

- [Integrating SDGs into architecture education](#) (City and Environment Interactions, 2024) investigates how architectural curricula currently integrate climate and sustainability issues.
- [Sustainability in Architectural Education Global Best Practices](#). Summary of how leading institutions are adapting their programs.
- Global Examples of Best Practices: UCL's Bartlett School of Architecture offers a range of sustainability-focused courses such as "[Environmental Design and Engineering](#)" and "[Sustainable Urbanism.](#)" Students engage in real-world case studies and simulation

tools to assess energy use and material performance; Delft University of Technology's "[Architecture and the Built Environment](#)" faculty is renowned for research in circular design and building technology. Their curriculum combines digital tools with sustainable materials, systems thinking, and urban climate design ; National University of Singapore (NUS) offers a [Master in Integrated Sustainable Design](#), focused on tropical and urban sustainability challenges. Emphasis is placed on net-zero energy buildings and resilient urban systems, critical for fast-growing Asian cities.

Resources

INPUT INDICATORS

Measure the resources required to deliver

- Existence of dedicated modules or courses on climate resilience and adaptation in design curricula
- % of faculty trained in climate-responsive design and adaptation

LEADING INDICATORS

Looks forward at future outcomes and events

- % of students completing resilience-focused coursework or projects before graduation
- Number of professional training or certification programs including climate adaptation as a core competency

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- % of new licensed professionals demonstrating competence in climate-responsive design
- Increase in demand for resilience training and certification among practitioners

KPIs

Showcase Resilient Design as a Cultural and Market Norm

Goal: Position resilience as central to the professions' identity and market value.

Description: Designers should lead public campaigns, exhibitions, and professional showcases demonstrating resilient projects. By making adaptation visible and aspirational, the sector can influence public perception, client demand, and ultimately the culture of construction.

Action 3

- [ROI: Codes, Standards, & Reporting on Resilient Design](#). AIA resource emphasising that designing beyond codes yields resilience benefits and value to clients.
- [Resilience in the Built Environment: Key characteristics for solutions](#) (Sustainable Cities and Society 2022) identifies what resilient design looks like and how to evaluate it.
- [Moving toward resilience and sustainability in the built environment](#) (Structural Safety, 2025). A conceptual discussion on how design and operation must shift to resilience-first.

Resources

INPUT INDICATORS

Measure the resources required to deliver

- Number of partnerships with cultural institutions, media, or industry associations to promote resilience
- Budget or resources allocated for resilience communication or showcase initiatives

LEADING INDICATORS

Looks forward at future outcomes and events

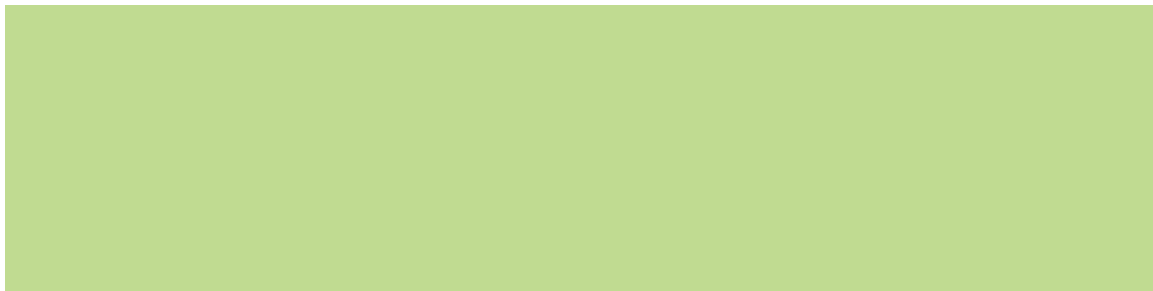
- Number of resilient design showcases, exhibitions, or competitions organized annually
- Number of awards or recognitions given to projects demonstrating outstanding adaptation strategies

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- Change in client demand for resilient or adaptive design elements
- Increased inclusion of resilience language in tenders, RFPs, and client briefs

KPIs



MATERIALS & SYSTEMS MANUFACTURERS AND SUPPLIERS

Who is this pathway for?

