# Integrating circular strategies into post-disaster rebuilding: pathways to resilient and resource-efficient recovery

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**Abstract.** The increasing frequency and severity of natural disasters pose significant challenges for the built environment, especially during post-disaster recovery and reconstruction. Traditional linear rebuilding practices often focus on rapid implementation and cost reduction, sometimes at the expense of sustainability, resource efficiency, and long-term resilience. In recent years, the Circular Economy (CE) has emerged as a promising and innovative approach to addressing these systemic issues. By prioritizing resource loops through reduction, reuse, recycling, and designing for adaptability, CE offers a more regenerative and resilient model for rebuilding. Despite its potential, a consistent and comprehensive Build Back Circular framework specific to post-disaster contexts is still underdeveloped. This study presents a systematic literature review of 30 peer-reviewed journal articles and conference proceedings to examine how CE principles can be operationalized in post-disaster recovery to support sustainable rebuilding practices. The review identifies two dominant domains where CE integration offers the greatest leverage: disaster waste management and post-disaster shelter design. The finding shows CE integration into waste management occurs through three identified clusters, including (i) Waste Handling & Processing; (ii) Digitalization & Traceability; (iii) Material Recovery & Circular Flows, and the design shelter-related CE strategies occur through four identified clusters, including (i) Material Circularity in Shelter Design; (ii) Design for Circularity Principles; (iii) Flexibility & Adaptability; (iv) Durability & Long-Term Performance. This study adds to the ongoing discussion on sustainable reconstruction by proposing a systems-based approach that aligns environmental, social, and economic goals in the wake of disasters, ultimately aiding long-term community resilience and sustainability.

**Keywords.** Circular Economy, Post-Disaster Recovery, Disaster Reconstruction, Waste Management, Shelter Design.

## 1 Introduction and background

The number of recorded climate change-driven disasters has grown “by a factor of five” from 1970 to 2020 [1]. In 2024, the Emergency Events Database (EM-DAT) documented 393 global disasters linked to natural hazards [2]. According to United Nations estimates, the annual number of global disaster events may rise to about 560 by 2030, or nearly 1.5 per day, reflecting a 40% growth relative to previous decades [3]. From 1980-2024, there were 403 confirmed weather/climate disaster events only in the United States [4]. Texas leads the nation in both the frequency and cost of severe weather events, accounting for 15% of all U.S. billion-dollar disasters [5]. Natural disasters cause extensive disruptions and significant impact on infrastructure and buildings, leaving debris and related environmental problems. In addition to the physical impacts of natural disasters on the built environment, their effects are also evident in the economy and homeownership [6]. The problem is exacerbated, especially when the US residential industry in significant areas has been found vulnerable to the impacts of natural disasters [7]. Therefore, the growing intensity and frequency of natural disasters in the US, combined with the vulnerability of the built environment and escalating economic impacts, underscore the importance of effective recovery planning and post-disaster reconstruction strategies.

Another important area of impact is the significant amount of waste generated post-disaster [8,9]. Traditional reconstruction models prioritize rapid rebuilding, which often leads to substantial waste generation and long-term vulnerabilities for affected communities. One promising way to reduce construction waste is to adopt and

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implement Circular Economy (CE) strategies. CE with four key principles, including slow, close, narrow, and regenerate [10] could be proposed as a mitigation measure to reduce waste associated with post-disaster problems. Geissdoerfer et al. (2017) define CE as a "*regenerative system that benefits the environment, economy, and society by minimizing resource input, waste, emissions, and energy leakage through the narrowing, slowing, and closing of material and energy loops*" [11].

