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Managing the Electronic Waste of Kuwait by Industrial Symbiosis and Reduce-Reuse-Recycle (3R) Applications

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Abstract

Kuwait faces a critical electronic waste management challenge, with approximately 50,000 tons of e-waste annually unprocessed by existing facilities, leading to environmental degradation and loss of valuable resources. This study develops a comprehensive framework integrating industrial symbiosis and 3R principles to address this capacity gap while creating economic value. Our methodology combined material flow analysis, industrial symbiosis network design, and economic feasibility assessment to identify and quantify resource recovery opportunities. Results revealed that 68.2% of e-waste materials are recoverable, with metal extraction - particularly copper - representing the dominant economic driver, contributing 83.9% of the projected 35,992,415.5 KWD annual revenue. The proposed solution demonstrates strong financial viability with a benefit-cost ratio of 2.01 while establishing circular material exchange networks between e-waste processors and eight local manufacturing industries. This framework provides Kuwait with a sustainable approach to transform e-waste challenges into economic opportunities while addressing environmental concerns through resource recovery and industrial collaboration.

Keywords
Electronic waste management, Industrial symbiosis, 3R framework (Reduce-Reuse-Recycle), Circular economy, Resource recovery, Kuwait

Biographies
Ozgur Uysal received his PhD degree in Industrial Engineering from Marmara University, Istanbul, Turkiye. He is currently working as an Assistant Professor at the American University of the Middle East, Kuwait. His research interests are decision science, supply chain management, occupational health and safety, entrepreneurship and sustainability.

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