Circular Economy in a Firm and Value Chain Perspective

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Theme:Embracing Emerging Technologies:
Strategies for Navigating the Path to Sustainability

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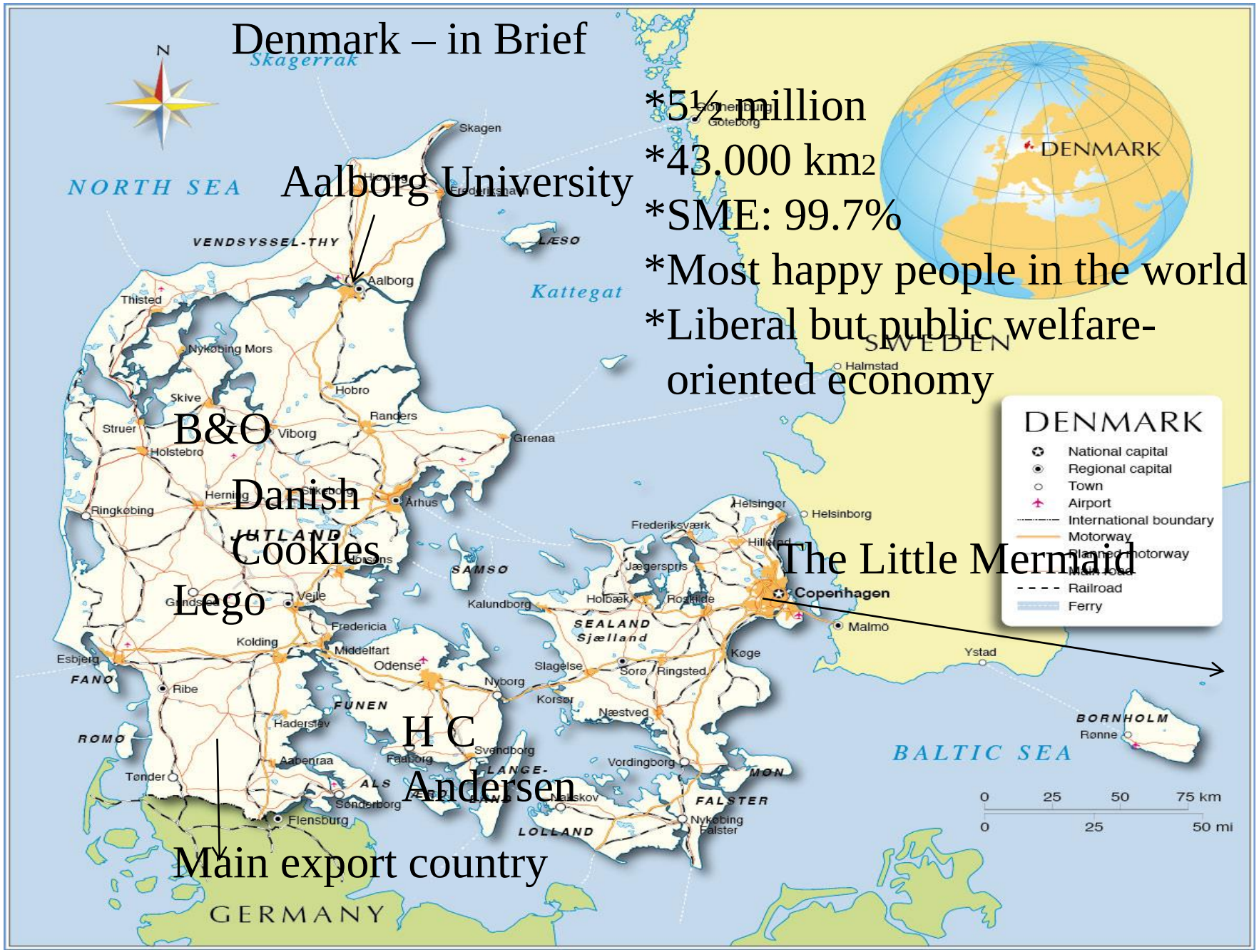
Denmark – in Brief



Aalborg University

*5½ million
*43.000 km2
*SME: 99.7%
*Most happy people in the world
*Liberal but public welfare-oriented economy

B&O

Danish

Cookies

Lego

H C Andersen

Main export country

The Little Mermaid

NovoNordisk
Novo Zymes

‘When people started stealing our waste,
- we realized that waste has value’

Interview with manager

Consumer: Are You Ready to Enjoy Nature ?

Landfill or ???

Circulate and you have gas for cooking - Biogas

Her lander Vestens genbrugstøj

Aim

*To provide insight into Circular Economy and its implementation at firm level

*Focus is on: Identification and implementation of concrete CE activities at firm level

*To provide you with a CE business language to strengthen your CE mindset

*To venture into ‘design’ as an innovation (barrier and solution to CE)

To contribute to a progression from the theory of the firm to the theory of the circular firm, i.e., a firm where sustainability goes hand in hand with firm development and growth in a process mediated by stakeholders

