Sensitivity analyses of carbon footprint measurement, comparative case studies

Éva Erdélyi

Budapest Business School, Hungary

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BGE

GHG emission is a main force of climate change, almost 1/3 comes from agriculture and **food production.**

Carbon-footprint is a **sustainability indicator** that summarizes the GHG emission equal to the **CO_2 amount** of the production or manufacturing of a product during its life cycle.

The **methodologies** used **for the calculation** of the carbon footprint are not uniform: many calculators (black box), software packages which have their inputs from different sources, and limitations in applications.

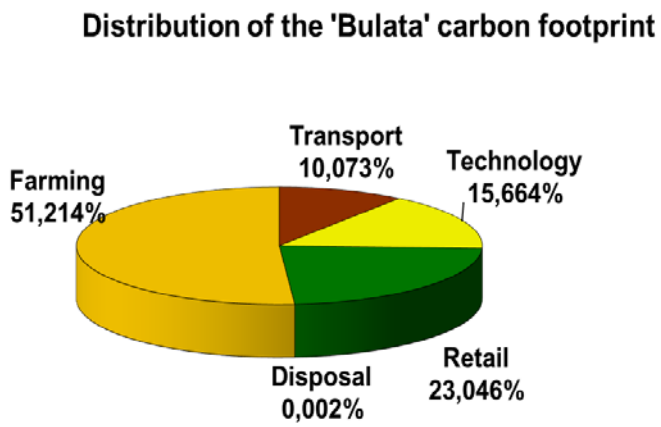
Carbon footprint: the sum of all materials, energy and waste across all activities in a product's life cycle multiplied by their emission factors; following the directions of **PAS 2070** (Publicly Available Specification 2070), and the **ISO 14000** package standards, IF data is available.

Crucial targets with indicators in Action2020 of The World Business Council for Sustainable Development:

- **sustainable farming** (raw materials of the food industry),
- **less food waste**
  (minimization, fewer transmission points in food value chains),
- **sustainable value chain** (footprint of food products),
- **sustainable products and services** (product lifetime),
- **life cycle development** (use of local sources, sustainable packaging, energy efficiency, product innovation).

Life cycle assessment (LCA) is a methodology used to evaluate the environmental impacts ***has high data inquiry***: taking into account all the manufacturing and consumption stages, ***from the production of raw materials to the end*** including all intermediate steps.

Disposal is present at:
Transport, Storage, Processing
Energy required in disposal/recycling process
Direct emissions due to disposal/ recycling:



Waste is ‚produced' at all the stages, not only at the end of life of the product

Life cycle assessment (LCA) is a methodology used to evaluate the environmental impacts ***has high data inquiry***: taking into account all the manufacturing and consumption stages,
from the production of raw materials to the end of life,
including all intermediate steps.

To reduce $CO_{2.}$ calculate, find critical points.

Reduction can be reached partly thanks to prevention, recycling, or using other ideas from the circular economy concept, but also **by changing the usual practices**.

SO follow the cycle: ***Plan, Do, Check, Act/Adjust, Plan, …*** *etc.*

Every step is important: many little makes a mickle.

Method

- continous building the LCA model of products
- manual data collection

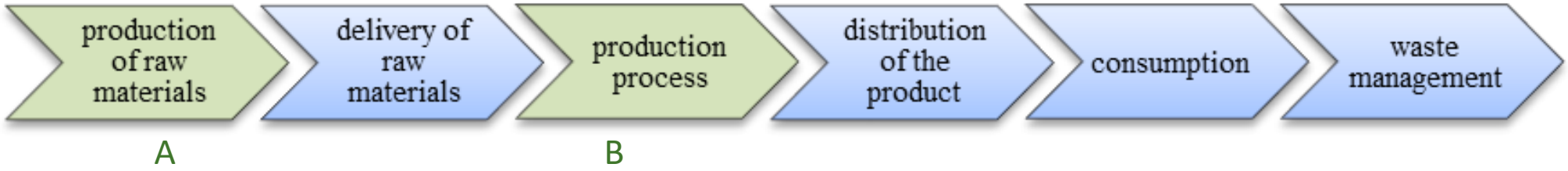
  (developed a database of CO2 emissions for the specific performance of the machines),
- in-depth interviews

  (collecting measurements in the steps of the manufacturing process)

Examples: for different stages of a ‚simple' production process

1. Production of rice

two technologies



A: Rice can be produced with underwater and overland technology.

significant water footprint,
4000 l / 1 kg rice

CO_2 emission can be reduced by 36,82%
during the soil preparation
and farming procedure,
which means 24,23% less the packaged.

