Improving product recovery decisions through enhanced product information

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Overview

- Introduction to the problem
- Linking product information with product recovery decisions
- Enhancing product information with “networked RFID”
- Improving product recovery decisions with enhanced product information
- Conclusions
The Problem

Government Regulations
- WEEE Directive
- RoHS Directive

Other financial benefits...
WHAT CAN BE DONE?

• Recycle
  – Not cost-effective
  – Not environment-friendly

• Refurbish/Reuse
  – Desired option
  – Problem: Information availability
Research Question

How does ready availability of product information affect the effectiveness of product recovery decisions?

How can we quantify the impact of information availability on product recovery decisions?
Case Studies

• 12 companies
  – 3 computer remanufacturers
  – 3 photocopier remanufacturers
  – 1 phone remanufacturer
  – 3 computer dismantlers
  – 2 white goods recyclers
PRODUCT RECOVERY OPERATIONS
INFORMATION REQUIREMENTS

• Current specifications (‘Decision enablers’)  
  – Material content  
  – Original specifications  
  – Later modifications

• Residual life (‘Decision verifiers’)  
  – Reliability  
  – Age  
  – Usage  
  – Maintenance  
  – Current condition
**INFORMATION “LOSS”**

Information associated with product:
- High: Production, Retail
- Low: Usage, Remanufacture, Resale, Disposal

Examples:
- Aero engines, Caterpillar, ...
- Photocopiers, Automobiles, ...
- Toasters, Blenders, ...

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Product Identification

- Access to Manufacturer Logs
- Product History
- Inspection & Testing
- "Expert" knowledge
- No information collected

Percentage of companies

- Recycling/Dismantling
- Remanufacturing
# INFORMATION AVAILABILITY

<table>
<thead>
<tr>
<th>Information Required</th>
<th>Pre-sorting</th>
<th>Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material content</td>
<td>✗</td>
<td>depending on access to design data</td>
</tr>
<tr>
<td>Original specification</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Later modifications</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Reliability</td>
<td>✗</td>
<td>depending on access to design data</td>
</tr>
<tr>
<td>Age</td>
<td>✗</td>
<td>depending on access to sales &amp; maintenance data</td>
</tr>
<tr>
<td>Current condition</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Usage</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Maintenance</td>
<td>✗</td>
<td>depending on the availability &amp; accuracy of maintenance logs</td>
</tr>
</tbody>
</table>
LINKING PRODUCT RECOVERY DECISIONS TO INFORMATION QUALITY

• Uniqueness
  – to enable individual information trails for each unique object throughout its lifecycle and across the whole supply chain.
**Linking Product Recovery Decisions to Information Quality**

- **Timeliness**
  - to ensure that information is readily available for decision-making and execution process with minimal need for manual inspection or testing.
Linking Product Recovery Decisions to Information Quality

- **Completeness**
  - to ensure that all relevant information is available for optimising decisions.

- **Accuracy**
  - to reduce or eliminate inaccurate representations of current and historical product information.
A NETWORKED RFID SOLUTION FOR PLM
EPC™ Network Technology
Building Blocks
**Information Quality <-> EPC**

- **Uniqueness**
  - Enable unique product “footprint” \(\rightarrow\) EPC

- **Completeness**
  - Ensure availability of relevant product info \(\rightarrow\) EPCIS/ONS/XML

- **Timeliness**
  - Ensure “ready” availability of product info \(\rightarrow\) RFID/Filtering

- **Accuracy**
  - Reduce/eliminate errors in info management \(\rightarrow\) RFID/XML
NETWORKED RFID FOR PLM
NETWORKED RFID FOR PLM

EPCIS Discovery Service

Date of manufacture
Parts/ materials used
(Dis)assembly recipe

Date of sale
Warranty details
Parts replaced

Usage/Maintenance

End-of-Life

Manufacture

Retail
NETWORKED RFID FOR PLM

Networked RFID for PLM

EPCIS Discovery Service

EPCIS - Date of manufacture
- Parts/ materials used
- (Dis)assembly recipe

EPCIS - Date of sale
- Warranty details
- Parts replaced

EPCIS - On-board data
- Usage history
- Parts installed

EPCIS - Manufacturing

EPCIS - Retail

EPCIS - Usage/Maintenance

EPCIS - End-of-Life

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NETWORKED RFID FOR PLM

Date of manufacture
Parts/ materials used
(Dis)assembly recipe

Date of sale
Warranty details
Parts replaced

On-board data
Usage history
Parts installed

Parts/materials identified
Disassembly history

Manufacture
Retail
Usage/Maintenance
End-of-Life

EPCIS Discovery Service
NETWORKED RFID FOR PLM

1. EPC xyz
   “Where can I find information about EPC xyz?”

ONS

EPCIS Discovery Service

2. “Tell me which part was replaced”

EPC xyz

“100 GB HDD”

EPCIS

Date of manufacture
Parts/ materials used
(Dis)assembly recipe

EPCIS

Date of sale
Warranty details
Parts replaced

EPCIS

On-board data
Usage history
Parts installed

EPCIS

Parts/materials identified
Disassembly history

EPCIS

Manufacture

Retail

Usage/Maintenance

End-of-Life
RFID-enabled Product recovery

- Book-in
- Inspection
- Testing

- Functional Condition
- Usage Rate
- Age
- Current Specifications
- Original Specifications
- Model
- Brand
- Product Type
- History Logs
- EPCIS or Component-level tagging
- EPCIS or Sensor Data

Manual | Barcode | RFID

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A Bayesian Product Recovery Decision Model

Utility of a decision = \( f(\text{certainty, payoff}) \)
EPC ENHANCED PRODUCT RECOVERY DECISIONS

Information

Test 1 Test 2 Test 3 Test 4

Higher Utility

Quicker decisions

Certainty

Utility (t)

Payoff

Time

EPC enabled information

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AUTO-ID LABS
CONCLUSIONS

• Process improvements
  – Quick and possibly automated identification & sorting
  – Error reduction

• Decision improvements
  – Better estimation of residual life and value
  – Better estimation of recyclable material content
  – Rich information leads to better decisions
Thank You

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