

# Decision support for life cycle design of food and packaging

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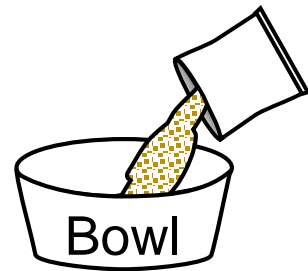
# Food and packaging

- ▷ Packaging has a lot of functions; productivity, safety, display, usability, ...
  - E.g., **instant soup products**

Packaging

Packet

Cup



Function

Low-grade <

**High-grade**

Cup is used as a bowl.

Material use

**Light** >

Heavy

**Trade-off**

Supporting a decision for life cycle design is needed.

# Objective

Support a decision for life cycle design of food and packaging.

## Strategy

- ▷ Visualize environmental impacts with product functions.
- ▷ Visualize the relations between functions and design parameters in life cycle.

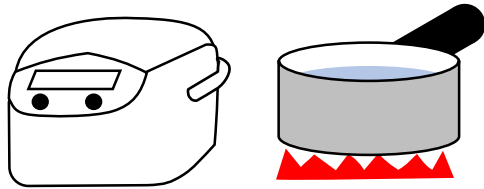
## Case study

- ▷ Two types of pre-cooked rice

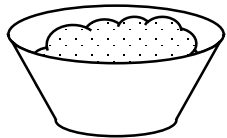


# What is pre-cooked rice?

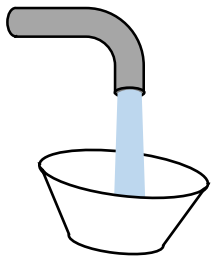
## ▷ Rice



Cooking  
30-60 min.



Consumption

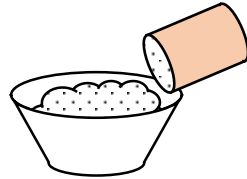


Washing

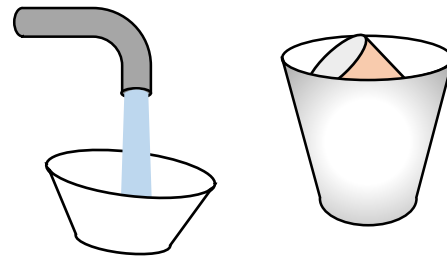
## ▷ Pre-cooked rice (pouch & tray)



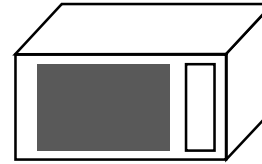
Pouch



Consumption



Washing & disposal



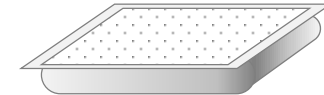
Heating  
2-3 min.

Saving time

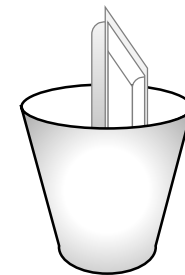
Tray



Use as a bowl

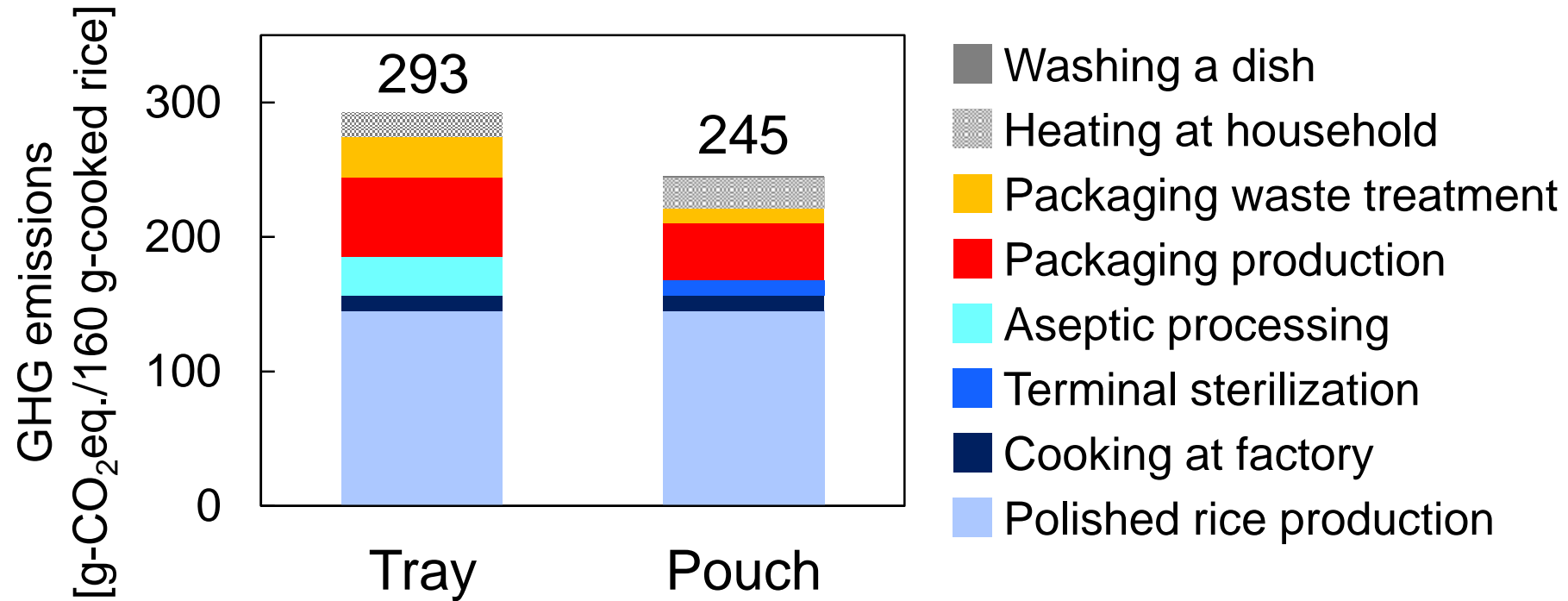


Consumption



Disposal

# LCA of pre-cooked rice



▷ The results based on ISO-LCA indicate the differences of **environmental impacts**.