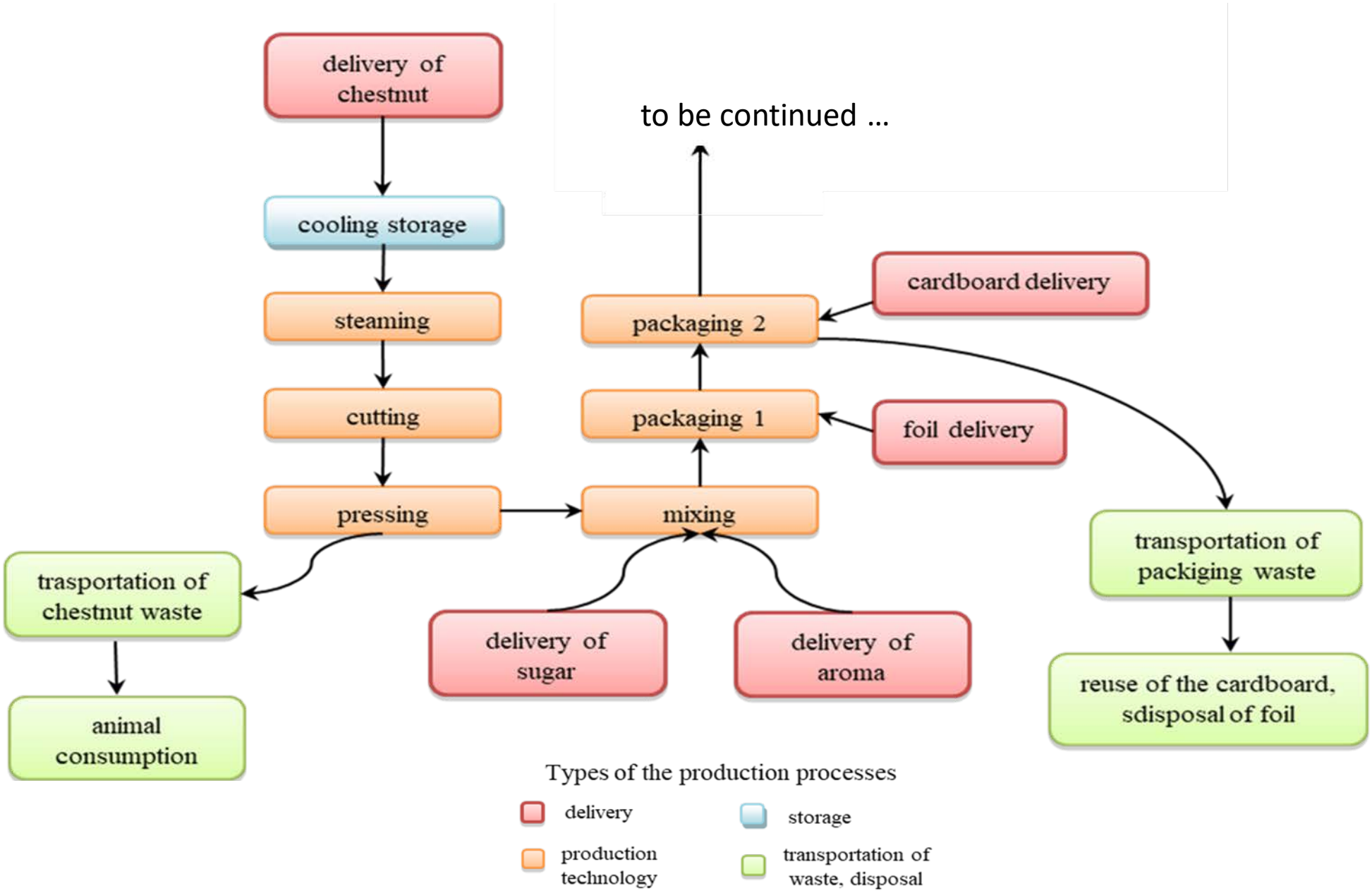
B: brown and white rice
+ a polishing stage

BUT cooking brown rice might need more energy,
BUT not if soaked in water before cooking.

