) and Environmental Commitment (EnvCom) and the Resilience sub-index.
- Collaboration can have a **significant impact** in driving sustainability and resilience at the same time.
- We found **no negative correlations** between resilience and sustainability

So what?

- Significant trade-offs between sustainability and resilience do not emerge according to our data
→ *sustainability or resilience can be developed without a significant negative impact on the other*
- By developing resilience only, companies tend to predominantly enhance resilience. However, it seems that resilience represents a grounding element for developing sustainability.
→ *An already resilient organization is more likely to “go green”.*
- By leveraging sustainability, it seems that companies can achieve better performance in terms of both sustainability and resilience at the same time.
→ *Sustainability can be an enabler of resilience and can reduce risks through better decision-making*
- In this sense, sustainability can be regarded as **an integral part of the social-ecological view of resilience**

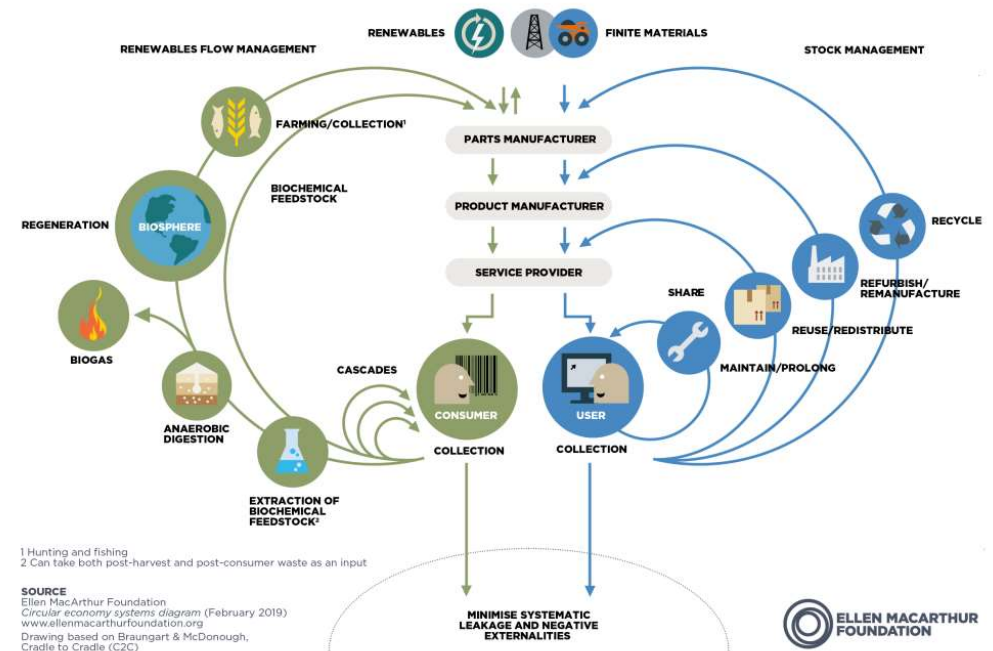
Green Measurement Toolkit

The premise for its design

Framework 10R

Circular economy		Strategies	
↑ Increasing circularity	Smarter product use and manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
		R1 Rethink	Make product use more intensive (e.g. by sharing product)
		R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	R3 Reuse	Reuse by another consumer of discarded product which is still in good condition and fulfils its original function	
	R4 Repair	Repair and maintenance of defective product so it can be used with its original function	
	R5 Refurbish	Restore an old product and bring it up to date	
	R6 Remanufacture	Use parts of discarded product in a new product with the same function	
	R7 Repurpose	Use discarded product or its parts in a new product with a different function	
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality	
	R9 Recover	Incineration of material with energy recovery	
Linear economy			

Butterfly Diagram



Green Measurement Toolkit

Categories for the design of circularity indicators

- The tool is based on seven main categories:
 - (i) *product and process design*
 - (ii) *circular business model*
 - (iii) *end-of-life management of products*
 - (iv) *circular supply chain*
 - (v) *industrial symbiosis*
 - (vi) *adoption of digital technologies*
 - (vii) *circular training, education, and engagement*

Green Measurement Toolkit

A questionnaire-based tool for Italian SMEs



Info domande

Per MATERIE RINNOVABILI si intendono i materiali ottenuti da cicli naturali derivanti da attività come la zootecnica, forestazione e agricoltura. Per MATERIE NON RINNOVABILI si intendono i materiali caratterizzati da lunghi periodi di formazione e la cui estrazione impatta negativamente sull'ambiente poiché derivanti da combustibili fossili.