Gap between the results and decisions.

▷ Makers manufacture a product to make the differences of **functions**.

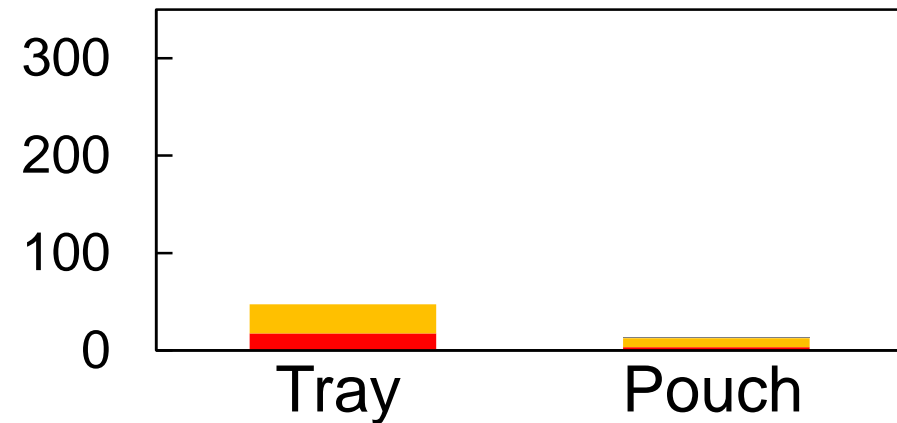
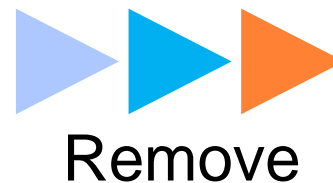
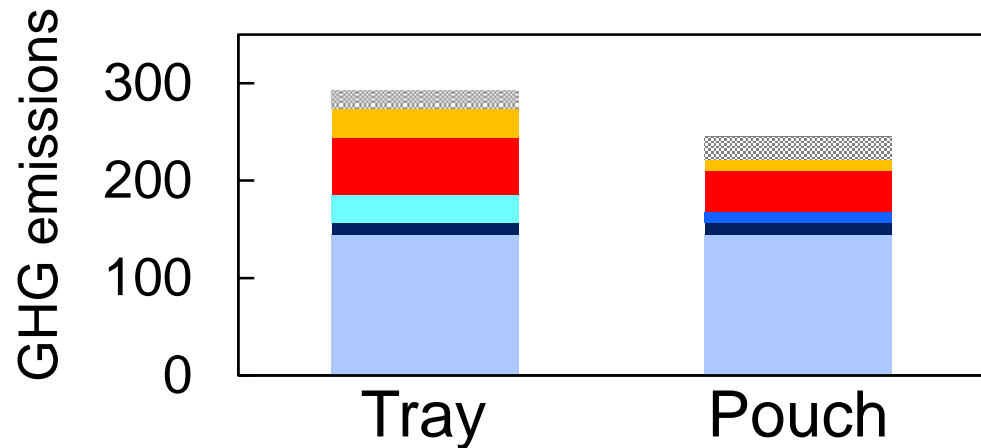
▷ Consumers select a product based on the differences of **functions**.



# Why the emissions occur?

▷ Functionality evaluation: allocation of the emissions to functions.

Focus: use as a bowl



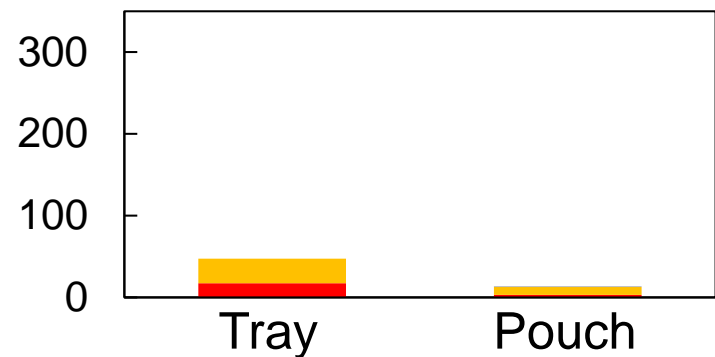
- Washing a dish
- Heating at household
- Packaging waste treatment
- Packaging production
- Aseptic processing
- Terminal sterilization
- Cooking at factory
- Polished rice production

