CIRCULARITY IN THE PLASTIC AND PACKAGING INDUSTRY

Malou van der Vegt
3rd of October 2022
INTRODUCTION: MALOU VAN DER VEGT

BACKGROUND
• Industrial Design Engineering
• Sustainable Packaging Design

LECTURER
• Industrial Engineering and Management

RESEARCHER
• Centre of expertise Smart Sustainable Cities
INTRODUCTION: MALOU VAN DER VEGT

1. Workshops
   barriers & enablers for recycled plastic

2. Case studies
   good practices
   circular economy
   business models

3. Case studies
   business support
   redesigning products
   with recycled plastic

4. CE roadmap
   plastic roadmap for
   IEM and AM
• Why do we use plastic?
• Why do we use packaging?
• Options for sustainable polymers
  • Recycling
  • Bioplastics
• Recycling or bioplastics? – what is better?
• Circularity
• Material & value flows
• Case study approach
SUSTAINABILITY
SUSTAINABILITY

Sustainable Development = "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

- Brundtland report, 1987
‘PLASTIC SOUP’
‘METAL SOUP’
WHY DO WE USE PLASTIC?

• Convenience: light-weight, fast to manufacture
• Attractive: transparant, many shapes
• Cheap

Can we go without plastic?
DILEMMA: PLASTIC SLEEVE AROUND CUCUMBER?

PRODUCT <> PACKAGING

Packaging is 10% of environmental impact, cucumber is remaining 90%
WHY DO WE USE PACKAGING?

FUNCTIONS OF PACKAGING

1. To protect & preserve
2. To distribute
3. To inform

Source: Ten Klooster, 2008
WHY DO WE USE PACKAGING?

SUSTAINABLE OPTION DEPENDS ON:

• Product

• Context

• Use

BUT: There is not one most sustainable packaging solution
DILEMMA: PLASTIC SLEEVE AROUND CUCUMBER?

CHOOSING PLASTIC SLEEVE:
- Substantiate choices as company
- ‘Recyclable’ packaging
- State disposal options on label
WHY DO WE USE PLASTIC?

• Convenience: light-weight, fast to manufacture
• Attractive: transparent, many shapes
• Cheap

But also:
• Shelf-life
• Hygiene
• Safety

Can we go without plastic?
SUSTAINABLE POLYMERS – WHICH OPTIONS?

- Recycling
- Bioplastics
- Circularity
SUSTAINABLE POLYMERS – WHICH OPTIONS?

- RECYCLING
- BIOPOLYMERS
- CIRCULARITY
SUSTAINABLE POLYMERS – WHICH OPTIONS?

RECYCLING

MECHANICAL RECYCLING
CHEMICAL RECYCLING
INDUSTRIAL RECYCLED MATERIALS
POST-CONSUMER RECYCLED MATERIALS
DESIGN FOR RECYCLING
Only PET-bottles from the deposit-return system can be reused for food applications.

Source: van der Vegt, 2020
The term *recyclable* does not necessarily mean that the material is also recycled in industry. It must also be correctly collected, sorted and reprocessed.

- A separate stream is needed *(enough volume)*
- Correct sorting should be possible *(technologies)*
- There should be application possibilities *(market)*
- There must be an economic value *(good quality)*.

**PLASTIC WASTE**

- **Limited recyclability (technologies): 19%**
- **Limited recyclability (contaminations): 24%**
- **Poor sortability (design): 13%**

**PLASTIC RECYCLING**

- **Not recyclable: 1%**

**Low quality (mix plastics): 17%**
PLASTIC RECYCLING

RECYCLING

DOWNCYCLING

UPCYCLING
EXAMPLE: LOW-QUALITY MATERIALS (SAVE PLASTICS)

- Low quality mix plastics
- Reliable stream & lower prices
- High contaminations
PLASTIC RECYCLING – NEW TECHNOLOGIES

- Barcode scanning
- Chemical recycling
- Plastic scanner
- Material passport

Toepassen van barcode scanning in recycle proces

Plastic scanner ‘scant’ materiaal van product
PLASTIC RECYCLING - MATERIAL RECOVERY

3D-print afval – granulaat – recyclaat printen
GREENWASHING

...ze bestaan voor 35 procent uit plastic en die hoeveelheid plastic is...
PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

METHOD: 1) FOCUS GROUPS

8 focus groups  |  81 people  |  74 organisations
PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

METHOD: 2) MAPPING FACTORS
PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

METHOD: 3) CATEGORISATION

1. Barrier, enabler or both
2. Position in value chain
3. Regulatory, technical, systemic, organisational, cultural

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<th>Position in supply chain</th>
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PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

RESULTS: 1) BARRIERS & ENABLERS

REGULATORY
Lack of clear policies and (stimulating) regulations

ECONOMIC
Price differences between virgin & recycled

TECHNICAL
Lower material quality & uncertainties about quality

SYSTEMIC
Availability and reliable stream of recyclate (from sufficient quality)

ORGANISATIONAL
Lack of short-term goals

CULTURAL
Lack of consumer demand/willingness & lack of knowledge

Source: Van der Vegt et al., 2022
EXAMPLE: OUTDOOR FURNITURE (KETER)

- Over 40% recycled materials
- Communicate about use
- Take recycled materials into account from start
- Use imperfections (include or hide)
PLASTIC RECYCLING – INCREASING UPTAKE IN INDUSTRY

Source: Van der Vegt et al., 2022
SUSTAINABLE POLYMERS – WHICH OPTIONS?