While some researchers have examined the potential of the CE as a crisis response to post-disaster recovery [12–17], the topic remains novel, and the existing literature remains limited. Additionally, some prior studies have reviewed the literature in this area, but they have primarily focused on specific subdomains, most notably post-disaster waste management. For instance, Jalloul et al. (2022) conducted a review of post-disaster waste management to identify essential data for quantifying various aspects of sustainable debris management. Their findings highlight key data needs related to: (i) the amount and composition of debris; (ii) the availability and suitability of temporary debris management sites; (iii) environmental and hazard considerations; (iv) economic factors; (v) social dimensions; and (vi) funding and policy constraints. They further propose a four-phase framework for data collection spanning pre-disaster, post-disaster response, short-term recovery, and long-term recovery [18]. Similarly, Caldera et al. (2025) examine the relationship between Disaster Waste Management (DWM) and community resilience. The research reveals the limited and ad hoc application of DWM practices and identifies opportunities for improvement across planning, waste treatment, environmental management, economic considerations, organizational capacity, and legal frameworks. Importantly, the review positions CE as one of several key dimensions of resilience, alongside community, urban, climate, medical supply chain, technological factors, and their application within DWM systems [8].

Beyond waste management, Rathnasinghe et al. (2025) discuss a new topic in the area; they reviewed papers to address the potential and major barriers of Off-Site Construction (OSC), including standardization issues, cultural insensitivity, and inadequate policy integration. The systematic review underscores OSC's advantages, time and cost efficiencies, as well as challenges such as high initial investment, logistical constraints, limited policy integration, and insufficient community involvement [19].

Given the fragmented nature of existing studies and the relevance of circular approaches in disaster contexts, there is a clear need for a comprehensive, integrative review of the literature to identify current trends and provide a holistic perspective on the topic for future directions. This study addresses that gap by systematically reviewing 30 peer-reviewed journal articles and conference proceedings to synthesize current knowledge to answer: *How can CE principles be integrated into post-disaster recovery to support sustainable rebuilding practices?*

## 2 Methodology

This study employed a Systematic Literature Review (SLR) to examine how circular economy principles can be integrated into post-disaster recovery to support sustainable, adaptable, and future-ready rebuilding practices. An SLR was selected because it ensures a rigorous, transparent, and replicable approach to synthesizing evidenc. Unlike narrative reviews, SLRs minimize bias and enable comprehensive coverage of relevant studies, providing a robust foundation for identifying trends, gaps, and future directions in the topic [20,21]. For this study, the SLR methodology consisted of five sequential stages: 1) Database selection and keyword search; 2) Establishing filtering criteria; 3) Abstract screening; 4) Full screening of articles; 5) Review through Litmaps (Figure 1).

*In the first stage* of the review process, database selection and keyword searching protocols were established to ensure broad and in-depth coverage. Web of Science (WoS; Clarivate Analytics) was selected for its emphasis on peer-reviewed, high-impact journals, while ScienceDirect (Elsevier) was included to capture domain-specific technical literature. This multi-platform approach minimized publication bias and limitations, increased literature saturation, and strengthened the review's validity. The keywords were defined based on the research scope, including "Circular Economy, Post-Disaster Recovery, Post-Disaster Reconstruction, Disaster Management." Accordingly, the query was formulated as: ("circular economy") AND ("post-disaster recovery" OR "post-disaster reconstruction" OR "disaster management"). The search was conducted using the Advanced Search in two databases to capture the most relevant studies. No restriction was applied to the publication year, as only 16 papers were published before 2020. At this stage, all document types were considered. The initial search yielded 435 ScienceDirect and 12 WoS papers.

*In the second stage*, a filter was established to refine the dataset. The applied filtered criteria included article type (reviews, research conference proceedings, and journal articles) as the inclusion criterion. After applying the filter criteria, the data set was reduced to 357 articles on ScienceDirect and 11 on WoS. *In the third stage*, abstracts from 368 articles were manually screened to identify duplicates and relevance to the study. No duplicate records were found. The manual abstract screening process refined the dataset to 41 papers deemed relevant for full-text screening. In the final stage, a set of 41 articles was subjected to manual screening, which included a comprehensive review of the full texts to ensure complete relevance to the research scope. This step resulted in a final set of 26 papers for detailed analysis. *In the fifth stage*, the researchers used Litmaps to identify an additional 4 papers based on keywords, their associations, and relevance to the earlier identified papers, resulting in 30 articles (n) that were analyzed to explore the research questions. Although post-disaster recovery has been widely studied, the integration of CE strategies within this context remains significantly underexplored. The small number of existing publications on CE-based post-disaster recovery highlights both the novelty of the topic and the significant potential for future scholarly contributions.