Food protection: sterility assurance & barrier materials

Saving cooking time at household

Baseline of cooked rice

# Functionality evaluation method



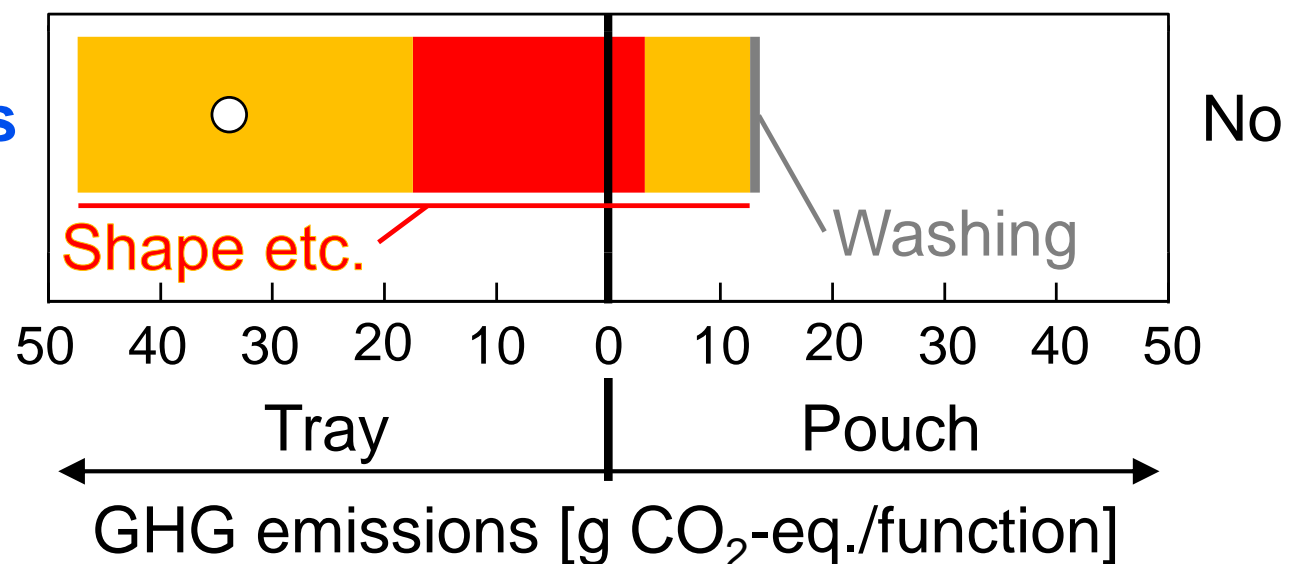
- Packaging production
- Packaging waste treatment
- Consumption



Yes

Function: **use as a bowl**

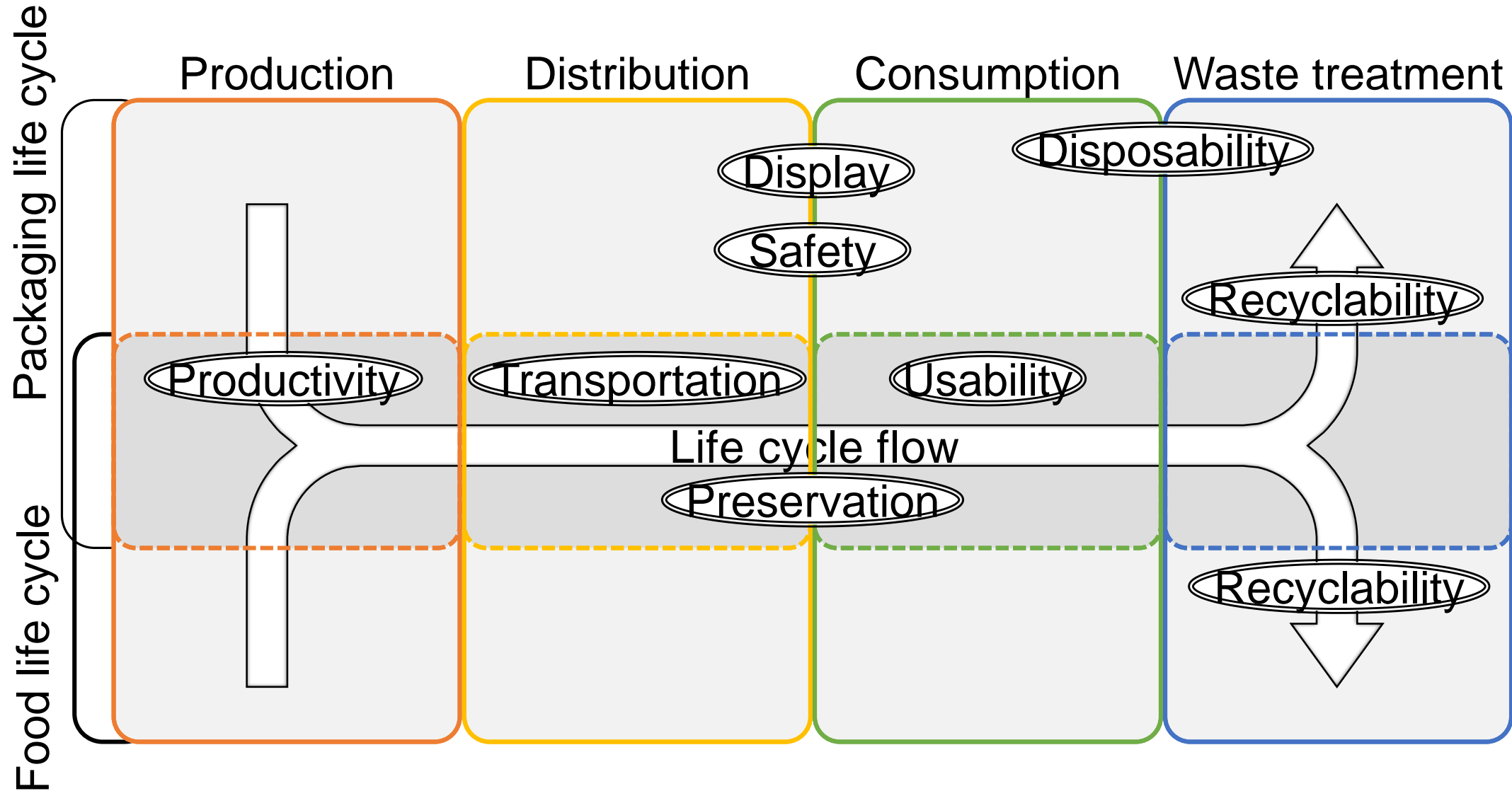
○ Environmental impacts of the function



Visualize the environmental impacts with the function.