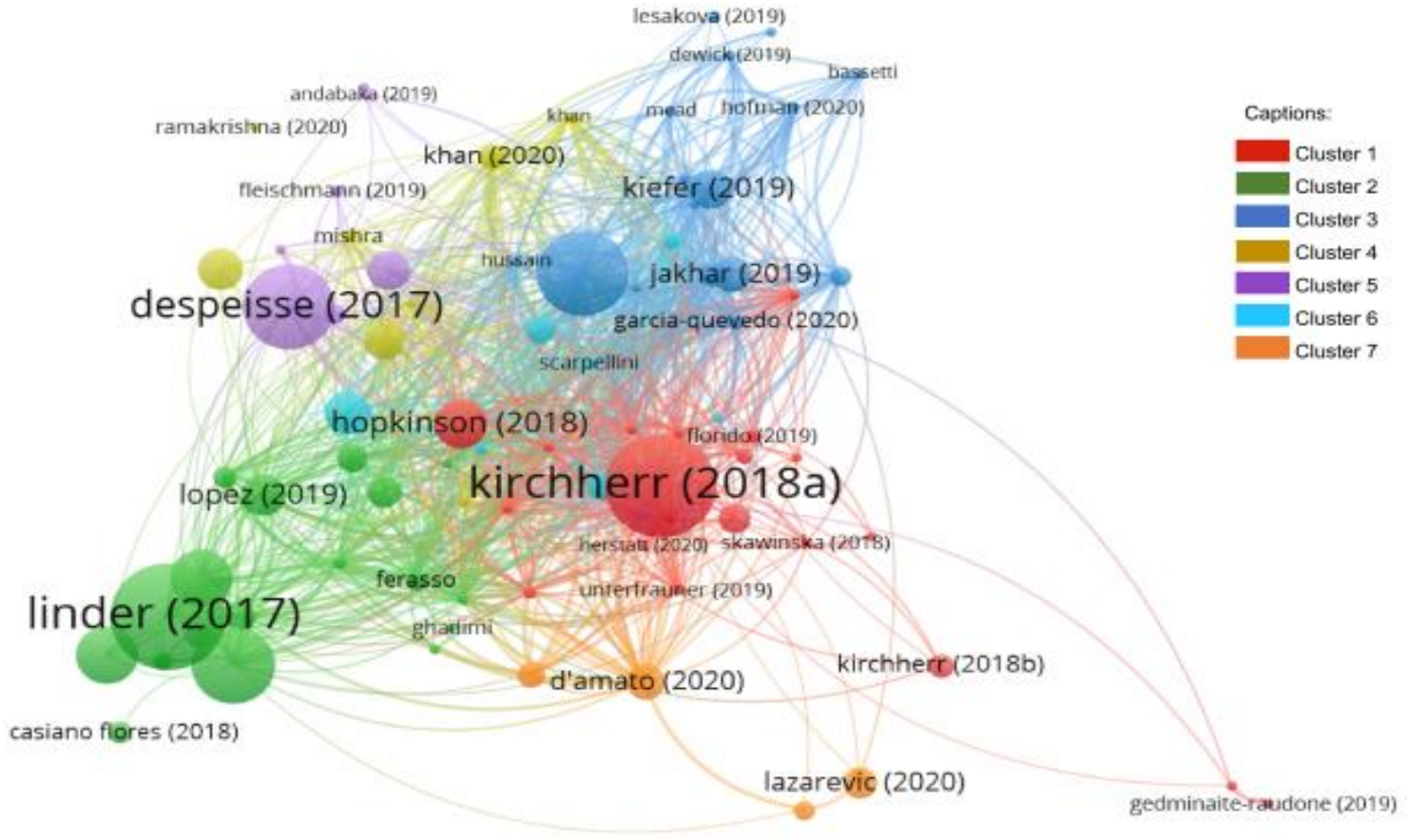
Maybe Danish people are the most happy in the world

BUT you – as scholars of Innovation – is the most lucky

Circular Economy is about nothing but **INNOVATION**

See overview of Innovation Theories

Social Science and Concept Creation



GURE 4 Cluster network [Colour figure can be viewed at wileyonlinelibrary.com]

Lit Review on Innovation and CE

Source: Suchek et al (2021): Innovation and Circular Economy: A Systematic Literature Review. *Business Strategy and the Environment (DOI: 10.00/bse.2834*

References related to Circular Economy and

*Eduardsen, J. and Sørensen, O.J. (2023): The Adoption and Implementation of Circular Economic Activities (paper submitted for journal publishing).

*Potting, j., Hekkert, M., Worrell, E. and Hanemaaijer, A. (2017): Circular Economy: Measuring Innovation in the Product Chain. PBL Netherlands Environmental Assessment Agency, The Hague.

*Karina Fernandez-Stark, K. and Gereffi, G. (2019): Global value chain analysis: a primer (second edition). In Reader.

*Andrade, C.; Sandrine, S. and Maïz, N. (2022): Thirty years since the circular economy concept emerged: Has it reached a consensus? HAL Id: hal-03512799 https://hal.science/hal-03512799.

References related to Circular Design

Andrews, D. (2020): The role of Design as a Barrier to and Enable of the Circular Economy. (In) M. Brandao, D. Lazarevic, and G. Finnveden, eds.: Handbook of the Circular Economy. Elgar: Cheltenham, UK (39-49)

Ceschin, F. and Gaziulusoy, I. (2016): Evolution of Design for Sustainability: From Product Design to Design for Systems Innovations and Transitions. Design Studies, vol 47, no C (November)

Agenda – Four sections

Section 1: General about CE

*Sustainability and CE (CE as the operational arm of sustainability that promises growth and sustainability)

*Defining CE and CE activities: We are not looking at: Strategy; Business Model; Motives, Drivers, and Barriers,

*CE-activities at firm level → Typology → Waste Hierarchy → CE in a Firm and Value Chain perspective.

Section 2: Firm Level and Value Chain Perspective

*Firm models: Functional/organizational model; value chain model (Porter)

*Value chain models: mapping and upgrading (garment) (Gereffi) + upgrading models for garment (OJS)

Section 3: CE at Firm and Value Chain Level

*CE in a value chain perspective (Waste hierarchy; upgrading)

*Towards a Theory of the Circular Firm and the Circular Value Chain.

Section 4: Findings

*Findings from a Study of CE in Denmark

Extract from a Study of DK-Firms: How circular are they?

Table 1: The Rate (yes/no) of Adoption of CE Activities.