Questionario

Ultimo aggiornamento:

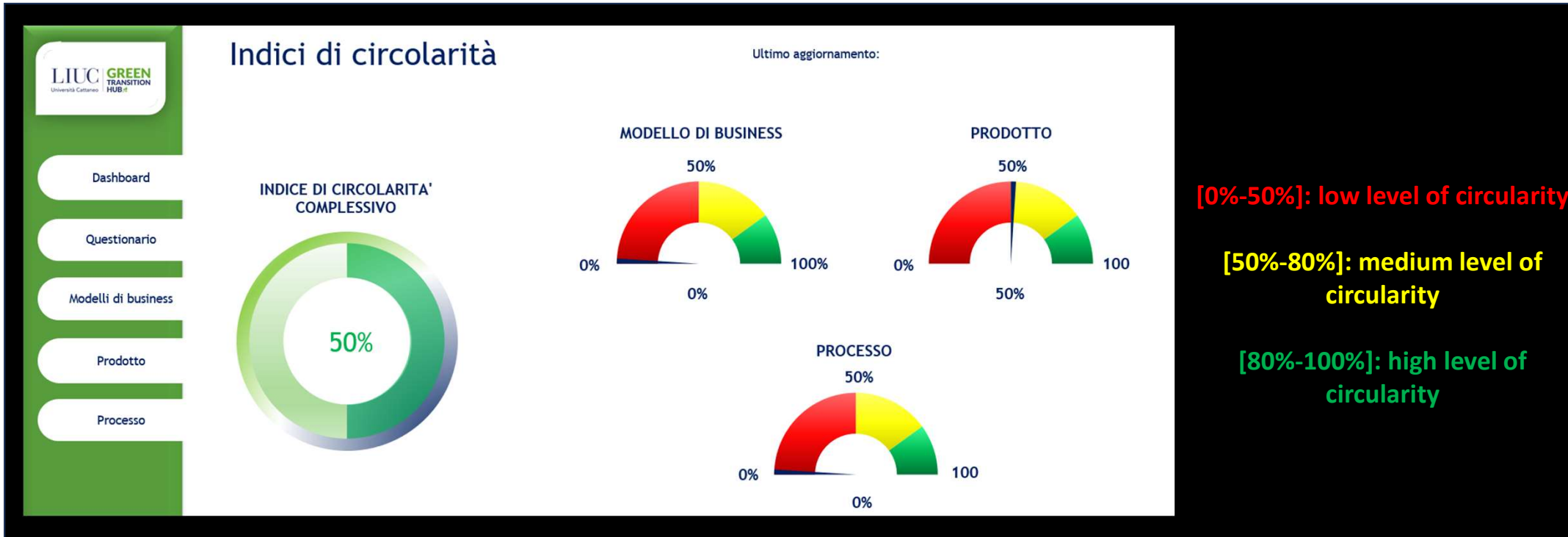


In che % il prodotto è costituito da materie prime rinnovabili e materie prime non rinnovabili?

Valore 1= massa in kg MP rinnovabili
Valore 2=massa tot. del prodotto

DOMANDA	1	2	3	4	5	6	7	8	9
VALORE 1									
VALORE 2									

Green Measurement Toolkit Dashboard



- One circularity measure for each category
- One overall circularity measure as result of matching the measure for each category

Green Measurement Toolkit

Toolkit features and next step

- It is a tool for disseminating circular economy principles to companies
- It allow to reflect on the enabling factors and barriers for the transition to the circular economy
- It enables the identification of actions to be implemented to improve the circularity level of the company
- Easiness of use
- The graphical user interface (i.e., the dashboard) is simple and intuitive
- Multidimensionality of the circular economy (reflected in the seven categories)
- The assessment is objective and synthetic
- Focus is on biological cycles, technological cycles, and product life cycle

Next Step

- *Test and validation*
- *Refinement and Consolidation*



LIUC
Università Cattaneo

GREEN 
TRANSITION HUB

www.liuc.it



Email: greenhub@liuc.it