# Functions in life cycle

- ▷ Functions provide the benefits in life cycle stages.

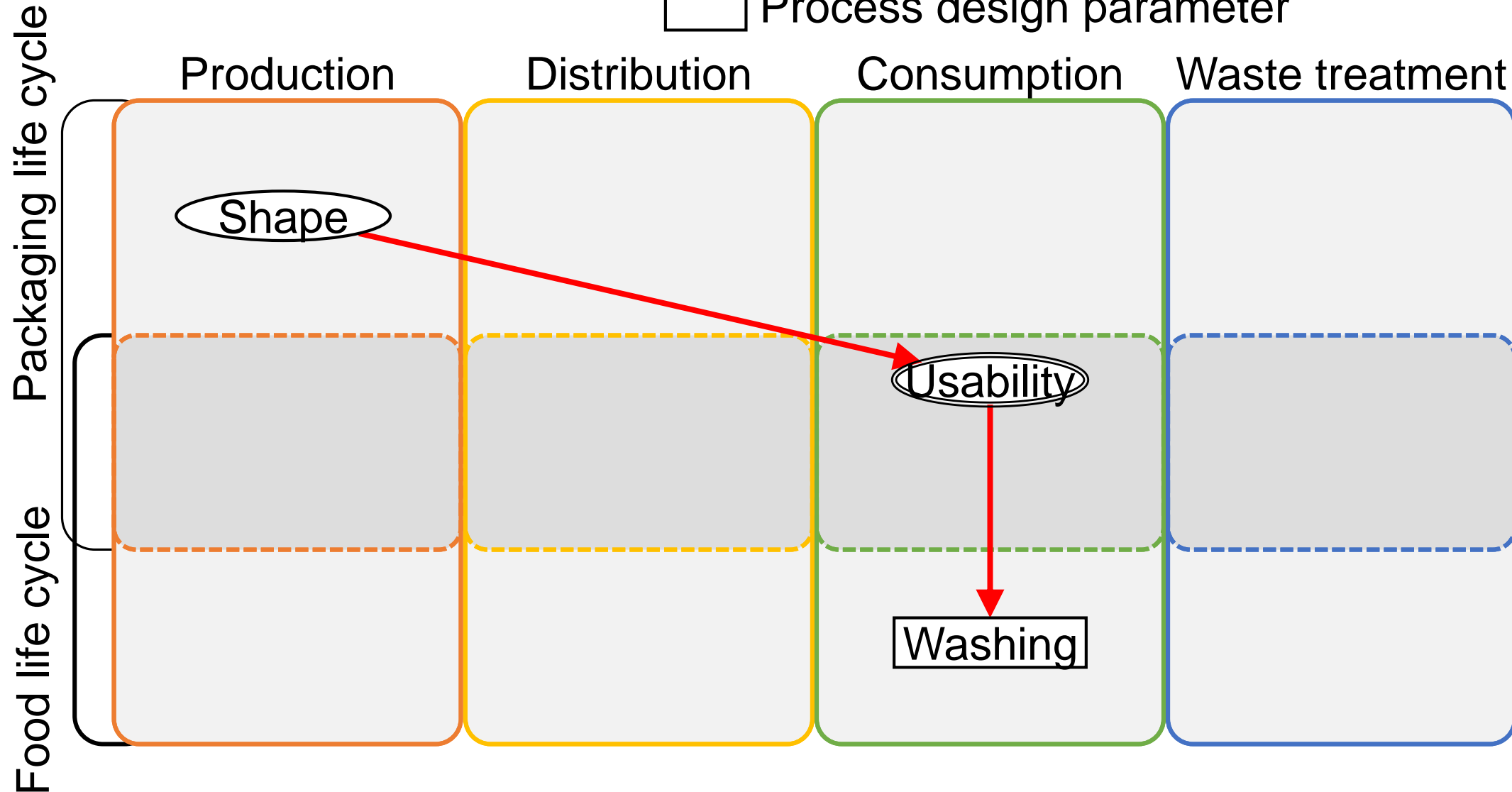




# Relations between function & design parameters

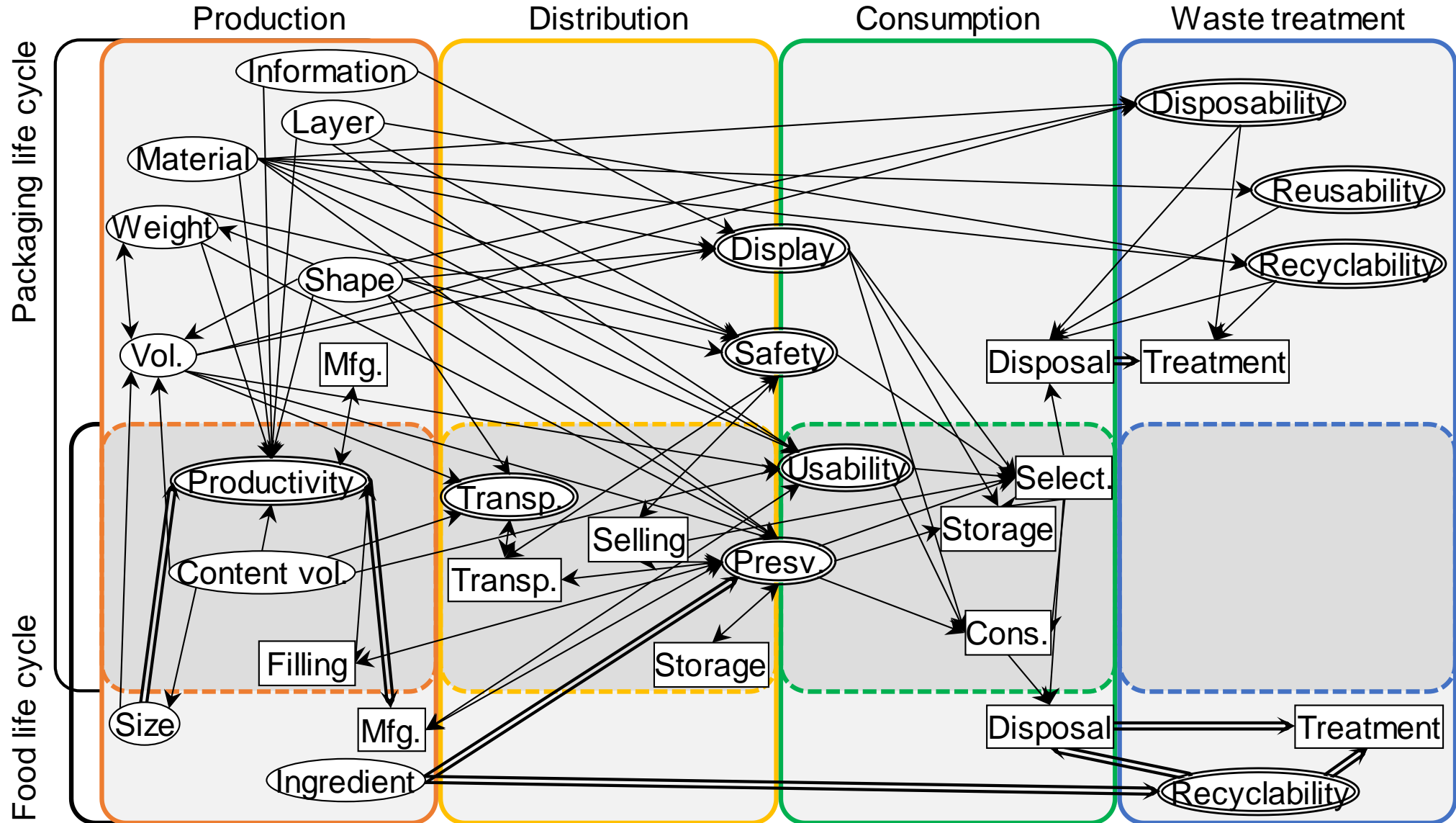
▷ Example: use as a bowl

○ Product design parameter    ○ Function  
□ Process design parameter