This pathway targets companies that manufacture, supply and install construction materials, building systems, equipment, and technical components, including producers of insulation, windows, HVAC systems, structural materials, finishes, and tools. It also applies to distributors, construction product certification bodies, and associated

professional federations and trade groups. These actors provide the backbone of the construction sector's supply chain and have a central role in ensuring the resilience and sustainability of buildings through the materials and systems they design, produce, certify, and promote.

Material and system manufacturers face a critical juncture: their products must meet increasing demand for climate-resilient solutions while complying with new performance standards and decarbonization goals. Climate change affects raw material availability, logistics, durability requirements, and product performance in situ. As extreme events become more frequent and chronic risks like heat and humidity increase, **the demand grows for materials and systems that can reduce vulnerabilities and extend building lifespans.** Yet, these stakeholders also face regulatory, market, and environmental pressure to simultaneously reduce embodied emissions, ensure circularity, and deliver affordable solutions. Innovation in materials, whether in biobased options, modular systems, or multifunctional components, is key to reconciling adaptation and mitigation. Trade federations and industry groups play a major role in disseminating R&D, updating norms, and supporting standardization efforts. The stakes are high: manufacturers must shift from reactive compliance to proactive solution development, integrating long-term climate performance into R&D, testing, and design.

Adaptation must shape both innovation and market expectations across supply chains.

Many material and system providers are making strides in eco-design and emissions reduction, but adaptation remains a less integrated priority. In the short term, resilience performance needs to be embedded into product development and certification. In the medium term, business models must evolve to reflect lifecycle resilience and service-based offerings. By 2050, manufacturers and suppliers should become enablers of systemic adaptation through resilient, low-impact, and circular solutions deployed at scale.

MATERIALS & SYSTEMS

MANUFACTURERS AND SUPPLIERS

Short-Term Actions

Actions	Resources & case studies	KPIs
Develop and Disseminate Material Passports and Climate Performance Guidance	Climate-Resilient Materials for the Built Environment: A Data-Centred Primer by 2050 Materials	Number of updated or new resilience standards and technical guidance documents published annually
Create an Inventory of Validated, Low-Risk Building Materials	Assessing the sustainability of a resilient built environment (Journal of Cleaner Production 2024)	Number of cross-sector collaborations or partnerships (e.g., with research bodies or associations) for data harmonization
Invest in Education and Professional Training on Resilient Materials	Study on the Durability of Construction Materials and Structures (MDPI Special Issue).	Number of professionals trained or certified on resilient material use and installation

Medium-Term Actions

Actions	Resources & case studies	KPIs
Promote Systemic Integration of Technical Solutions	Planning and Designing Methods for Supporting the Built Environment Resilience by Accurately Accounting for Supply Chains (MULTICLIMACT D2.2)	% of product lines supported by open technical specifications and training modules for builders and designers
Enhance Regulations to Address Life and Property Safety	Next Generation Building Materials for Energy Efficiency and Climate-Resilience (Discover Applied Sciences, 2025)	Number of technical submissions or data sets provided to support new resilience standards
Invest in and Promote Innovation for Climate-Resilient Materials and Systems	Emerging Trends in Sustainable Building Materials: Technological Advances (Renewable and Sustainable Energy Reviews 2023)	Number of co-developed prototypes or pilot materials tested for resilience performance

Long-Term Actions

Actions	Resources & case studies	KPIs
Develop and Validate Standards for Raw Secondary Materials	(Re-)Use of Secondary Materials by the GlobalABC	Number of new certified raw or secondary materials introduced to the market
Collaborate Globally and Continuously Adapt Standards and Methods	BAMB (Buildings as Material Banks) open publications on Materials Passports and Reversible Building Design	Frequency of internal product review cycles considering updated climate data and hazard models
Invent New Incentives and Business Models for Circular Resilient Materials	OECD Business Models for the Circular Economy report	% of client contracts including circular material service models

Short-term actions

Develop and Disseminate Material Passports and Climate Performance Guidance

Goal: Enable informed decision-making by providing transparent information on product resilience, limitations, and appropriate applications.