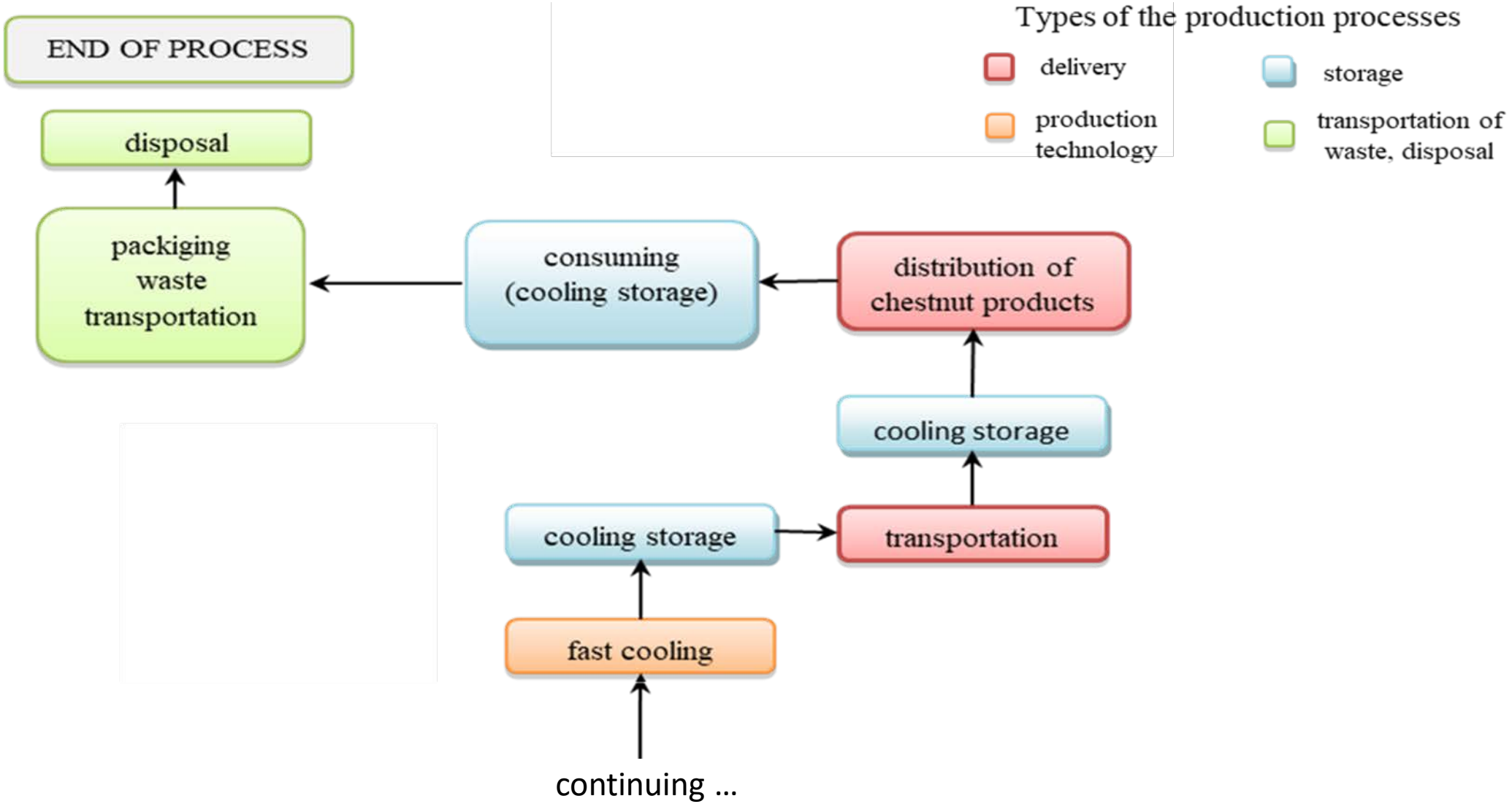
+ calculations for different types of stoves,
different energy source used in consumption phase

complex approach

Process map: Flowchart of the frozen chestnut pure product, Prima Maroni Ltd.



Process map: Flowchart of the frozen chestnut pure product, Prima Maroni Ltd., continued



continuing …

Transportation is taking up most of the environment in many cases.