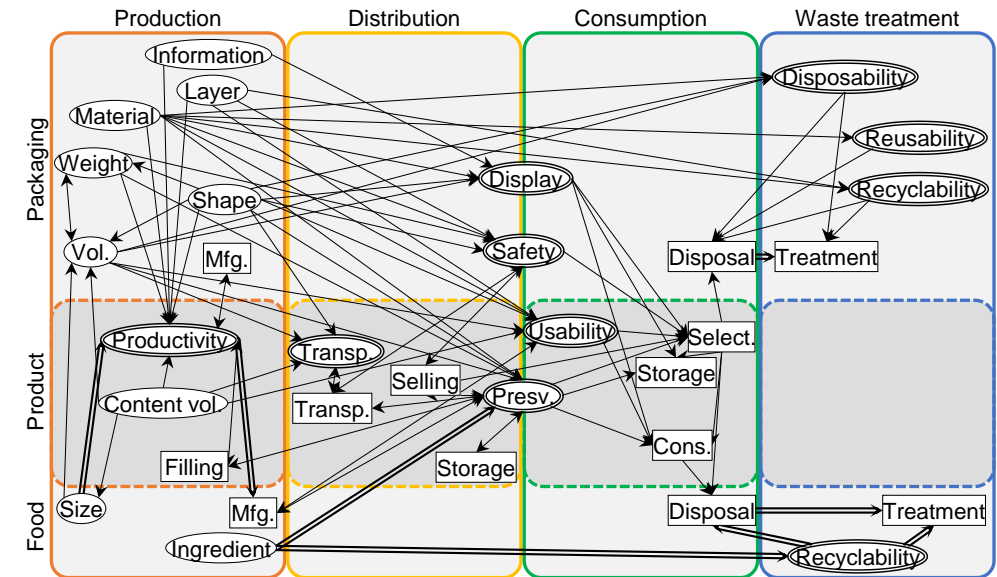
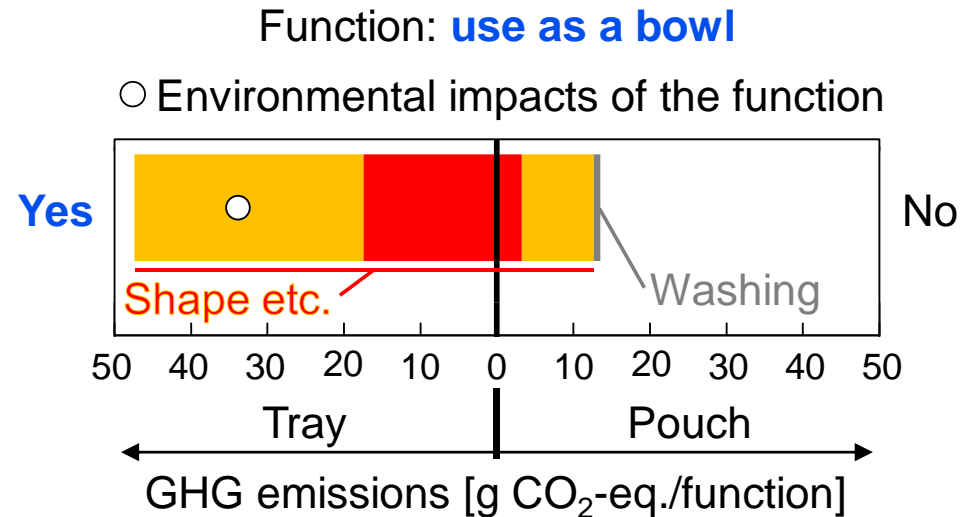
# Relations between function & design parameters

## ▷ Overview of function network diagram



# Conclusions and outlook

- ✓ Functionality evaluation method was developed.
- ✓ Function network diagram was introduced.