Description: Materials and systems manufacturers should take the lead in creating and publishing material passports: standardized, digital documents that compile key data on product composition, resilience, recyclability, environmental impact, and performance under climate stressors (e.g., heat, flooding, wildfire, high winds, moisture, fungal and biological attack). These passports should clearly indicate limitations, optimal use cases, and performance ratings under specific hazard conditions, enabling designers, contractors, developers, and regulators to make better-informed decisions. Offering reliable data and transparent benchmarks builds trust with the market, supports regulators in establishing enforceable standards, and reduces uncertainty for insurers and investors. Providing this clarity ensures that products are not only technically available but also properly understood and widely adopted, positioning manufacturers as essential partners in advancing climate-resilient construction.

- [Climate-Resilient Materials for the Built Environment: A Data-Centred Primer](#) by 2050 Materials helps manufacturers understand how to set meaningful KPIs and publish transparent performance metrics (durability, hazard tolerance, life-cycle).
- BAMB (Buildings as Materials Banks)'s [best practice guide to Materials Passports](#) provides a guide for actors along the construction value chain and shows the benefits of materials passports and how these can be implemented into general building practice
- [Emerging Trends in Sustainable Building Materials: Technological Advances](#) () provides methodological guidance for manufacturers to evaluate new materials. Includes durability, resilience under climate stressors (heat, moisture, etc). Useful for drafting internal testing/ standards documentation.
- [Novel Approaches for Building Materials Reliability and Durability from Intense Loading to Long-Term Behaviour](#) is an active topic research in Frontiers in Built Environment. It will offer advanced methodologies for assessing materials under extreme conditions.

INPUT INDICATORS

Measure the resources required to deliver

- % of product lines with published technical sheets detailing resilience properties (e.g., fire resistance, heat resistance, moisture durability, insect and fungal attack, recyclability)

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of updated or new resilience standards and technical guidance documents published annually

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- % increase in product adoption due to improved performance clarity or compliance with resilience standards

Create an Inventory of Validated, Low-Risk Building Materials

Goal: Help builders and designers quickly identify the right products for specific climate hazards.

Description: Each manufacturer should create and share a clear, practical checklist or catalog of their own validated, low-risk materials and systems. These documents should outline which products to use in which scenarios (e.g., flood-resistant coatings, heat-tolerant roofing, wind-resistant façades), including product performance, limitations, and recommended applications. By organizing information in a hazard-targeted format, builders and designers can quickly sort and select the most suitable materials, reducing uncertainty and saving time during planning.

Action 1

Resources

KPIs

Action 2

- [Assessing the sustainability of a resilient built environment](#) (Journal of Cleaner Production 2024). This research review covers methodologies for linking hazard-induced damage and environmental loss. Useful when manufacturers validate and present their materials' low-risk status.

Resources

INPUT INDICATORS

Measure the resources required to deliver

- Number of datasets shared or contributed to public or sectoral resilience databases

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of cross-sector collaborations or partnerships (e.g., with research bodies or associations) for data harmonization

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- Extent to which shared data is cited or integrated into national or international resilience frameworks

KPIs

Invest in Education and Professional Training on Resilient Materials

Goal: Empower industry professionals to integrate resilient materials effectively into construction projects.

Description: Materials and systems manufacturers should develop and promote training programs, hands-on workshops, and certification courses that focus on material selection, sustainable practices, and resilience strategies. These initiatives should target builders, contractors, designers, and other professionals across the value chain to ensure correct use, avoid misuse, and maximize the performance of resilient materials. Over time, this strengthens the capacity of the sector to mainstream resilient materials and ensures that innovations are not only developed but also successfully adopted at scale.

Action 3

- [Study on the Durability of Construction Materials and Structures](#) (MDPI Special Issue). Offers academic research on durability of materials; manufacturers can use such studies to underpin training content, validate claims, and educate users.
- [Next Generation Building Materials for Energy Efficiency & Climate Responsiveness](#) (Discover Applied Science 2025). Although energy-focused too, shows emerging materials and how they need evaluation and training for correct deployment.

