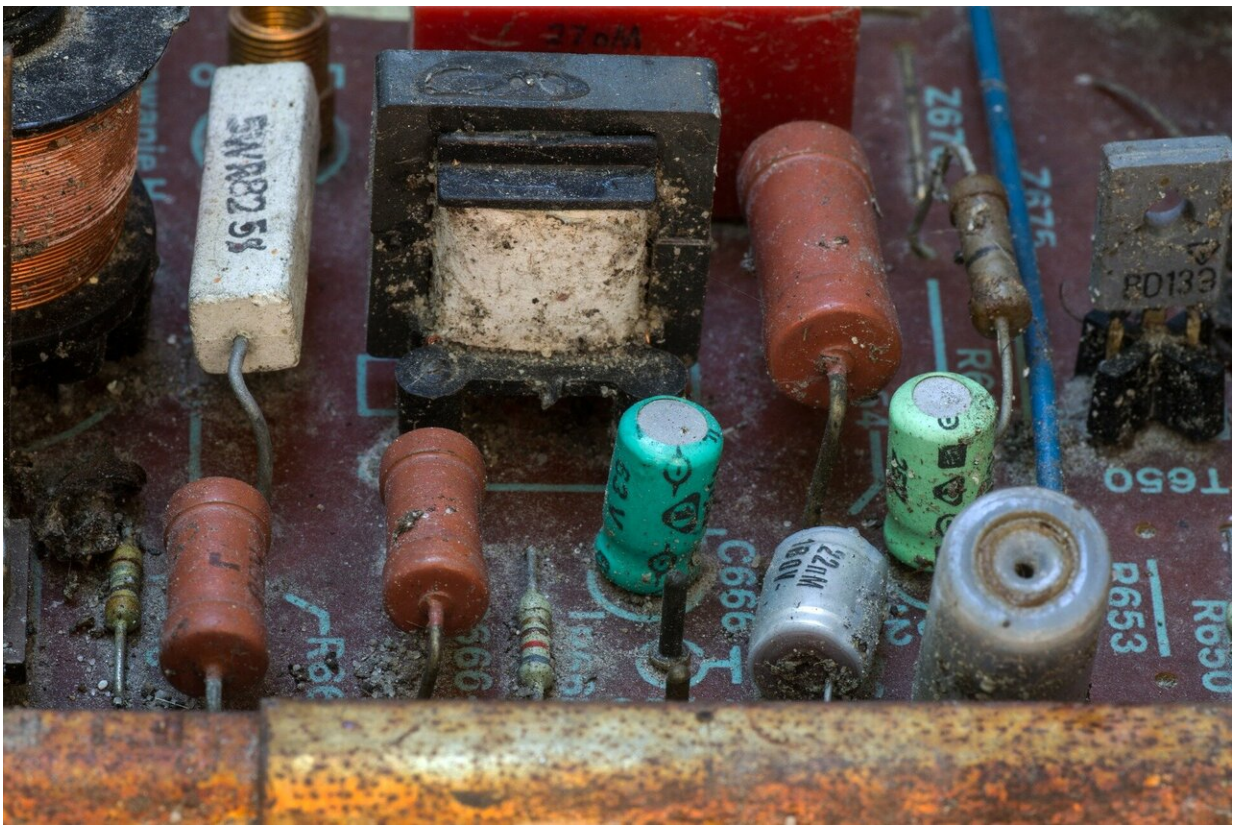
Modeling a circular economy for electronic waste

June 21 2021, by Maggie Pavlick



Credit: CC0 Public Domain

Think about how many different pieces of technology the average household has purchased in the last decade. Phones, TVs, computers, tablets, and game consoles don't last forever, and repairing them is

difficult and often as expensive as simply buying a replacement.

Electronics are integral to modern society, but electronic waste (e-waste) presents a complex and growing challenge in the path toward a circular economy—a more sustainable economic system that focuses on recycling materials and minimizing waste. Adding to the global waste challenge is the prevalence of dishonest recycling practices by companies who claim to be recycling electronics but actually dispose of them by other means, such as in landfills or shipping the waste to other countries.

New research from the Hypothetical Materials Lab at the University of Pittsburgh Swanson School of Engineering develops a framework to understand the choices a recycler has to make and the role that digital fraud prevention could have in preventing dishonest recycling practices.

"Electronics have huge environmental impacts across their life cycle, from mining rare raw materials to the energy-intensive manufacturing, all the way to the complicated e-waste stream," said Christopher Wilmer, the William Kepler Whiteford Faculty Fellow and associate professor of chemical and petroleum engineering, who leads the Hypothetical Materials Lab. "A circular economy model is well-suited to mitigating each of these impacts, but less than 40 percent of e-waste is currently estimated to be reused or recycled. If our technology is going to be sustainable, it's important that we understand the barriers to e-waste recycling."

Some U.S. firms that have touted safe, ethical and green recycling practices never actually recycle much of what they receive; instead, their e-waste was illegally stockpiled, abandoned or exported. Between 2014 and 2016, the Basel Action Network used GPS trackers in electronics delivered to U.S. recyclers, showing that 30 percent of the products ended up overseas.

The researchers developed a model framework that analyzes dishonest end-of-life electronics management and what leads recyclers to pursue fraudulent activities. They find that the primary way to ensure an e-waste recycler will engage in honest practices with minimum supervision is to make it the more profitable option, either by decreasing the costs of recycling or increasing the penalties for fraudulent practices.

"The main barrier to honest recycling is its cost," said lead author Daniel Salmon, a graduate student in the Department of Electrical and Computer Engineering. "One of our main findings is that if we find a way to make it more profitable for companies to recycle, we will have less dishonest recycling. Targeted subsidies, higher penalties for fraud and manufacturers ensuring their electronics are more easily recyclable are all things that could potentially solve this problem."

The researchers also suggest the use of the blockchain as neutral, third-party supervision to avoid fraudulent recycling practices.

"Our model mentions the influence of monitoring and supervision, but self-reporting by companies enables dishonesty. On the other hand, something like the blockchain does not," said Wilmer, who founded Ledger, the first peer-reviewed scholarly journal dedicated to blockchain and cryptocurrency. "Relying on an immutable record may be one solution to prevent fraud and align behaviors across recyclers toward a circular economy."

The work is part of a larger NSF-funded convergence research project on the circular economy, which is led by Melissa Bilec, deputy director of the Mascaro Center, associate professor of civil and environmental engineering, and Roberta A. Luxbacher Faculty Fellow at Pitt.

More information: Daniel Salmon et al, A framework for modeling fraud in E-waste management, *Resources, Conservation and Recycling*

(2021). DOI: 10.1016/j.resconrec.2021.105613

Provided by University of Pittsburgh