- Visualize trade-off relations btw functions and environmental impacts quantitatively to support a decision for life cycle design.
- ▷ Evaluate sustainability from various stakeholders: food losses, sufficiency & cost.
- Contribute to life cycle design of all stakeholders.

# Acknowledgement

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# Characters of pre-cooked rice products

## Tray product



137 kt/year

### Tray

Available

Aseptic processing

6 months

Product example

Production amount  
(in Japan, 2016)

Packaging

Use as a bowl

Sterility assurance

Expiration date

## Pouch product



31 kt/year

### Pouch

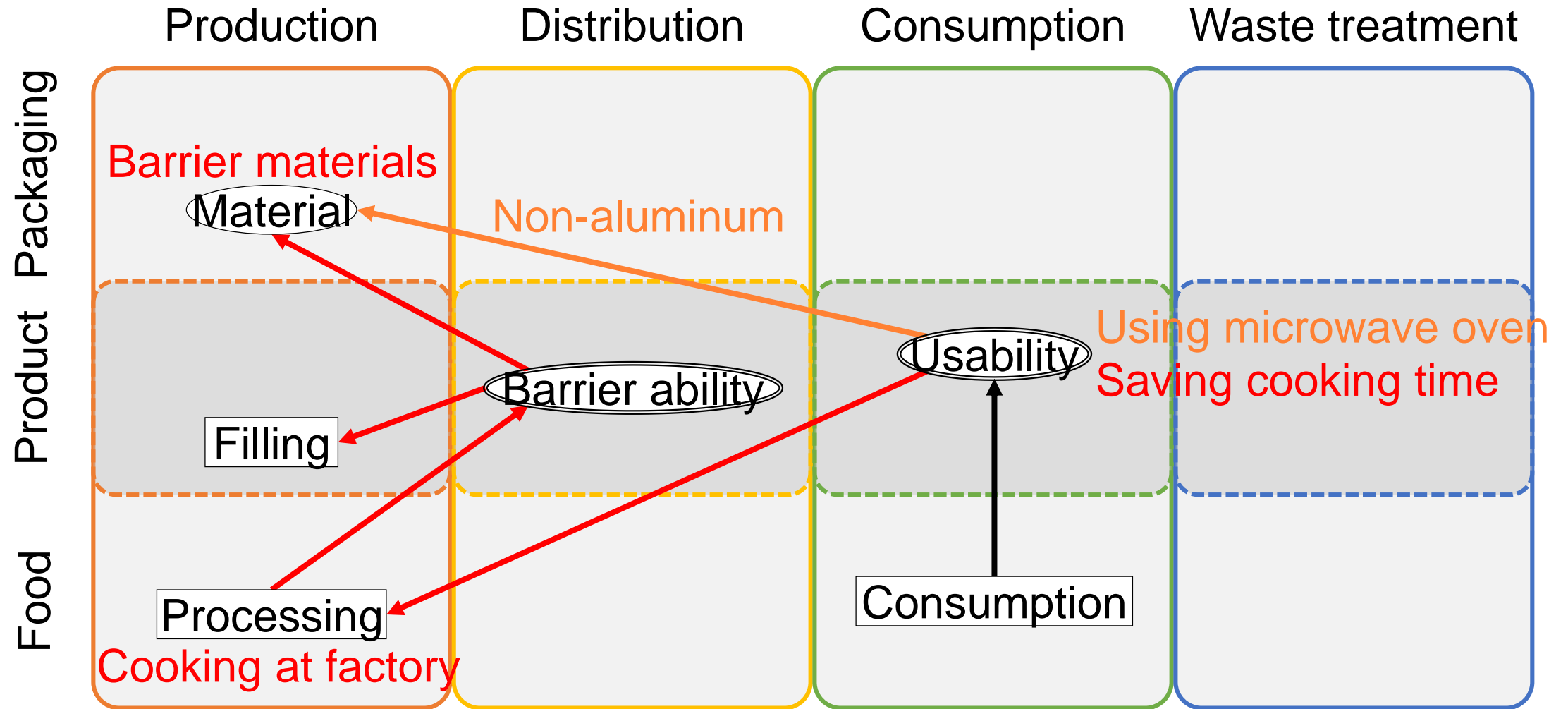
Not available

Terminal sterilization

12 months



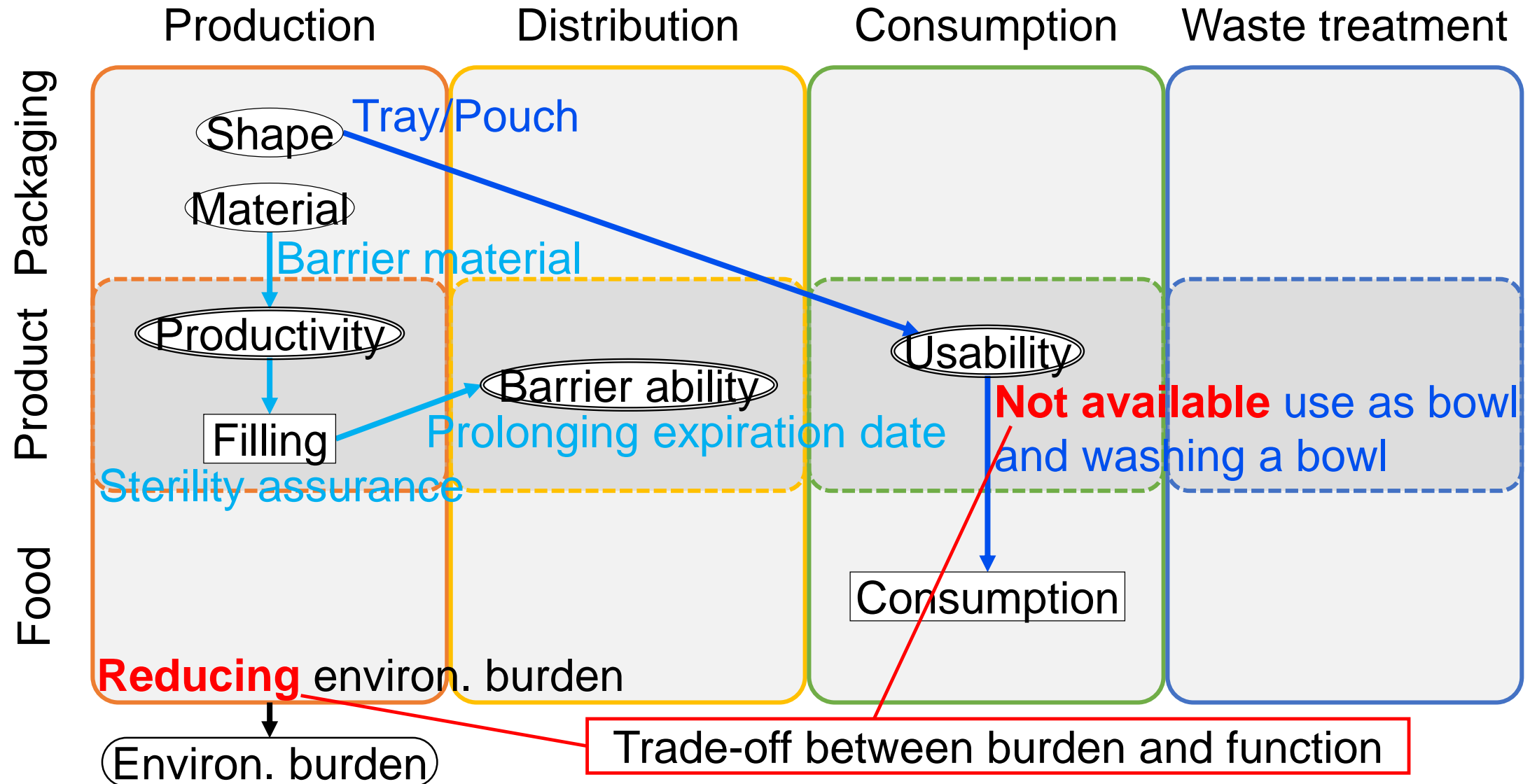
# Analysis of demands for pre-cooked rice





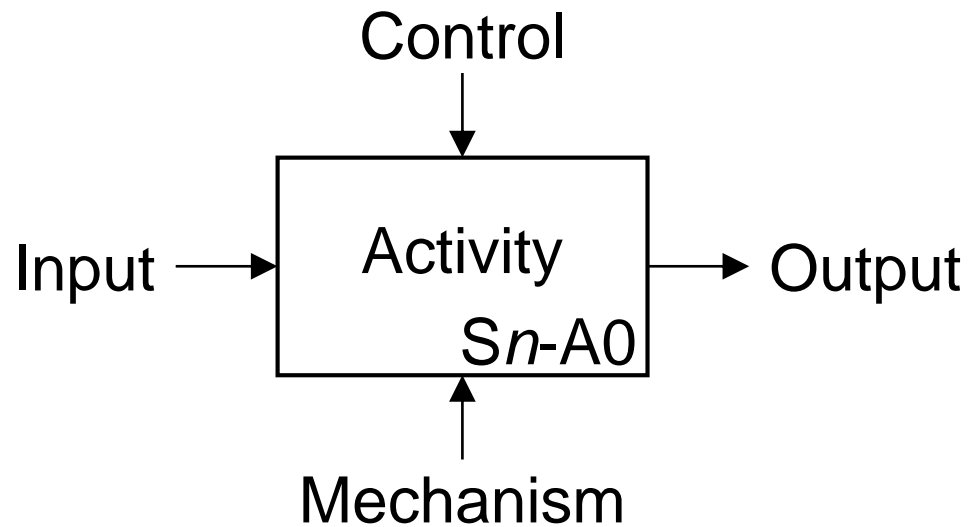
# Analysis of effects of pre-cooked rice

▷ The difference between base case  & alternative 



# Activity model

- ▷ IDEF0 (NIST, 1993)  
: The type zero method of integrated definition for function modeling