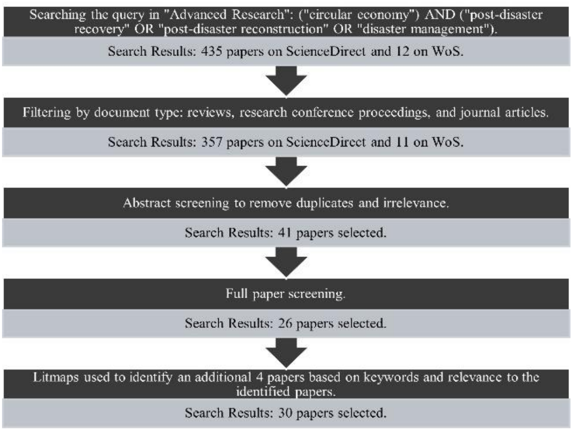


**Fig. 1.** Five Sequential stages of data collection.

## 3 Results and discussion

A total of 30 peer-reviewed publications comprising research conference proceedings and journal articles were systematically analyzed using the SLR process. Most of the reviewed studies were published since 2019, reflecting the novelty of the topic (Figure 2). The most frequent publication outlets were Low-Carbon Materials and Green Construction (3), Buildings (3), Resources, Conservation and Recycling (2), and International Journal of Disaster Risk Reduction (2). Given the novelty of the topic, publications are dispersed across many journals, with no specific/single journal emerging as a frequent outlet.

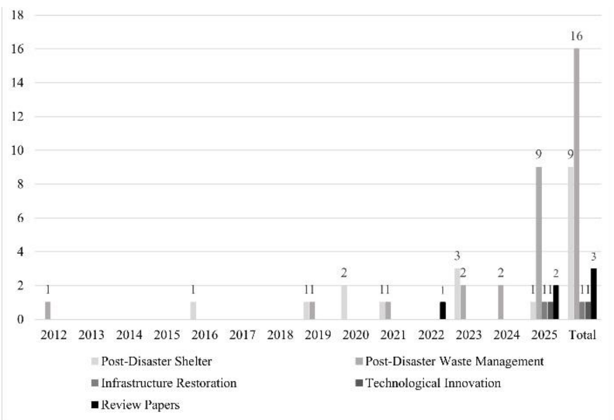


**Fig. 2.** The number of publications based on the five identified clusters.

All 30 reviewed papers were manually classified by theme, yielding five clusters which included: i) Post-Disaster Shelter; ii) Post-Disaster Waste Management; iii) Infrastructure Restoration; iv) Technological Innovation; v) Review Papers. The temporal representation of the publications based on the cluster is depicted in Figure 2 and shows an increasing trend over the last few years for post-disaster shelter and post-disaster waste management clusters.

Based on the identified clusters, in addition to themes such as infrastructure restoration (1), technological innovation (1), and review studies (3), the topic predominantly centers on two major areas: post-disaster shelter (9) and post-disaster waste management (16), as shown in Table 1. Therefore, based on current research, CE principles have been integrated into post-disaster recovery, addressing two major challenges: waste management and shelter design, because these challenges address the largest, most complex, and interdependent needs of affected communities: managing enormous debris flows and providing safe, dignified places to live.

**Table 1.** Identified clusters in CE integration to post-disaster recovery studies

| Categories | Authors of Studies |
|---|---|
| Post-Disaster Shelter | Amin Hosseini et al., 2016, Askar rt al., 2019, Moreno-Sierra et al., 2020, Javanfforouzande et al., 2020, Rathnasinghe et al., 2021, Karimi et al., 2023, Arnetoli & Bologna, 2023, Montalbo & Sanati, 2023, Feng & He, 2025 |
| Post-Disaster Waste Management | Xiao rt al., 2012, Fatimah et al., 2019, Guerrero- Miranda & Luque Gonzalez, 2021, Xiao et al., 2023, Pradhananga & ElZomor, 2023, Galluccio et al., 2024, Aydin et al., 2024, Gajovic et al., 2025, Temelli et al., 2025, Parsaee et al., 2025, Xiao et al., 2025, Bektas & Jingjie, 2025, Cetin & Kirchherr, 2025, Shevchenko et al., 2025 |
| Infrastructure Restoration | Byers et al., 2025 |
| Review Papers | Jalloul et al., 2022, Rathnasinghe et al., 2025, Caldera et al., 2025 |
| Technological Innovation | Mallick et al., 2025 |