Resources

INPUT INDICATORS

Measure the resources required to deliver

- Amount invested annually in professional training, workshops, or e-learning for builders, engineers, and distributors

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of professionals trained or certified on resilient material use and installation

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- Reduction in misuse or installation errors of materials reported in quality audits or warranties

KPIs

Medium-term actions

Promote Systemic Integration of Technical Solutions

Goal: Ensure that manufacturers work collaboratively to create a seamless supply chain of resilient materials and systems, facilitating easy access for builders and designers.

Description: Engage in partnerships with other manufacturers to integrate compatible products and materials, streamline training programs, and enhance resource availability. This systemic approach ensures that builders can easily find and implement resilient solutions without encountering barriers due to a lack of coordination among suppliers.

- [Planning and Designing Methods for Supporting the Built Environment Resilience by Accurately Accounting for Supply Chains](#) (MULTICLIMACT D2.2) provides a conceptual framework for analysing supply-chain resilience in the built environment (including material/systems suppliers). Manufacturers can use this method to collaborate across suppliers, map interdependencies, assess supply-chain risks and design coordinated solutions (compatible products, joint training, streamlined supply).
- [Strategies for Enhancing Global Supply Chain Resilience to Climate Change](#) (International Journal of Management & Entrepreneurship Research, 2024). While not specific to building materials, it offers strategies for manufacturers in supply-chains (e.g., localisation, redundancy, flexible sourcing) which are directly applicable for integrating resilient materials systems across the value chain.
- [Climate-Change and Adaptation in Global Supply-Chain Networks](#) (The Review of Financial Studies 2024). Article documenting how climate exposure affects suppliers and their customers. Demonstrates importance of systemic integration: if material systems are disconnected (supplier risk, incompatible products, etc), it undermines resilience. Good for making the business case internally.

INPUT INDICATORS

Measure the resources required to deliver

- Existence of joint-development or interoperability agreements with other manufacturers
- R&D budget share dedicated to co-designed or cross-compatible systems

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of joint pilot projects or demonstrations showing multi-manufacturer resilience solutions
- % of product lines supported by open technical specifications and training modules for builders / designers

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- Adoption rate of integrated solutions by builders and designers (% of sales linked to collaborative products)
- Reduction in installation errors or compatibility-related failures in projects using integrated systems

Enhance Regulations to Address Life and Property Safety

Goal: Advocate for regulatory frameworks that prioritize both life safety and property safety in building codes and resilience measures.

Description: Collaborate with policymakers to ensure that regulations encompass provisions for rapid recovery from disasters, including standards that support building resilience while ensuring occupant safety. This may involve integrating requirements for emergency access, structural integrity, and material performance under extreme conditions.

Action 1

Resources

KPIs

Action 2

- [Strong Building Codes for a Safer, More Resilient Future](#), World Bank review of building codes for resilience & disaster risk. Useful for manufacturers advocating with policymakers to ensure material/systems performance standards (durability, hazard tolerance) are embedded in regulations, linking to life & property safety.
- [Next Generation Building Materials for Energy Efficiency and Climate-Resilience](#) (Discover Applied Sciences, 2025) emphasises integration into codes. Shows how innovative materials need regulatory recognition (codes, performance standards) before uptake; manufacturers can use this when promoting regulation changes.
- [Managing Supply Chain Resilience in Climate and](#)

[Disaster-Prone Environments](#) (Competitiveness Review, 2025). Though focussed on supply chains, this touches on regulation, safety, disaster-risk alignment which is relevant for materials/systems manufacturers pushing for regulatory change.

- UNDP examples of [locally led solutions in the Global South](#): shows emerging market and regulatory contexts where locally adapted material and systems and regulatory frameworks are critical. Manufacturers operating in or supplying to the Global South should reference this when advocating standard and regulation updates.

Resources

INPUT INDICATORS

Measure the resources required to deliver

- Number of regulatory working groups or code-development committees with manufacturer representation
- % of testing budget allocated to extreme-event performance (fire, flood, heat, wind)

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of technical submissions or data sets provided to support new resilience standards
- Existence of internal compliance roadmap aligned with updated codes and safety regulations

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- % of product portfolio certified under new resilience or safety standards
- Reduction in claims or failures linked to product malfunction during extreme events

KPIs

Invest in and Promote Innovation for Climate-Resilient Materials and Systems

Goal: Advance the development, validation, and market uptake of innovative materials and building systems that enhance resilience to climate impacts while meeting performance, affordability, and sustainability criteria.