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## Stakeholder

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S1: Policy maker

S2: Packaging maker

S3: Food maker

S4: Distributor

S5: Consumer

S6: Packaging waste manager

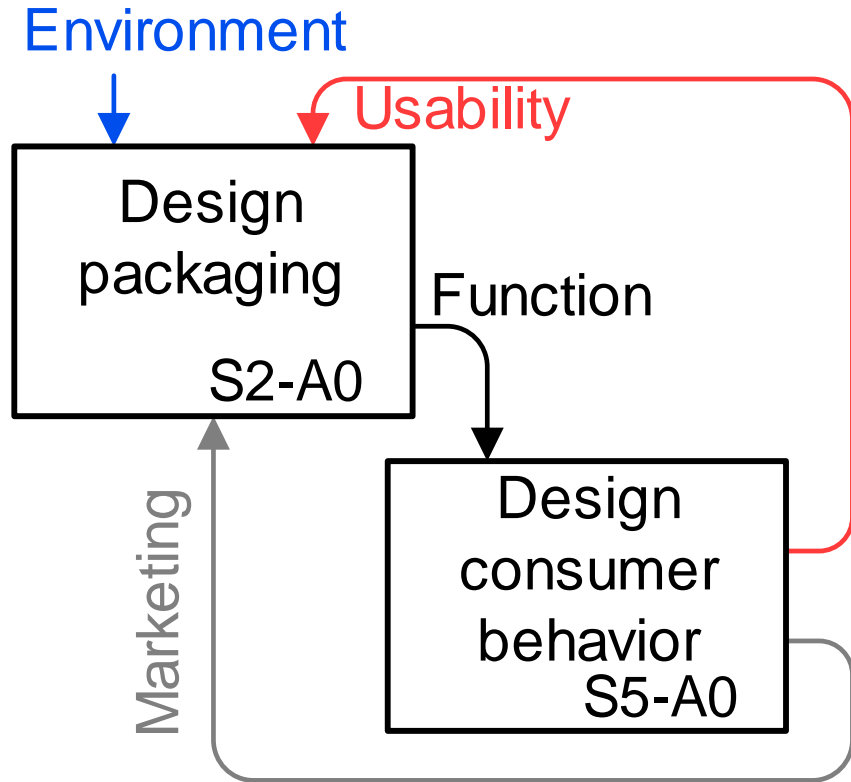
S7: Food waste manager

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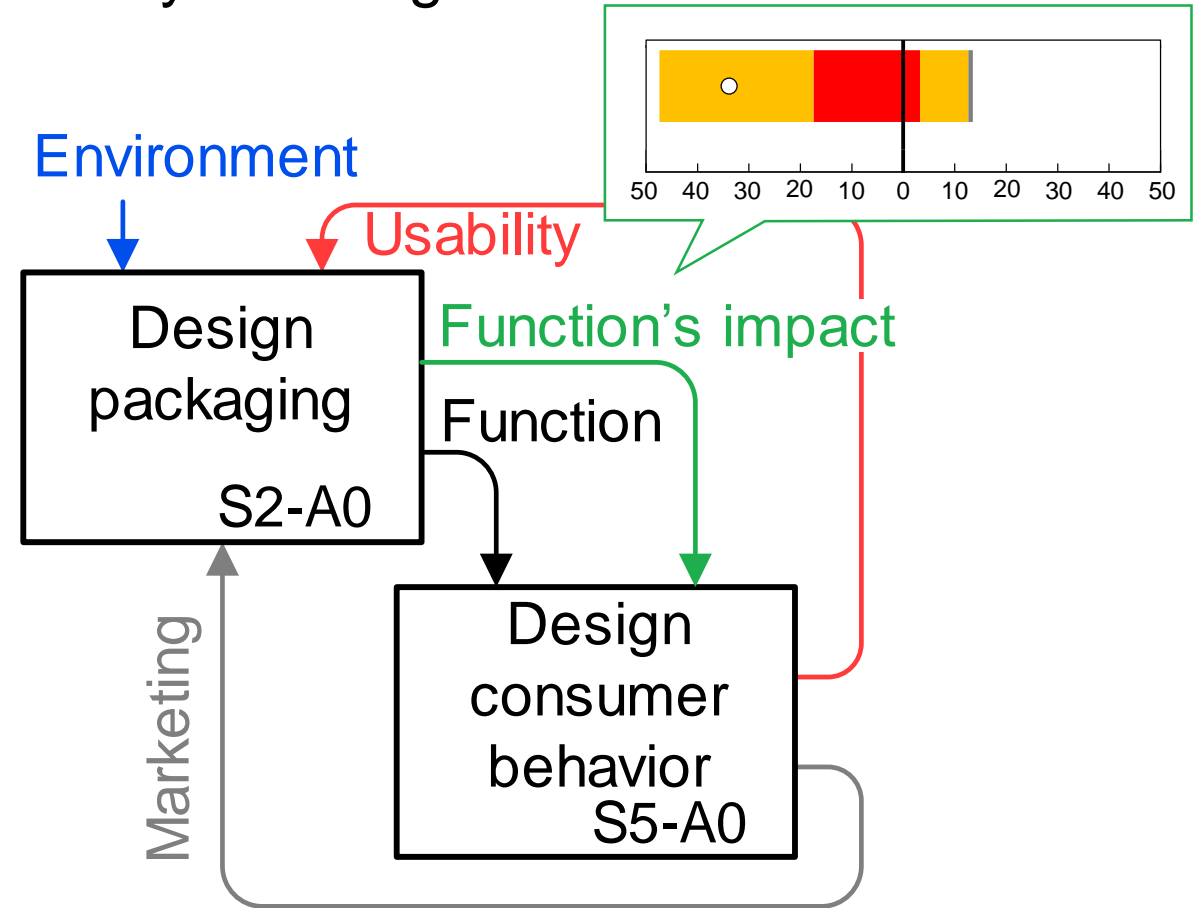
- ▷ Information flows between different stakeholders are described.

# Information flows btw packaging maker & consumer

▷ Present state



▷ Life cycle design



→ Identify information for life cycle design.

# Boundary for assessment

▷ **Focus** is input and output for a specific product