*Disaster Waste Management* (DMW) is a major problem due to the complexity of debris. Earthquakes and other disasters generate hundreds of millions of tons of Construction and Demolition Waste (CDW), mainly concrete, brick, steel, wood, glass, and mixed mineral fractions. Bektaş and Jingjie (2025) quantified the ecological-costs associated with recent earthquakes, illustrating the massive environmental burden when debris is handled linearly [22]. Several studies emphasize that landfilling or uncontrolled dumping of debris leads to air, soil, and water pollution, dust, and exposure to hazardous materials such as asbestos [16,22,23] which can adversely affect both humans and the environment. Multiple studies have also demonstrated that disaster debris is not just a waste problem but a strategic resource. Quantitative analyses show that large shares of debris can be recycled or reused, around 46% in the Sullivan tornado case, with 28% lower Greenhouse Gas (GHG) emissions compared to the linear scenario [16].

*Shelter design* is another major problem, as it is a primary need that directly affects the survival, health, privacy, and psychological recovery of the impacted population post-disaster. Karimi et al. (2023) emphasized that emergency shelters must address social–cultural, physical–technical, environmental, economic, and organizational factors [15]. Askar et al. (2019) note that temporary accommodation is the primary step in reconstruction, yet conventional shelters were widely criticized as unsustainable and resource-consuming, often worsening conditions in developing countries [12]. Moreover, studies show that "temporary" units frequently convert to long-term or "permanent" settlements, but they are not designed for this reality. Askar et al. (2019) argue that conventional temporary housing can lead to permanent slums, material waste, and social problems. Therefore, shelter strategies influence long-term settlement patterns. Finally, shelter provision consumes massive amounts of materials, energy, and land, and poorly designed units become future demolition waste.

For these reasons, it is logical that current CE-oriented research has focused on disaster waste management and post-disaster shelter, as these two domains both generate the most serious problems and offer the greatest leverage for circular, sustainable, and future-ready post-disaster recovery.

### 3.1 Integrating CE principles into post-disaster recovery to support sustainable rebuilding practices

CE principles can be integrated into post-disaster recovery by transforming the traditional linear "demolish–dispose–rebuild" approach into a regenerative system that slows, narrows, closes, and regenerates material loops, a fundamental tenet of CE. As previously discussed, studies indicate that two major concerns in post-disaster recovery are DWM and shelter design. When CE is integrated into post-disaster recovery as a remedy strategy, it should address these two problems. Therefore, CE strategies should address disaster-generated waste during rebuilding, turn debris into resources to reduce it, and ensure that post-disaster recovery plans do not impose additional burdens on the ecological systems supporting the impacted areas.

#### *3.1.1 Transforming disaster debris into a resource to slow and close the materials loop*

By treating disaster debris as a resource to slow and close material loops, the volume of waste sent to landfills is minimized, thereby significantly reducing associated environmental impacts. Fatimah et al. (2019) showed that CE integration occurs through waste segregation, treatment, recycling technologies, Information and Communication Technology (ICT)-enabled monitoring, and governance systems that convert debris into valuable materials for reconstruction [24]. Pradhananga & ElZomor (2023) highlighted that CE integration begins with the recovery of salvageable materials (architectural and historic), reducing losses of culturally significant structures, and treating disaster debris as a valuable resource rather than waste. The authors emphasize deconstruction over demolition, promoting design strategies such as material homogeneity and buildings planned for easy disassembly, all of which enable components to be reused or recycled instead of discarded. Regarding this, a key requirement is training the construction workforce in selective deconstruction, sorting, reuse, and recycling methods, which improves both recovery efficiency and labor capacity [13].