	Yes	No	NA
Minimize resource consumption	70 %	28 %	1 %
Sorting and recycling of waste	92 %	8 %	0 %
Use of recycled materials in production	48 %	39 %	13 %
Extensions of Product Lifecycle	32 %	60 %	8 %
Improvement of Product Repairability	31 %	66 %	3 %
Using sustainability in marketing	68 %	30 %	3 %
Introduction of new sales models	32 %	64 %	3 %

Definitions

CE is about
-using less natural resources by consuming less or smart
-using less or alternative (sustainable) natural resources to produce a product;
-using the product longer, i.e. prolonging the life cycle of products, and
-keeping resources in loops through recovering and recycling resources.

The ambitious goal of CE is to align the well-being of the planet and humans with economic prosperity through the innovation and growth of firms
(Negri et al 2021; Prieto-Sandoval et al 2018).

Thus, no conflicts between sustainability, growth and consumption if CE is achieved ??? But..

Popular version: The 3 Ps – profit, planet and people

The Linear Economy

Non-sustainable Ressources

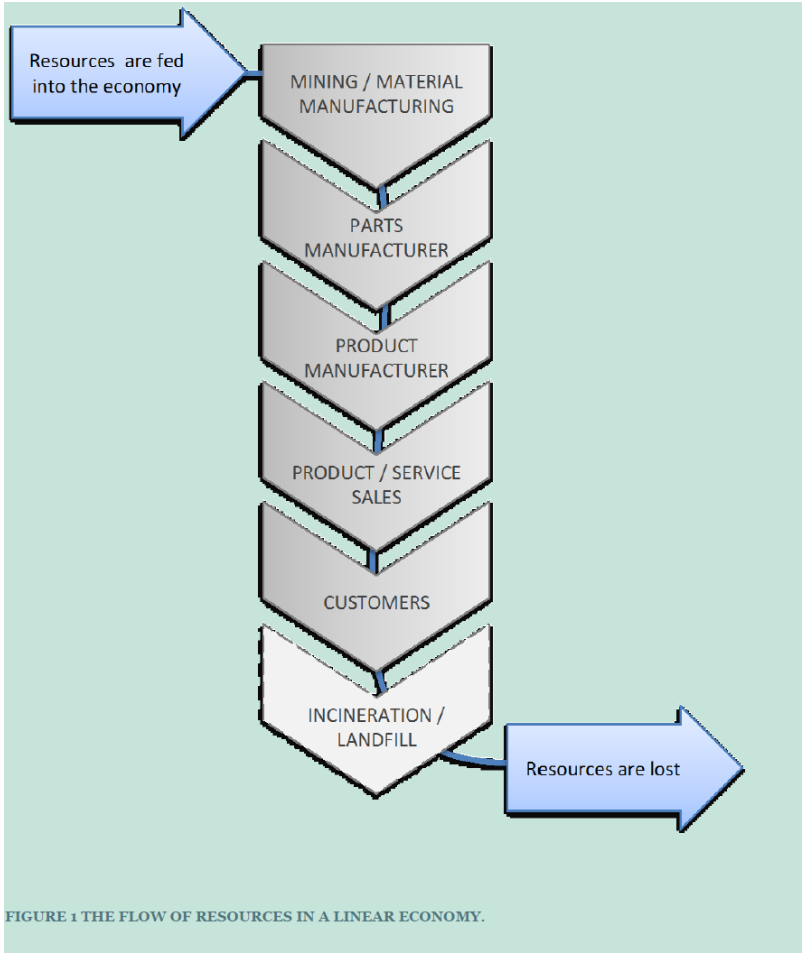


FIGURE 1 THE FLOW OF RESOURCES IN A LINEAR ECONOMY.

