

Digital Transformation and AI Technology: New Driving Forces in E-waste Management


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The global transition toward a circular economy, combined with rapid technological advancement, is fundamentally reshaping the governance and practice of electronic waste (e-waste) management. The 2025 International E-waste Management Network (IEMN) Annual Meeting, held in São Paulo, Brazil from Sept. 15 to 18, highlighted the transformative role of digital technologies and artificial intelligence (AI) in redefining resource recovery systems. The meeting provided a comprehensive analysis of evolving Extended Producer Responsibility (EPR) frameworks and emerging technological applications across Asia and the Americas, with particular emphasis on digital product passports (DPP) and AI-enabled waste sorting systems. It also examined the strategic opportunities for Taiwan to integrate into global “urban mining” supply chains, leveraging its technological capabilities and supportive policy environment.

E-waste has emerged as a critical global challenge due to the rapid shortening of product life cycles and the increasing complexity of electronic devices. Within the broader context of climate governance, resource circulation is recognized as a key pathway to reducing carbon emissions and mitigating environmental risks. However, developing countries often face financial constraints and technological barriers when implementing circular economy strategies. In this regard, the IEMN serves as an important multilateral platform for sharing best practices, facilitating technical cooperation, and transforming waste-related challenges into economic opportunities. The 2025 annual meeting brought together over 60 participants from government, academia, and industry, underscoring the growing international consensus on the integration of digital innovation into e-waste management.

Across Asia, countries exhibit diverse levels of regulatory maturity and institutional capacity in implementing EPR systems. Taiwan represents a leading example, with its well-established “Four-in-One Recycling Program,” which integrates communities, local governments, recycling enterprises, and a central recycling fund. By 2024, Taiwan achieved a recycling rate of 71.1% for e-waste, with over 200,000 tons collected annually. Current policy efforts focus on advancing the Resource

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Circulation Promotion Act and promoting green design incentives, while the development of a digital product passport platform enables comprehensive tracking of material composition and carbon footprints throughout product life cycles.

Other Asian countries are at different stages of transition. Malaysia has developed a relatively robust system for industrial e-waste management, supported by certified recycling facilities and strict control over hazardous waste under the Basel Convention. Meanwhile, countries such as Vietnam, Thailand, and the Philippines are progressing toward more formalized regulatory frameworks. Vietnam has introduced mandatory EPR obligations and source separation requirements under its 2020 Environmental Protection Law. Thailand is in the process of drafting legislation to address the dominance of informal recycling practices, while the Philippines is exploring the establishment of Producer Responsibility Organizations (PROs) to strengthen collection systems in geographically fragmented contexts.

In the Americas, countries demonstrate strong ambition in adopting advanced technologies and experimenting with policy innovations. Brazil, as the host country, showcased a comprehensive governance model anchored in its National Solid Waste Policy and reverse logistics framework. The country has also launched a national AI strategy with a budget of USD 4.2 billion, incorporating environmental sustainability as a key pillar. Recycling industries such as Green Eletron and ABREE illustrated how producer responsibility systems can be scaled nationally while integrating informal waste collectors into formal supply chains. Other countries, including Chile and Colombia, have implemented or expanded EPR frameworks, with Chile setting ambitious recycling targets for solar panels and Colombia regulating a wide range of product categories. In contrast, the United States continues to rely on a decentralized, state-based approach, with growing attention to critical materials recovery and the “Right to Repair” movement.

Technological innovation is increasingly central to improving the efficiency, safety, and transparency of e-waste management systems. AI-enabled automated sorting technologies have demonstrated significant advantages over traditional labor-intensive processes. For example, Taiwan-based AIRECO has developed AI systems trained on synthetic image datasets, enabling 24-hour automated sorting operations that increase efficiency fivefold while reducing labor costs by up to 80%. Similarly, AI-assisted X-ray detection technologies, such as those developed by Visia.ai, enhance the identification of hazardous materials like lithium batteries, thereby improving operational safety and reducing fire risks.

Digital product passport has emerged as a key enabler of global circular supply chains. By integrating information on material composition, carbon emissions, and recycling instructions, DPP system enhances traceability and facilitate cross-border resource circulation. This aligns with global ESG trends and supports data-driven governance in the circular economy. At the same time, advances in urban mining technologies, including low-energy bioleaching processes, offer new pathways for recovering valuable metals from e-waste, particularly in regions lacking large-scale infrastructure.

The findings of the 2025 IEMN meeting suggest that digital technologies and EPR frameworks are becoming the dual engines driving global resource circulation. For Taiwan, this presents a strategic opportunity to expand its role in the international circular economy by exporting advanced recycling technologies and digital solutions. Through continued investment in innovation, policy support, and international collaboration, Taiwan can position itself as a key contributor to the global transition toward sustainable and data-driven e-waste management systems.

Looking forward, the integration of interoperable data systems, capacity-building initiatives, and regional cooperation will be critical to achieving long-term sustainability goals. As digital transformation accelerates, the ability to align technological innovation with regulatory frameworks and market mechanisms will determine the effectiveness of global e-waste governance. Ultimately, the shift from waste management to resource management reflects a broader paradigm change, in which environmental challenges are reframed as opportunities for economic value creation and sustainable development.