Gajović et al. (2025) confirmed that CE principles can be integrated into post-disaster recovery by strengthening demolition and waste management systems that prioritize material recovery, selective demolition, on-site sorting, and recycling. The paper shows that CE-based reconstruction requires supportive institutional frameworks, diversified CE business models, and technological tools for tracking, processing, and reintegrating secondary materials. The paper emphasized the growing role of technologies in CE advancement, including digital traceability of materials, waste flow monitoring, construction databases, automated sorting technologies, data-driven CE indicators, and material passports. In addition, strong policy frameworks, regulations, and incentives to support CE practices during debris clearance and rebuilding. Leveraging CE for economic, social, and environmental co-benefits, ensuring reconstruction is affordable, sustainable, and future-proof [27]. Temelli et al. (2025) emphasized the embedding of long-term CE principles such as zero-waste design, traceability, and recycling infrastructure. The paper emphasizes that sorting waste by damage category and material type is essential for CE-based recovery [28].

In addition, Rathnasinghe et al. (2025) introduce Off-Site Construction (OSC) as an effective approach to Post-Disaster Reconstruction (PDR), offering accelerated delivery, enhanced quality control, and reduced on-site disruption. In their systematic review, they highlight OSC's key advantages, most notably time and cost efficiencies, as well as persistent challenges, including high initial investment, logistical constraints, limited policy integration, and insufficient community involvement [19]. Bektaş & Jingjie (2025) confirmed that debris reuse initiatives create local jobs in sorting, recycling, brick making, aggregate production, modular construction, and on-site rebuilding. CE reduces reconstruction timelines and supports economic stabilization of affected communities [30].

### *3.1.2 Embedding circular R-strategies into rebuilding processes to address future*

Shevchenko et al. (2025) proposed a dual hierarchy of 6Rs (Upgrading, Reusing, Repairing, Refurbishing, Remanufacturing, and Recycling) to embed CE into the United Nations' "Build Back Better" framework. It is dual because their proposed hierarchy is divided into Past-Oriented R-Strategies, including design for using building components coming from a post-disaster territory (slowing-past) and design for using recyclable materials coming from a post-disaster territory (closing-past), and Future-Oriented R-Strategies, including design for the reusability of building components in the future (slowing-future) and design for the recyclability of building materials in the future (closing-future). This ensured that all usable elements were retained, while unavoidable debris is utilized as a resource [25]. Overall, the dual 6R hierarchy is comprehensive because it addresses debris from damaged buildings and ensures that newly built post-disaster shelters are designed for future reuse and recycling, preventing them from becoming a long-term burden.

Design-for-disassembly (DfD) and reversibility in shelters reflect a future-oriented perspective of post-disaster recovery. Arnetoli & Bologna (2023) demonstrate that CE recovery is strengthened by structures designed for disassembly, reuse, reconfiguration, and recycling, enabling materials and components to circulate across multiple disaster cycles. Designing adaptable, modular, reusable, and upgradable shelters, using recycled and locally sourced construction materials, are some of the other CE strategies that are emphasized by the literature; Karimi et al. (2023) show that CE is integrated through emergency shelters designed to be modular, repairable, upgradable, and adaptable. This enables shelters to transition into permanent housing, reducing waste and resource consumption [11].

Moreno-Sierra et al. (2020) demonstrate the use of recycled plastics, mixed aggregates, and rubble to create modular, thermally resilient shelter systems that support local capacity building. Their findings suggest that recycled plastic materials exhibit high resilience to varying weather conditions and are suitable for constructing shelter modules. The paper demonstrated that recycled materials (such as PET plastics, concrete rubble, and mixed aggregates) can be processed mechanically or chemically into modular bricks, structural components, and resilient shelter systems, thereby enabling rapid, low-carbon reconstruction. CE practices support sustainability by minimizing landfill disposal, lowering environmental impacts, and reducing reliance on virgin materials. They enhance adaptability and future-readiness through flexible, modular shelter designs that can be scaled, reassembled, or adapted to different climates. Thermal simulations in the study demonstrate that recycled PET-based modules perform as well as or better than traditional materials, supporting comfort, durability, and climatic resilience. [26].