- Recycling
- Bioplastics
- Circularity
SUSTAINABLE POLYMERS – WHICH OPTIONS?

BIOPOLYMERS

- BIOBASED PLASTIC
- BIODEGRADABLE PLASTIC
- BIOBASED COMPOSITES
**BIOPLASTICS – BIOBASED VS. BIODEGRADABLE**

Biobased: the material is obtained from biomass (plants, e.g. sugar cane, maize, starch). This is about the origin of the material.

Biodegradable: the material breaks down under specific conditions. This is about what happens to the material at end-of-life.

**Biobased ≠ Biodegradable**
Bioplastics are also considered plastic in the EU. That is why, just like conventional plastic, these are prohibited in products under the SUP directive (including cutlery, plates, cotton swabs, etc.)
Problems with biodegradable packaging:

- Degradation under specific conditions
- No solution for pollution
- Converted into CO₂, water, and methane:
  - Little biomass
  - Material disappears from the value chain
- Recycling or incineration yields more energy
- Degradation time is too long for composters (3-4 weeks vs. 12 weeks)
- Labels confuse consumers
- Misunderstandings regarding plastic, biobased, biodegradable
- Problems for plastic recycling process:
  - Possible rejection of whole batch

There are options for using biodegradable plastics if the packaging still contains organic material (e.g. coffee capsules, tea bags, organic waste bags) or, for example, on a product (sticker on banana peel). Other options are, for example, catering or airplane meals, where the packaging can be thrown away together with the food residues.
BIOPLASTICS – BIOCOMPOSITES

Only ‘recyclable’ if:

• Separate stream
• Or large enough volumes

**Biocomposite**: composite of two materials, often plastic is mixed with a fiber (e.g. wood, hemp), of which one or both are biobased.
EXAMPLE: BIOBASED MATERIALS

Bio-PE is recyclable with fossil-based PE.
EDIBLE SIX PACK RING

SALTWATER BREWERY CREATES EDIBLE SIX-PACK RINGS.
SUSTAINABLE POLYMERS – WHICH OPTIONS?

Which option is better?

- RECYCLING
- BIOPLASTICS
- CIRCULARITY
DILEMMA: BOTTLING OF WATER
LINEAR ECONOMY

Source: Velzing et al., 2021
RESULT

BUT: Still single-use

DEPLETION

POLLUTION

Source: Velzing et al., 2021
Earth Overshoot Day 2021 fell on July 29.
SUSTAINABLE POLYMERS – WHICH OPTIONS?

- Recycling
- Bioplastics
- Circularity
SUSTAINABLE POLYMERS – WHICH OPTIONS?

- Recycling
- Bioplastics
- Circularity
CIRCULARITY - CIRCULAR ECONOMY

Source: Velzing et al., 2021
LINEAR VS. RECYCLING VS. CIRCULAR ECONOMY

**LINEAR ECONOMY**
- Take
  - Make
    - Use
      - Waste

**RECYCLING ECONOMY**
- Take
  - Make
  - Recycle
    - Use
      - Waste

**CIRCULAR ECONOMY**
- Take
  - Make
  - Recycle
  - Use
    - Return
      - Repair
      - Reuse
CIRCULARITY - VALUE HILL

LINEAR ECONOMY

CIRCULAR ECONOMY

Source: Achterberg, Hinfelaar & Bocken, 2016
CIRCULARITY - CIRCULAR STRATEGIES

Source: PBL, 2015

Source: Van der Vegt et al., 2021
EXAMPLE: BOTTLING OF WATER
EXAMPLE: BOTTLING OF WATER
SUSTAINABLE POLYMERS – WHICH OPTIONS?

CIRCULARITY

- Resource Recovery
- Product Take-Back
- Reuse
- Product As-A-Service
- Design for Circularity
Mitsubishi liften worden geleverd met een materialen paspoort

Producten van 10XL worden geleverd met een materialen paspoort
Het aanbieden van ‘inzameldagen’ om producten terug te nemen (Keter)

Op de producten van 10XL zit ‘statiegeld’. Dit geldt krijgen bedrijven terug bij inname.
CIRCULARITY - REUSE

Refill van bierflesje

Reuse van bierkratje

Eten dat wordt besteld via DeliverZero komt in een herbruikbare verpakking (Ozarka)
CIRCULARITY - PRODUCT AS-A-SERVICE (ACCESS)

Huren van wasmachine

Huren van koptelefoon

Abonnement op kunstbloemen
CIRCULARITY - DESIGN FOR CIRCULARITY

• Design for disassembly
• Design for recycling
• Design for durability and performance
• Design for standardisation
• Less material usage
HOW DO YOU MAKE SUSTAINABILITY CHOICES?