http://www2.mst.dk/Udgiv/publications/2016/06/978-87-93435-86-5.pdf

The circular economy

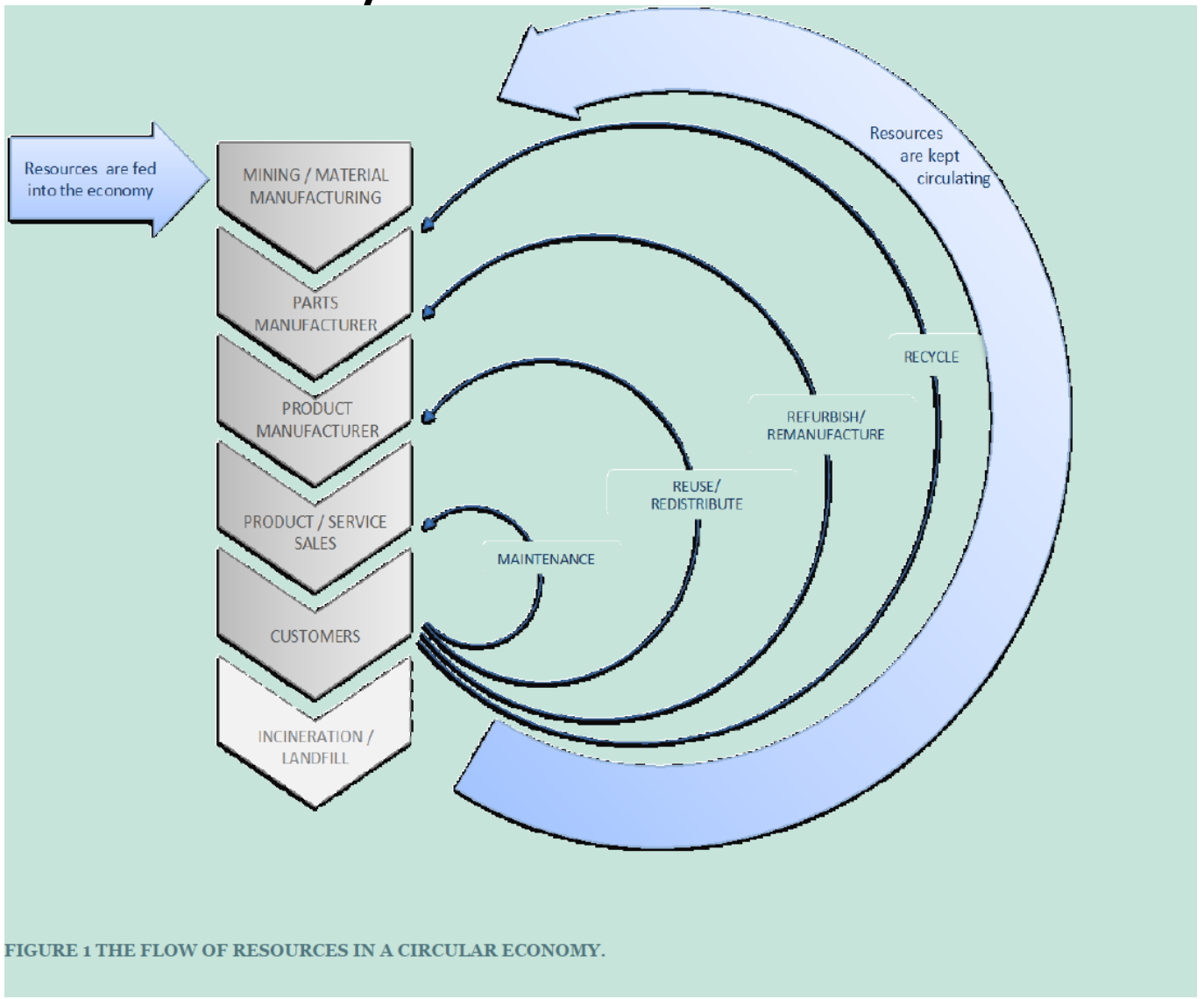


FIGURE 1 THE FLOW OF RESOURCES IN A CIRCULAR ECONOMY.

http://www2.mst.dk/Udgiv/publications/2016/06/978-87-93435-86-5.pd
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Do we need a new CE based theory of the firm – a new mindset

The present theories of the firms assume the firm to be a profit seeking institution (Max P

Now with sustainability on the agenda, do we need to change the theory:

a) Max P/S – profit under conditions
b) Max P and S – optimize two goals
c) Max S/P – sustainability under condition of no loss

Social Entrepreneurship -

a) Max social impact/P
b) Max social impact/Government support

Firm or Product Theory in CE

Most CE theories assume a firm – and they do not specify much about the firm.
It is assumed that the firm is profit oriented

But CE is not so much about a firm – it is about the products it produces
and the sustainability of producing that product. But firms (its owners and managers)
are setting the CE agenda; outline the strategies and business models and driving
the associated activities.

The ‘cradle-to-cradle theory’ is one of few theories that
explicitly focusses on the product over its lifespan.

Existing Schools of Thought - what do they put on the CE agenda

Perhaps we do not have a theory of CE, but we have several 'schools of thought'. Wautelet (2018) identified six different but overlapping schools of thought.

1. **The Spaceship Earth**, putting the importance of the *relationship between the economy and the environment* on the agenda. The globe is isolated but for the sun and the natural resources are not limitless (Boulding 1966)

2. **Industrial Ecology**, putting the *harm caused by the industrial system to the environment* on the agenda and require the system to be reorganized/redesigned.

3. **Cradle-to-Cradle,** focusing on *impact of products over their lifecycle* and create a platform that firms can use to assess the impact and what need to be done in terms of *new design* principles across the life cicle.

4. **Performance Economy**, looking at where most resources are used (3/4 of energy resources used in mining and basic material production, e.g aluminium). They focus on moving the agenda from 'doing things right' (efficiency) to 'do the right things' (effectiveness). They also pointed out the need for efficient markets, (ref to the slide on governance mod

5. **The Blue Economy**, putting new innovative *business models* on the agenda. And looking for cascading effects where the waste of one product becomes the input to another.

6. **Biomimicry** focusing on the *best ideas from nature* (how nature conduct sustainability) and study how these natural principles and processes can be transferred to the human world and used in our interaction with nature (nature has no waste)

Wautelet, T. (2018): The Concept of Circular Economy: Its origin and its evolution. Working Paper (Research Gate)

Dimensions Across Schools

Across the theories or schools of thought, we see several different perspectives and dimensions:

1. Firm Level, but mostly the research is at the system level
2. Critical of what happens today (the linearity) versus constructive, looking at what can be done. In general, the CE is an optimistic theory.
3. Most studies focusing on understanding and analysis but some schools are more normative.
4. Most studies are still at the conceptual level (given CE a vocabulary/words) and not at the action level (providing advices)

With such a diversity in terms of schools, often we call for colliding the thoughts to **a consensus and a theoretical frame** we all can agree to and have as our starting point.

However, the CE phenomenon is highly complex with multiple interactive interfaces that we do not have methodological capacity to model and come up with a common frame.

Science development have to a large extent relied on studying isolated micro phenomena under assumptions a assuming (hoping) that all the micro pieces eventually will add up and provide a complete picture.