Based on Karimi et al.'s paper (2023), CE principles can be integrated into post-disaster rebuilding by designing shelters that are modular, reusable, repairable, upgradable, and adaptable, ensuring they can evolve along with community needs. This approach includes using recycled, local, and recyclable materials, such as PET, wood from local sources, recyclable steel, and fabrics, to minimize environmental impact while supporting local manufacturing and livelihood recovery. In this case, the designed shelter will be location-specific and should adhere to local regulations, constraints, and opportunities. The shelters are intended to be durable, climate-resilient, and repairable to maximize lifespan, with features such as PET bottle-based insulation and recycled panels derived from disaster-generated waste. Furthermore, the shelters are conceived as flexible systems capable of expanding, shrinking, or relocating across different contexts, while also integrating social and economic sustainability by ensuring comfort, dignity, safety, cost efficiency, and effective resource reuse [15].

Arnetoli & Bologna (2023) showed that CE principles can be embedded in post-disaster recovery by redesigning temporary and permanent reconstruction processes through Design for Disassembly, Reuse, and Recycling (DfDRR), using a matrix of post-use scenarios to guide decisions across the entire disaster cycle. Instead of treating emergency structures as disposable, the proposed matrix reframes them as materials with future value, whose end-of-life is planned from the design stage [27].

Askar et al. (2019) propose incremental housing in which a durable "*starter core*" is expanded over time, thereby avoiding temporary-housing waste and reducing material use throughout recovery. It provides time-efficient housing construction approaches while responding to immediate large-scale interventions. Flexibility, modularity, scalability, and adaptability are the most common CE strategies focusing on incremental housing in the study. Socially, the strategy fosters community participation, psychological recovery, affordability, and local empowerment, which are critical for long-term resilience [12].

Montalbano & Santi (2023) highlighted that the construction of sustainable temporary housing units requires consideration of various parameters to achieve a balanced equilibrium between economic, social, and environmental impacts. Possible future research directions are emphasized, including the use of digital tools and BIM models to promote the adoption of CE practices and to validate design solutions through value analysis [28]. Moreover, integrating low-carbon materials and renewable energy is an alternative future direction for shelter design. Feng & He (2025) demonstrate CE integration through renewable materials, recyclable components, energy-efficient design, and PV/solar systems, creating shelters that minimize emissions and reduce resource dependency. The authors confirm that environmental sustainability in temporary buildings depends on three major factors: material selection, building design, and energy sources [29].

## 4 Conclusion

This review highlights post-disaster recovery as a critical opportunity to implement CE principles, particularly through disaster waste management and post-disaster shelter design, which represent the most material and impact-intensive recovery domains. Based on the review of 30 peer-reviewed publications, CE integration into waste management occurs through three identified clusters, including (i) *Waste Handling & Processing*: waste segregation and sorting (including on-site sorting), automated sorting technologies, waste treatment and processing; (ii) *Digitalization & Traceability*: digital traceability of materials, waste-flow monitoring, material passports, ICT-enabled monitoring, use of digital tools for tracking materials and waste streams; (iii) *Material Recovery & Circular Flows*: recovering salvageable architectural and historic materials, disassembly, modular construction, reuse, and recycling methods, OSC to convert debris into valuable materials for reconstruction. In addition, training workers, policy frameworks, regulations, and incentives are some other aspects addressing the social and economic sides of the topic. In addition, training workers, policy frameworks, regulations, and incentives are some other aspects addressing social and economic sides of the topic.

The design shelter-related CE strategies occur through four identified clusters based on the reviewed papers, including (i) *Material Circularity in Shelter Design*: reuse of building components, use of recyclable materials from post-disaster contexts, use of locally sourced materials; (ii) *Design for Circularity Principles*: design for the reusability and recyclability of shelter components for future applications, DfD, designing for reusability of shelter component, designing for future recyclability of materials, modularity, reversibility, easy assembly, reconfiguration, upgradeability; (iii) *Flexibility & Adaptability*: flexible and scalable systems, expandable, shrinkable, or relocatable shelters, adaptability to different climates and community needs; (iv) *Durability & Long-Term Performance*: durable design, climate-resilient shelters, repairability to extend lifespan, design strategies that minimize environmental impact, supporting local manufacturing and livelihood recovery.

