

SYSTEMIC STRATEGIES FOR E-WASTE MANAGEMENT IN ADVANCING THE CIRCUCLAR ECONOMY: A COMPREHENSIVE REVIEW

RESUMO

Introdução

The exponential growth of Waste Electrical and Electronic Equipment (WEEE) is a critical global issue, with 62 billion kg generated in 2022. Brazil, South America's largest producer, contributed 2.4 billion kg annually (Baldé et al., 2024). The unsustainable linear model necessitates a shift to a Circular Economy (CE), but this transition is complex due to technological, social, and regulatory interdependencies. This study systematically reviews research applying system approaches to e-waste management within the CE.

Problema de Pesquisa e Objetivo

E-waste generation is rising nearly five times faster than formal recycling capacity. Improper management releases large amounts of hazardous substances each year, including 58,000 kg of mercury and 45 million kg of plastics with brominated flame retardants, posing serious risks to human and environmental health. (Baldé et al., 2024). Given this context, the purpose of this research is to conduct a bibliometric review to map how system approaches have been applied to address e-waste management within a CE framework, identifying key research trends, clusters, and intellectual gaps.

Fundamentação Teórica

The CE transition for the electronics sector is a complex system with feedback loops and non-linear relationships across technological, social, and policy dimensions (Sterman, 2000; Guzzo et al., 2022). This study integrates e-waste management with Circular Economy (CE) principles, like reuse, remanufacturing, and recycling, through the holistic analytical lens of Systems Thinking to develop integrated strategies.

Metodologia

The bibliometric analysis was structured in accordance with the three stages proposed by Tranfield et al. (2003): (1) review planning, (2) review execution, and (3) reporting of results. The analysis used the Web of Science (WoS) database. The search query combined keywords such as ("electronic waste" OR "e-waste"), ("circular economy"), and ("systems thinking" OR "systems approach" OR "system dynamics"). The collected bibliographic data was processed using Biblioshiny to identify publication trends, geographic relevance, and thematic clusters.

Análise e Discussão dos Resultados

Bibliometric findings indicate a clear annual growth in scientific production, with research output accelerating since 2020 (4.47% growth rate). Geographically, country citation analysis reveals China as the most prominent country in e-waste publications. Notably, Brazil ranks 7th among the most cited countries. The analysis also reveals distinct thematic clusters around technology, socioeconomics, and policy, which helps identify critical research gaps between these areas.

Considerações Finais

The bibliometric analysis highlights the growing academic interest in the intersection of e-waste, circular economy, and systems approach, with a marked acceleration in scientific output since 2020. The prominence of China reflects its central role in global research and practice, while Brazil's position among the most cited countries underscores its emerging relevance in this field. The identification of thematic clusters spanning technology, socioeconomics, and policy provides a valuable roadmap for future investigations and guiding the development of effective strategies.

Referências

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Palavras-Chave: e-waste / circular economy / systems thinking