CE – at Firm Level

Due to the complexity of CE, to achieve a Circular Economy, all stakeholders need to be engaged:

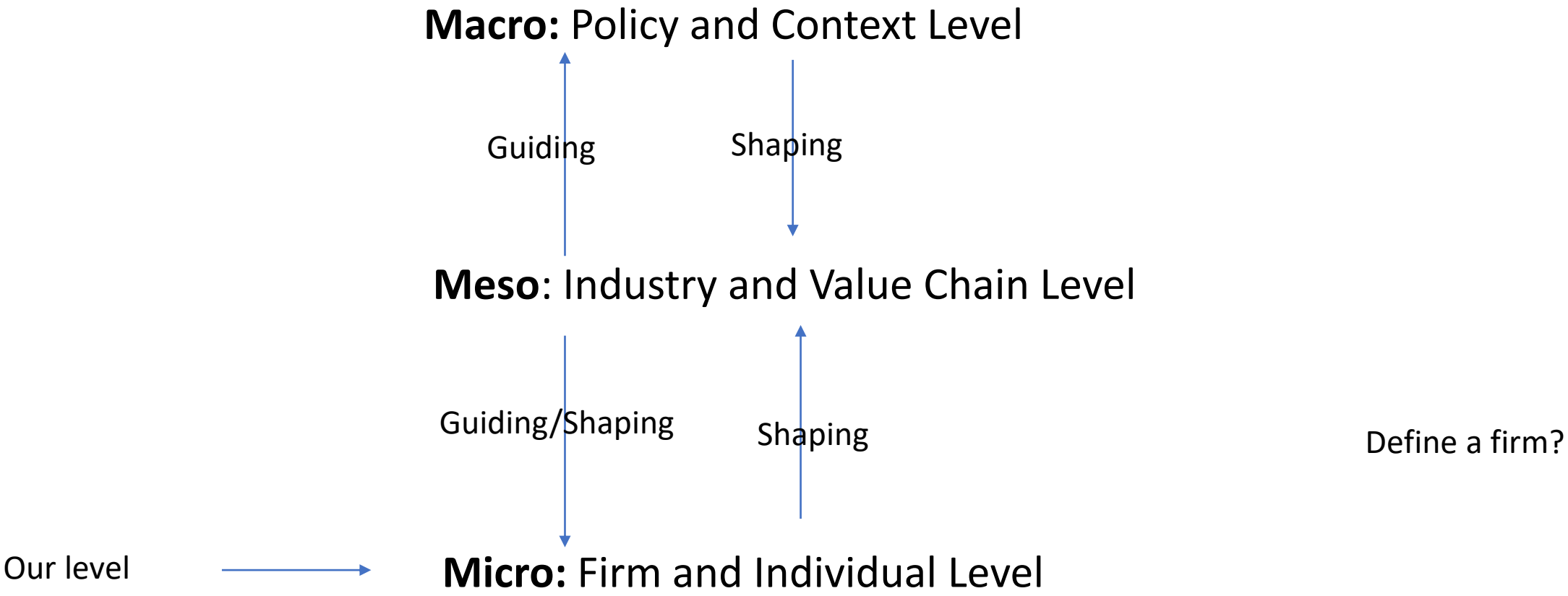
*Government and its agencies;
*Firms and their associations;
*Consumers;
*NGOs;
*Researchers, etc

…… but here focus is on the firms, i.e. the CE activities they implement.

*We need a model of the firm – our CE actor.

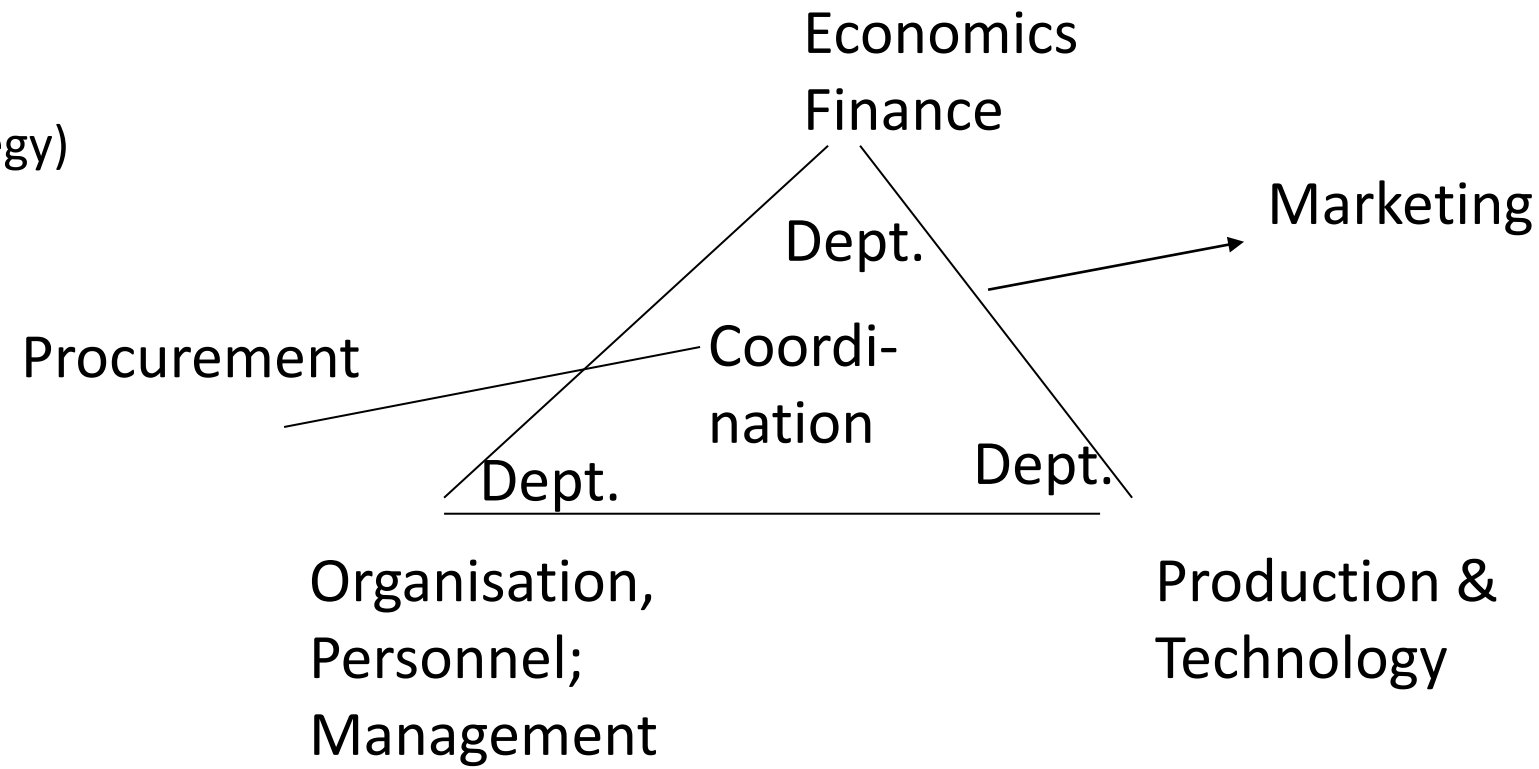
*We need a map of the value chain in which the firms are located.