Among the reviewed papers, only one focused on technological innovations that could facilitate this process. This gap should be addressed in future studies intending to consider CE integration into post-disaster recovery. The use of digital tools and BIM models to facilitate material traceability and waste-flow monitoring could be incorporated into waste management and shelter design to adopt CE practices in post-disaster management. Furthermore, despite searches across multiple databases, the relatively small body of relevant studies, as a limitation, makes it challenging to draw comprehensive conclusions.

### References

[1] WMO, Weather-related disasters increase over past 50 years, causing more damage but fewer deaths. https://wmo.int/media/news/weather-related-disasters-increase-over-past-50-years-causing-more-damage-fewer-deaths.
[2] CRED, 2024 disasters in numbers (CRED, 2025).
[3] C. Saulo, A decade of the Sendai Framework for disaster risk reduction and the imperative of enhanced resilience. Int. J. Disaster Risk Sci. **16**, 4 (2025).
[4] NCEI, U.S. billion-dollar weather and climate disasters, 1980–present. https://doi.org/10.25921/STKW-7W73.
[5] NCEI, Texas has the most billion-dollar disasters nationwide. https://texas2036.org/posts/texas-has-the-most-billion-dollar-disasters-nationwide/.
[6] T. L. Sheldon, C. Zhan, The impact of natural disasters on U.S. home ownership. J. Assoc. Environ. Resour. Econ. **6**, 1169 (2019).
[7] D. Zhao, A. P. McCoy, J. Smoke, Resilient built environment: New framework for assessing the residential construction market. J. Archit. Eng. **21**, 1 (2015).
[8] S. Caldera, C. Jayarathna, C. Desha, Disaster waste management for resilient communities: A systematic literature review. Clean. Waste Syst. **12**, 100333 (2025).
[9] A. Naderi, K. Z. Benis, M. Dowlati, H. Seyedin, A. Behnami, M. Farzadkia, Identifying methods and challenges of waste management in natural disasters. J. Environ. Manage. **373**, 123514 (2025).
[10] C. De Wolf, S. Çetin, N. M. P. Bocken (eds.), A circular built environment in the digital age (Springer Int. Publ., Cham, 2024).
[11] M. Geissdoerfer, P. Savaget, N. M. P. Bocken, E. J. Hultink, The circular economy – A new sustainability paradigm? J. Clean. Prod. **143**, 757 (2017).
[12] R. Askar, A. L. Rodrigues, L. Bragança, D. Pinheiro, From temporary to permanent: A circular approach for post-disaster housing reconstruction. IOP Conf. Ser.: Earth Environ. Sci. **225**, 012032 (2019).
[13] B. Byers, D. Bompa, Q. Jin, C. De Wolf, A. Bendiek-Laranjo, Circular economy for post-hazard infrastructure restoration: Strategies for resilience and resource efficiency. Sustainability **1**, 1 (2025).
[14] S. Çetin, J. Kirchherr, The build back circular framework: Circular economy strategies for post-

disaster reconstruction and recovery. Circ. Econ. Sust. **5**, 1689 (2025).

[15] R. Karimi, S. Shirowzhan, S. M. E. Sepasgozar, Architectural design criteria considering the circular economy and buildability for smart disaster relief shelter prototyping. Buildings (2023).

[16] M. Parsaee, T. Abazari, W. Bedwell, M. Goodarzi, E. Harvey, Circular economy in disaster recovery: Life cycle approaches to debris. CIB Conf. **1**, 1 (2025).

[17] P. Pradhananga, M. ElZomor, Revamping sustainability efforts post-disaster by adopting circular economy resilience practices. Sustainability **15**, 15870 (2023).

[18] H. Jalloul, J. Choi, N. Yesiller, D. Manheim, S. Derrible, A systematic approach to identify, characterize, and prioritize the data needs for quantitative sustainable disaster debris management. Resour. Conserv. Recycl. **180**, 106174 (2022).

[19] A. Rathnasinghe, A. Rahubadda, N. Thurairajah, U. Kulatunga, Beyond efficiency: Rethinking off-site construction for post-disaster housing reconstruction, in Proc. 13th World Constr. Symp., (2025).