Description: Invest in R&D focused on materials and systems that can withstand heatwaves, flooding, drought, and other climate-related stressors. This includes developing, testing, and validating products using clear, transparent performance standards and protocols for resilience. Beyond innovation, manufacturers must also work to ensure the commercial viability and uptake of these solutions by actively engaging with designers, builders, and developers through product demonstrations, pilot projects, and tailored guidance. This action requires aligning innovation with scalability, quality assurance, and targeted market outreach, so that new resilient solutions don't just exist but are chosen, trusted, and implemented.

- [Smart Materials for Biomimetic Building Envelopes: Current Trends and Potential Applications](#) (Results in Engineering, 2024) provides an advanced R&D perspective on resilient building-envelope materials (important for manufacturers designing next-gen systems).
- [Emerging Trends in Sustainable Building Materials: Technological Advances](#) (Renewable and Sustainable Energy Reviews 2023) shows how sustainable and resilient materials are evolving; manufacturers should align their innovation roadmaps accordingly.

Action 3

Resources

INPUT INDICATORS

Measure the resources required to deliver

- % of annual R&D budget allocated to climate adaptation and resilience

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of co-developed prototypes or pilot materials tested for resilience performance

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- Number of successful commercialization cases of tested resilient materials

KPIs

Long-term actions

Develop and Validate Standards for Raw Secondary Materials

Goal: Establish clear and rigorous standards for the use of secondary materials in construction, ensuring they meet safety, durability, and performance requirements.

Description: Materials and systems manufacturers should actively lead the development of rigorous standards for secondary raw materials, ensuring that recycled products meet requirements for safety, durability, and climate resilience. This involves testing, piloting, and publishing transparent performance data to prove efficiency and market readiness. Once validated, manufacturers should collaborate with regulators, certification bodies, and procurement authorities to integrate these standards into building codes, regulations, and large-scale procurement frameworks. Taking responsibility for both technical validation and regulatory mainstreaming accelerates adoption, reduces uncertainty for builders and designers, and levels the playing field for resilient, circular solutions. This dual approach ensures that innovative materials move from niche applications to systemic use, helping close resource loops while strengthening climate adaptation in the built environment.

- The EU's [Safe and Sustainable by Design chemicals and materials Methodological Guidance](#) provides some insight of secondary materials performance
- [\(Re-\)Use of Secondary Materials](#) by the GlobalABC offers context in the use of secondary raw materials.
- [Barriers, success factors, and perspectives for the reuse of construction products in Norway](#) (Journal of Cleaner Production 2022). To increase technical knowledge exchange on the use of secondary materials, governments can support training, education and research on the practices and skills needed to conduct selective deconstruction. These studies give data to advocate with governments
- [Circular economy in construction](#) (Heliyon, 2024) uses a comprehensive literature review to define the core components of a circular economy applicable to the building sector and to identify key research gaps and barriers that must be addressed to advance CE implementation in construction.
- [EN 12620: Aggregates for concrete](#) (incl. recycled aggregates) formal European spec covering aggregates from natural, manufactured and recycled sources; reference point for validating recycled inputs into concrete mixes
- The [Use of recycled aggregates in concrete](#) JRC Report (EU) showcases practical barriers and measures to scale recycled aggregates (technical, regulatory, economic) and market uptake guidance; good template for internal validation roadmap.
- Standards such as [Cradle to Cradle Certified Product Standard](#) are credible, multi-attribute certifications (material health, circularity, social, water) often used in public procurement that support secondary-material claims.

INPUT INDICATORS

Measure the resources required to deliver

- Existence of internal R&D program or partnerships dedicated to validating secondary material performance

LEADING INDICATORS

Looks forward at future outcomes and events

- Number of new certified raw or secondary materials introduced to the market

LAGGING INDICATORS

Looks back at whether the intended result was achieved

- % of total production incorporating certified secondary or recycled materials

Action 1

Resources

KPIs