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ACTIVE RECYCLING AGENTS AS CIRCULAR ECONOMY INSTRUMENTS: SYSTEMIC APPROACHES TO SOLID WASTE GOVERNANCE IN BRAZIL

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Introdução
Environmental governance in Brazil is complex, with solid waste management as a “wicked problem” requiring systemic coordination. Active Recycling Agents (ARAs) act as nodes linking waste generators to cooperatives and municipalities, redistributing reusable materials and fostering inclusion. Grounded in General Systems Theory, ARAs enable flows through pairing and ducts but remain informal and underfunded. Their institutionalization via governance networks, accreditation, and digital platforms could strengthen PNRS targets, support SDGs 11, 12, 13, and 17, advancing Brazil’s circular economy.

Contexto Investigado
To meet PNRS goals, Brazil must expand recycling, eliminate landfills, and raise recovery rates. ARAs, framed by General Systems Theory, act as nodes connecting households, cooperatives, and reuse markets, advancing SDG 12 and circular economy income. Despite potential in condominiums and collaborative governance, ARAs remain informal and underfunded, facing systemic bottlenecks from pairing mismatches and weak logistical and informational ducts. The absence of ducts increases entropy, limiting the ARA’s capacity to capture value and prolonging the environmental degradation.

Diagnóstico da Situação-Problema
ARAs act as micro-managers of waste and governance catalysts, fostering partnerships (SDG 17) and linking informal and formal actors. As nodes, they reflect GST principles, reducing friction and enhancing adaptive capacity. Recycling in Brazil is a complex adaptive system where pairing initiates flows, ducts sustain them, and ARAs manage complexity, generate income, and strengthen governance. Formalizing ARAs in policy, with support from governamental programs, can raise efficiency, cut landfill reliance, and advance PNRS goals through matching platforms, last-mile logistics, and governance.

Intervenção Proposta
Solid waste management is a “wicked problem” requiring collaborative governance among public, private, and civil actors. The proposed model, grounded in General Systems Theory, frames household recycling as a complex adaptive system. Key premises stress micro-level sorting (P1), local reuse generating income (P2), and the interplay of major “arteries” (cooperatives, fleets) with capillaries (ARAs) (P3–P4). Household waste is the focus (P5), given its variability (P6). Mathematical model estimates waste generation through demographic, spatial, and socioeconomic factors, with ARAs as a node.

Resultados Obtidos
Household solid waste recycling can be seen as a complex adaptive system under General Systems Theory, where micro-processes interact with systemic “arteries.” ARAs emerge as critical nodes linking households to infrastructures (grounded in GST), reducing friction and enabling adaptive governance. Their institutionalization advances SDGs 11, 12, 13, and 17 by fostering circularity, resilience, and inclusiveness. Mechanisms such as matching platforms, ducts, and multi-level governance strengthen flows, reduce landfill reliance, and accelerate Brazil’s transition to a circular economy.

Contribuição Tecnológica-Social
Brazil and Colombia face weaknesses in waste governance and reliance on informality, though Brazil has PNRS as a broader policy. ARAs emerge as innovations integrating formal and informal systems, acting as collaborative nodes aligned with SDG 17. Their institutionalization, via accreditation, cooperatives, and digital platforms, can strengthen resilience, reduce landfill use, and foster inclusiveness. Proposed mechanisms include digital matching, last-mile logistics, and integration into governance. ARAs directly advance SDGs 11, 12, 13, and 17, vital to Brazil’s circular economy and PNRS.

Palavras Chave
Active Recycling Agents (ARAs), Circular Economy , Solid Waste Governance