It is present in more steps of the life of products:

- from delivery to the place of the production (from Italy - 55,65% than Portugal)

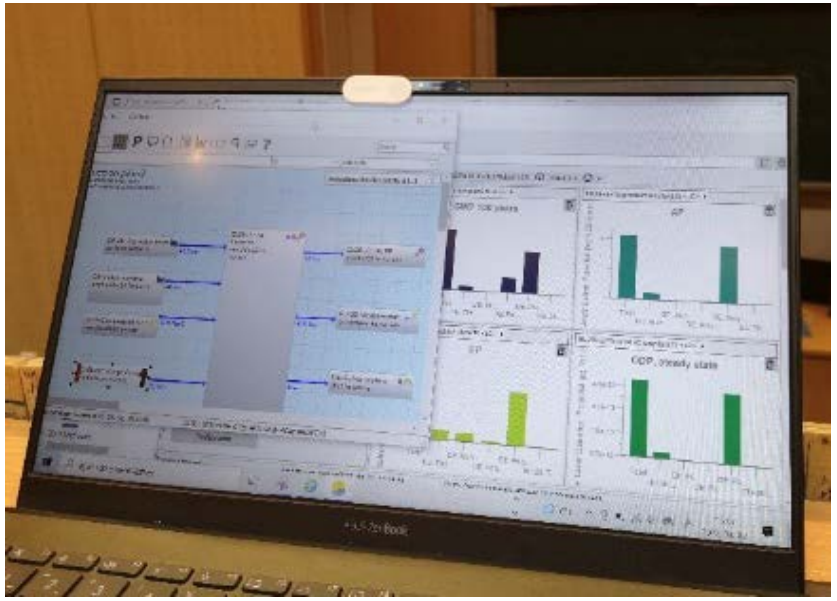
  could be more for all the components
- transporting from the place of manufacturing to the packaging place,
- delivery of the packaging materials to the place of packaging (more),
- from the packaging to the storage place,
- delivery from the storage to the retailers, etc.

Case studies, comparison for reliability

Calculation example, 5b Step: Transport to Stores			
Average distance (km) Budapest*, countryside**	*22	**120	Supplier, interview
Kg CO_2 e per km	*1	** 2.5	Emkas CO_2 e calculator based on vehicle type
Kg CO_2e per outbound journey	*22	**120	Calculation: emission per km x km journey
% empty on inbound journey	*0	**0	Supplier, interview
Average distance (km)	*22	**120	Supplier, interview
Kg CO_2 e per km	*1	**1	Emkas CO_2 e calculator based on vehicle type
Kg CO_2e per return journey	*0	**0	Calculation: % empty on inbound x emissions per km x km journey
Kg CO_2 e per total trip	*22	**120	Calculation: emissions outbound +emissions return
Tonnes Bulata per trip	*20	**20	Supplier interview
## Kg CO_2 e per tonne Bulata	*1.1 x 0.70= 0.77 **6x 0.30= 1.8 2.57		Calculation: (emission per total trip/ tonnes Bulata per trip) x x 0.7 or 0.3

CO_2 calculation is buildt bottom-up

vs.