Improving one aspect should not make things worse for another.
MATERIAL & VALUE FLOW MAP

RESOURCE SUPPLIER ➔ MANUFACTURER ➔ WHOLESALER/RETAILER ➔ END USER

linear material flow  
value flow
EXAMPLE: CIRCULAR (?) OFFICE CHAIR

Coil → Metal parts → Assembly → Wholesale → Office/Home → Factory

Plastic granulate → Plastic parts → Weaving → Fabric
EXAMPLE: HAVAL

Products designed with as little material as possible

Circular reusable containers, designed to last long
MATERIAL & VALUE FLOW MAPPING – WHY?

Source: Procelijn, 2017

Source: Konietzko, 2017
MATERIAL & VALUE FLOW MAPPING – **WHY?**

- Provides an **overview of the complete value chain**
  - Not just a focus on ‘visible impact’: materials, or usage

- A way to **explore opportunities for circularity** with other stakeholders
  - Not just focus on circularity within company

- Shows **where in the chain problems** may arise
  - To check whether a certain change also (negatively) affects other parts of the chain
CASE STUDY METHOD CIRCULAR BUSINESS MODELS

1. Circularity of the business model
2. Circularity in the chain
3. Circularity of operational process
CASE STUDY METHOD

1) CIRCULARITY OF BUSINESS MODEL
CASE STUDY METHOD
1) CIRCULARITY OF BUSINESS MODEL

- Focus on circularity
- Includes return flows
- Not only customers, but also end-users
- End-of-life of products
- Context: regulations & trends
- Positive & negative impacts on environment and society

Source: van der Vegt et al. 2021
CASE STUDY METHOD

2) CIRCULARITY IN THE CHAIN

Source: van der Vegt et al. 2021
CASE STUDY METHOD

3) CIRCULARITY OF OPERATIONAL PROCESS
CASE STUDY METHOD

3) CIRCULARITY OF OPERATIONAL PROCESS

Source: van der Vegte et al. 2021
EXAMPLE: OZARKA – CIRCULAR BUSINESS MODEL

POLICIES & REGULATIONS
- No concrete regulations for SUP takeaway disposables
- Not looking for a top-down approach

TRENDS
- Covid-19: no catered events, increase in takeaway
- Increasing market of restaurant and takeaways
- Consumer interests in less waste and responsible packaging
- Competitors have product mind-set

KEY RESOURCES
- Products:
  - PP clamshells or PP Mepal designs
  - Silicone containers
  - Glass base, PP lid
  - Tailored for customers
  - One cleaning facility
  - Food order platform
  - Vehicles for transport

LOCK ACTIVITIES
- Distribution, warehousing
- Acquisition
- Washing & sanitising
- Working with partners for design, production & food order platform
- (further) developing concept & BMS

VALUE PROPOSITION
- Reusable containers replacing SUP disposables
- Reuse containers in their original manufactured state
- Zero or reduced waste
- Three solutions:
  - Reusables as a service (B2B)
  - DeliverZero (B2C)
  - ARK Reusables (B2B)
- Service concept rather than product offering

CUSTOMERS & USERS
- Prepared food industry
- Restaurants, takeaways
- Caterers for events
- Hotels, chain restaurants
- Large & small customers
- Looking for responsible packaging

KEY PARTNERS
- Three independent contractors
- Different manufacturers or local distributors
- Collaborations with many others

DISTRIBUTION
- Arrangements for drop offs & pick-ups
- Amsterdam area
- Reusables as a service: redistribution of containers after usage and cleaning

END-OF-USE
- Reuse dozens of times, theoretically up to 1000 times
- Broken or damaged pieces are collected at end-of-life
- Ozarka takes full responsibility for recycling

COSTS & REVENUES
- Investments higher than revenues (start-up)
- Preliminary work comes with more upfront costs

POSITIVE IMPACTS
- Zero waste (or as low as possible)
- Taking responsibility for waste at EOL

NEGATIVE IMPACTS
- Water and energy usage for cleaning
- Transportation

Ózarka
EXAMPLE: OZARKA – CIRCULARITY IN THE CHAIN
EXAMPLE: OZARKA – CIRCULARITY IN THE CHAIN
EXAMPLE: OZARKA – OPERATIONAL CIRCULARITY
PLASTIC FANTASTIC TRUCK TOUR

• Tuesday 11th of October
• 11.30 - 15.30 hr
• HL7, back-side (Cambridgelaan)