[20] H. Snyder, Literature review as a research methodology: An overview and guidelines. J. Bus. Res. **104**, 333 (2019).

[21] D. Moher, A. Liberati, J. Tetzlaff, D. G. Altman, T. P. Group, Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. PLOS Med. **6**, e1000097 (2009).

[22] N. Bektaş, Z. Jingjie, Sustainable waste management strategies for earthquake debris: Lessons from the 2008 China and 2023 Türkiye-Syria disasters. Int. J. Disaster Risk Reduct. **116**, 105153 (2025).

[23] J. Xiao, Y. Lu, J. Yu, M. Yu, X. Xiao, S. P. Shah, Post-earthquake construction waste reuse: Advancing green reconstruction and sustainability. Low-Carbon Mater. Green Constr. (2025).

[24] Y. A. Fatimah, R. Murniningsih, A. Setiawan, M. Aman, A smart sustainable approach for waste management in post-natural disaster phase. IOP Conf. Ser.: Mater. Sci. Eng. **674**, 012042 (2019).

[25] T. Shevchenko, S. Çetin, B. Yannou, J. Kirchherr, M. Saidani, A dual circular strategies hierarchy as a guiding framework for post-disaster recovery and reconstruction: Focus on Ukraine. J. Clean. Prod. **524**, 146478 (2025).

[26] A. Moreno-Sierra, M. Pieschacón, A. Khan, The use of recycled plastics for the design of a thermal resilient emergency shelter prototype. Int. J. Disaster Risk Reduct. **50**, 101885 (2020).

[27] M. V. Arnetoli, R. Bologna, Design scenarios for a circular vision of post-disaster temporary settlements. Urban Book Ser. (2023).

[28] G. Montalbano, G. Santi, Sustainability of temporary housing in post-disaster scenarios: A requirement-based design strategy. Buildings **13**, 2952 (2023).

[29] X.-T. Feng, B.-J. He, Sustainability vision for low-carbon, comfortable, inclusive, and recyclable temporary buildings. Energy Build. **328**, 115213 (2025).

methodology: An overview and guidelines, Journal of Business Research **104**, 333 (2019).

[21] D. Moher, A. Liberati, J. Tetzlaff, D. G. Altman, and T. P. Group, Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement, PLOS Medicine **6**, e1000097 (2009).

[22] N. Bektaş and Z. Jingjie, Sustainable waste management strategies for earthquake debris: Lessons from the 2008 China and 2023 Türkiye-Syria disasters, International Journal of Disaster Risk Reduction **116**, 105153 (2025).

[23] J. Xiao, Y. Lu, J. Yu, M. Yu, X. Xiao, and S. P. Shah, Post-earthquake construction waste reuse: advancing green reconstruction and sustainability, Low-Carbon Materials and Green Construction (2025).

[24] Y. A. Fatimah, R. Murniningsih, A. Setiawan, and M. Aman, A Smart Sustainable approach for waste management in post-natural disaster phase, IOP Conference Series: Materials Science and Engineering **674**, 012042 (2019).

[25] T. Shevchenko, S. Çetin, B. Yannou, J. Kirchherr, and M. Saidani, A dual circular strategies hierarchy as a guiding framework for post-disaster recovery and reconstruction: Focus on Ukraine, Journal of Cleaner Production **524**, 146478 (2025).

[26] A. Moreno-Sierra, M. Pieschacón, and A. Khan, The use of recycled plastics for the design of a thermal resilient emergency shelter prototype, International Journal of Disaster Risk Reduction **50**, 101885 (2020).

[27] M. V. Arnetoli and R. Bologna, Design Scenarios for a Circular Vision of Post-disaster Temporary Settlements | SpringerLink, Technological Imagination in the Green and Digital Transition, The Urban Book Series (2023).

[28] G. Montalbano and G. Santi, Sustainability of Temporary Housing in Post-Disaster Scenarios: A Requirement-Based Design Strategy, BUILDINGS-BASEL **13**, 2952 (2023).

[29] X.-T. Feng and B.-J. He, Sustainability vision for low-carbon, comfortable, inclusive, and recyclable temporary buildings, Energy and Buildings **328**, 115213 (2025).