Levels of CE Analysis



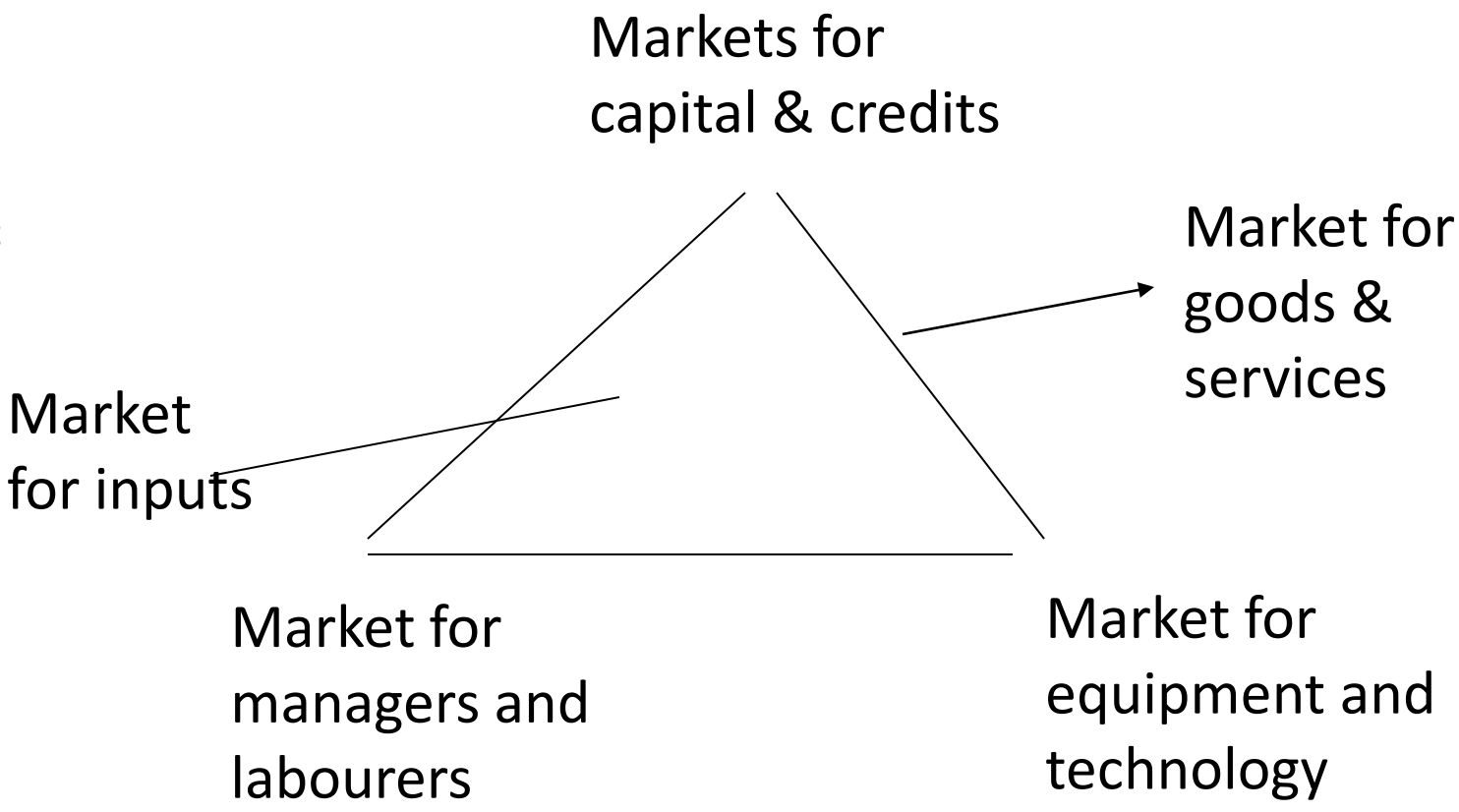
Functional Model of the Firm

A CE activity can be achieved inside the firm:
*Single person
*Single department
*Unit for CE
*Corporate Management (strategy)
*Board