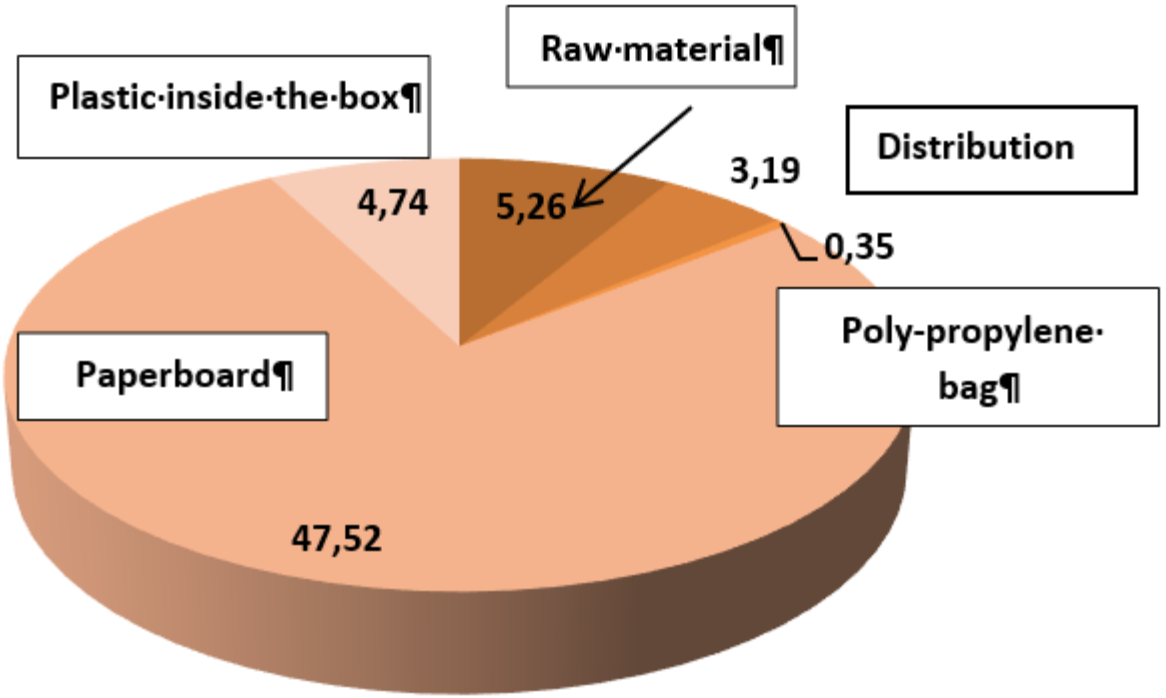


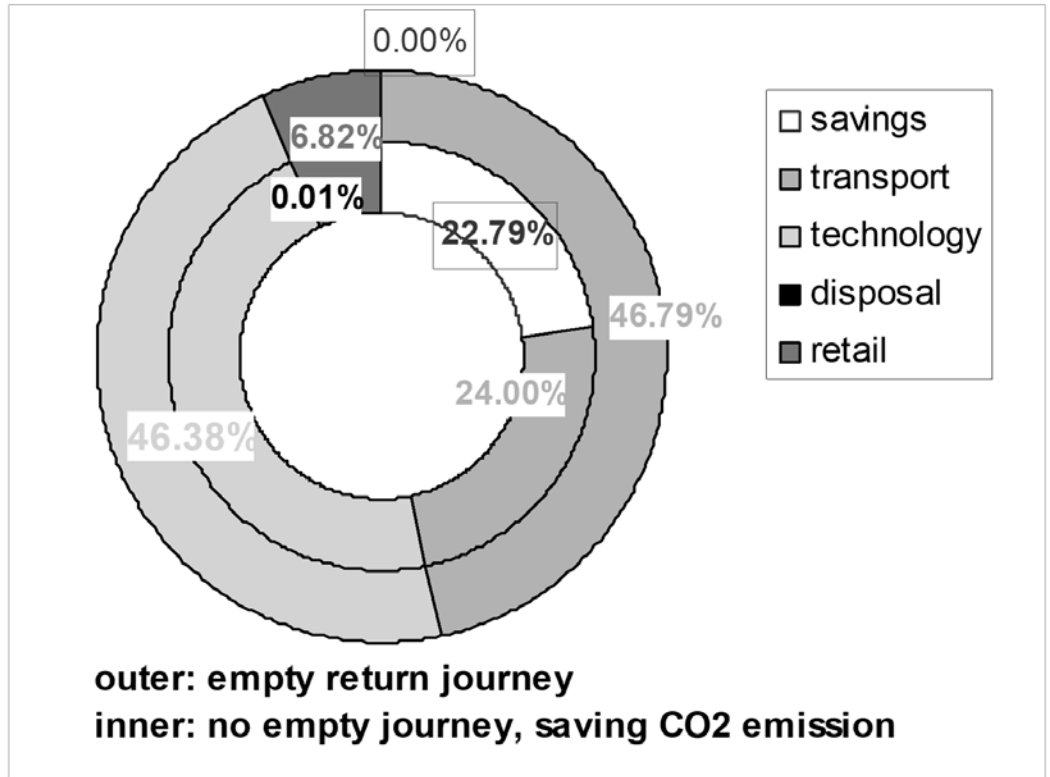
+ Since it is always related to a specific product it helps the stakeholders to **understand the environmental impacts** of different strategies and **helps decision making**.

- Softwares have huge **cost.**

The most serious limitation of the caculation is that the willingness of **providing data** suitable for such calculation is still poor from the stakeholders of the production chain.

Monitoring, cooperating


Raw·material¶
Plastic·inside·the·box¶
Distribution
3,19
4,74
5,26
0,35
Poly-propylene·bag¶
Paperboard¶
47,52


0.00%
6.82%
0.01%
22.79%
46.79%
24.00%
46.38%
savings
transport
technology
disposal
retail
outer: empty return journey
inner: no empty journey, saving CO2 emission