An Empirical Study on the Disposal and Acquisition of Second-Hand Products

LORENA M. FORTUNA, PHD CANDIDATE
VASIL DIYAMANDOGLU, PHD, ASSISTANT PROFESSOR

DEPARTMENT OF CIVIL ENGINEERING
GROVE SCHOOL OF ENGINEERING
THE CITY COLLEGE OF NEW YORK

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Advancement in Solid Waste Management

- Waste is seen as resource
- New concept for materials management: Zero waste
- General goals:
  - Increase resource recovery
  - Little or no resource disposal
  - Sustainable materials management
- Promotion of alternative processes that have the capacity to increase resource recovery
Product Reuse

- Flea Markets
- Thrift Stores
- Collection Bins
- Building materials reuse stores
Product Reuse

Online Platforms

Materials Exchanges
Motivation

- Product reuse has the potential to promote waste prevention by increasing recovery of products.

- The promotion of reuse requires understanding household practices of disposal and acquisition of second-hand products.
The main goals of the study were to identify

• preferred methods to discard and acquire second-hand products:
  • How products are disposed of and how are they acquired?
  • How are products transported?
  • How far do they travel?
• associations between the disposal and acquisition practices of second-hand products;
Research methods

- Three surveys covering one type of commonly reused product:
  - Books
  - Clothing
  - Furniture

- Surveys were conducted using the Amazon Mechanical Turk ("MTurk") online outsourcing platform where pre-registered users perform tasks posted on the website
Research methods

• 17 questions, collecting data on:
  ◦ Demographics (age, gender, education, income, household size)
  ◦ Duration of ownership
  ◦ Reuse potential
  ◦ Methods used for discarding and acquiring products
  ◦ Distance traveled and type of vehicle used

• Chi-square tests were conducted to investigate associations
Demographics

- Number of participants: 564 (books), 559 (clothing), and 575 (furniture)
Disposal Methods

- Sold or donated via a material exchange.
- Sold or donated via online classifieds.
- Sold or donated via word of mouth to a friend, acquaintance or...
- Donated to a thrift shop.
- Discarded the item in a collection bin for second-hand products.
- Recycled via curbside recycling program.
- Sold on yard sale or swap event.
- Discarded as waste to be collected by the garbage truck.
- Returned to municipality during a special collection.
- Returned to retailer. Or manufacturer.
- Discarded as waste to be collected by the garbage truck.
- Storage off-site.
- Other.

Clothing (N = 514)
Book (N = 495)
Furniture (N = 557)
Disposal: Method of transportation

- Private car
- Rental car or van
- Public transportation
- Cab/taxi
- Trash or recycler truck
- Other.

- Books and Clothing sold/donated online
- Furniture sold/donated online

Percent of total respondents

Clothing (N = 514)
Books (N = 495)
Furniture (N = 557)
Acquisition Methods

- At a thrift store, vintage shop.
- At a street fair, garage sale, swap event.
- Online.
- From a friend, acquaintance or neighbor.
- Other

Percent of total respondents

Clothing (N = 486)
Books (N = 543)
Furniture (N = 542)
Acquisition: Method of transportation

- **Private car**: High usage for acquiring various items.
- **Mail carrier**: Moderate usage for acquiring books online.
- **Public transportation**: Usage for acquiring books and clothing in street fairs.
- **Rental car or van**: Usage for acquiring furniture.
- **Other**: Low usage for acquiring various items.

**Percent of total respondents**
Acquisition: Distance traveled

- Distance traveled (miles)
- Acquisition methods
- Friend/Family
- Online classifieds
- Street fair/Swap Event
- Thrift Store

Clothing
Furniture
Books
Association between acquisition and disposal

- Associations observed:
  - Books exchanged via friends or acquaintances
  - Clothing exchanged via thrift shops
  - Furniture exchanged online
Conclusions

• Tendency of people to choose disposal methods that are convenient and require low effort on their part

• The size and weight of products will impact the selected disposal method

• The existence of preferred disposal and acquisition methods for second-hand products can be explored to improve recovery of products from the waste stream

• Characterization of disposal methods can be applied to quantify the benefits of product reuse
Model to optimize emissions from solid waste management including flow due to product reuse

\[ E(M, EF, d)_{\text{min}} = \sum (EF_{x,y} \cdot d_{x,y} \cdot M_{x,y}) + E_{de} + E_{op} + E_{me} + E_{re} + E_{rec} + E_{land} + E_{inc} \]

- \( EF_{x,y} \): emission factors due transportation from process \( x \) to \( y \)
- \( d_{x,y} \): distance between processes \( x \) and \( y \)
- \( M_{x,y} \): mass of products transported
- \( E_{rec} \), \( E_{land} \), \( E_{inc} \): emissions for recycling, landfilling and incineration
- \( E_{de} \), \( E_{op} \), \( E_{me} \), \( E_{re} \): emissions for reuse processes

Emissions associated with transportation

Emissions associated with processes
Emissions of Reuse Processes

\[ E_{de} = DR \cdot EF_{prod} \cdot M_{de} \]
\[ E_{op} = DR \cdot EF_{prod} \cdot M_{op} \]
\[ E_{me} = DR \cdot EF_{prod} \cdot M_{me} \]
\[ E_{re} = (DR \cdot EF_{prod} + EF_{re}) \cdot M_{re} \]

- \( EF_{prod} \): emission factor for the manufacture of new products. \( EF_{prod} < 0 \)
- \( DR \): displacement rate describes the amount of products substituted by reuse. Typically, \( 0 < DR < 1 \)
Simulate waste diversion goals

- Compare emissions for different diversion goals:
  - Zero waste
    \[ M_{\text{land}} + M_{\text{inc}} \leq 0.05 \ M_0 \]
  - Waste prevention
    \[ M_r + M_{\text{rec}} \geq 0.50 \ M_0 \]

Where:
- \( M_r \): Mass diverted to reuse
- \( M_{\text{rec}} \): Mass diverted to recycling
- \( M_0 \): Initial mass
- \( M_{\text{land}} \): Mass diverted to landfill
- \( M_{\text{inc}} \): Mass diverted to incineration
Model Application

- Textiles, 100% cotton
- Initial mass = 1,000kg
- DR = 0.50
Model Application

Emissions of CO2 equivalent (kg)

-4,000 -3,500 -3,000 -2,500 -2,000 -1,500 -1,000 -500 0

Zero Waste  Waste Prevention  Business-As-Usual

Reduction in Emissions
Next steps

- Apply the model to different municipalities
- Investigation of low impacting reuse routes
Questions?

Contact:
Lorena Fortuna
lorenasfm@gmail.com