Model of the Firm and its Markets and Value Chain

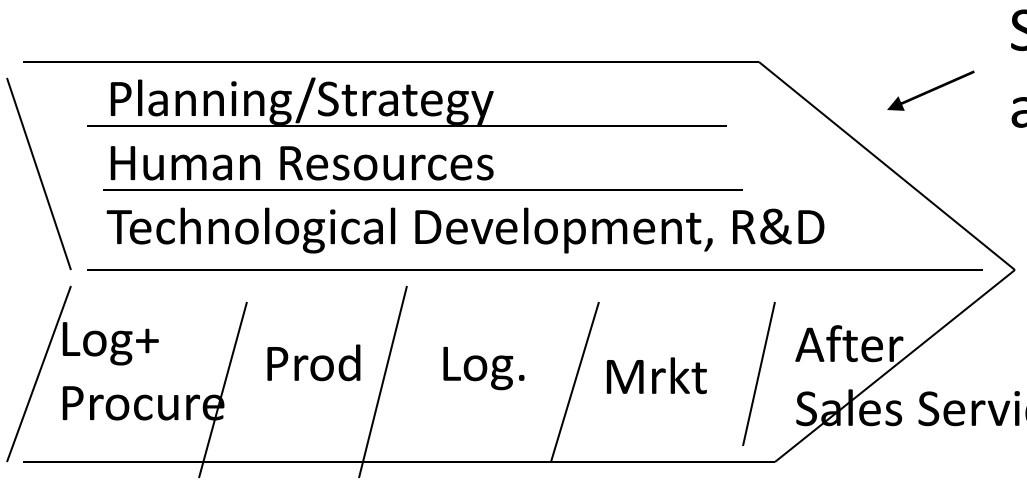
Pressure from outside:
*Customers
*Suppliers
*Capital suppliers
*Regulations, standards, etc



A CE activitiy can be achieved through the markets and the value chain

The (Corporate) Value Chain,

The firm as a black box in the GVC.
We need to know more about the internal side of the firm.



Basic value adding
activities (primary activities)

Can we organize the
Internal activities so
that we do them:

- *Cheaper*
- *Better*
- *Faster and now..*
- ***Sustainable***

Porter (1980)

The (Global) Value Chain

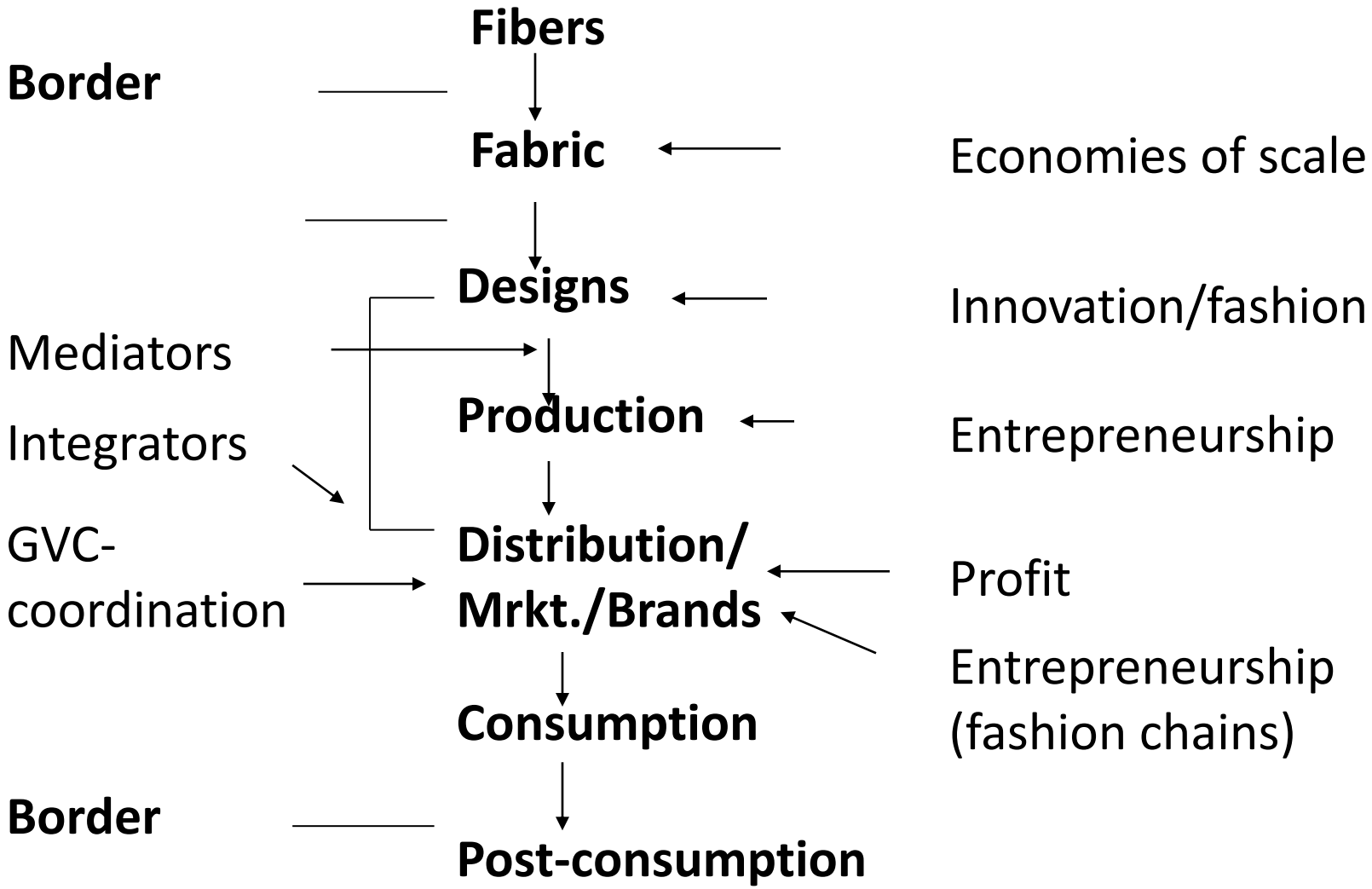
Activity based definition

A transactionally linked sequence of activities across firms and borders in which each activity adds value to the process of production of goods and services (Dicken 2015).

Actor based definition

A set of *identifiable* and *autonomous* actors, who,
* through activities and *interaction*,
* build transactions, *co-operative* or *mutual* relations,
and
* get access to *resources*, controlled by other partners,
* in their endeavours to create value for stakeholders

Garment (global) value chain



Issues to discuss

*Identify as many circularity problems as possible along the garment value chain.

*Identify the three most critical ones..

*Discuss fashion – how to be fashionable without being non-sustainable.

*What should be the circular dress code for researchers of the ga rment value chain
– how to be fashionable without being non-sustainable.

Governance * Modes of GVCs

Market	*Price signals from sellers; Little interaction; Standard specifications. (Fish)
Modular	*Lead buyers transfer module designs to producers who have (tacit) know-how to produce. (Cars)
Relational	*ntensive interaction between B&S is required. Explicit coordination and transfer of (tacit) knowledge. Mutual dependence (B&O-car radio).
Captive	*Lead buyers control suppliers who have limited know-how. (Garment/electronics)
Hierarchy	*No qualified suppliers, i.e. the activities must be conducted within the firm

*How the chain is coordinated and managed.

**What are the circularity potential of each of these governances?

Upgrading of Value Chains

Upgrading is a dominant discussion within the value chain literature

The upgrading discussion centers around **creating and capturing additional value** through doing things cheaper, better, or faster – and now we add doing things sustainable.

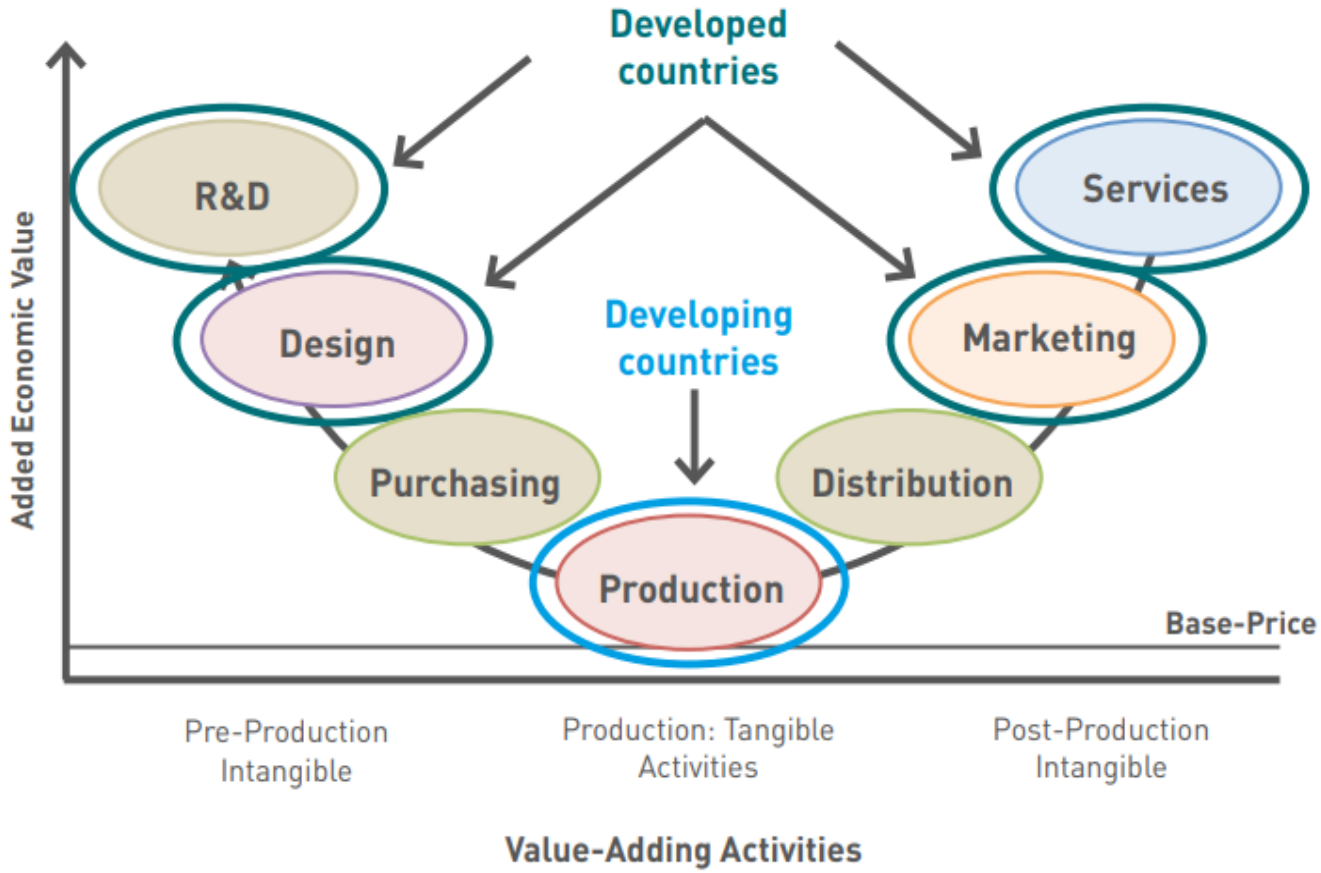
The upgrading literature makes a distinction between upgrading of:

*__Products,__ i.e. products with higher value, e.g. organic food (or sustainable products)
*__Process__, i.e. produce the product more efficient (or use less natural resources)
*__Functions__, i.e. increase the value added content, e.g. integrate new functions (or start new sales modes like
*C__hain upgrading__, i.e. moving into a new but related value chain, e.g. moving into producing parts internally
producing clothings using alternative/more sustainable raw materials).

Upgrading bridges easily to innovation as an upgrading often implies some degree of innovation (although a specific company may also upgrade by taking over existing activities or copy-cat others).

Fernandez-Stark and Gereffi (2019): Global Value Chain Analysis: A primer.

Figure 7. Smile Curve of High-Value Activities in Global Value Chains



If we look at CE as a Value-addition process, we may use the smile-curve to discuss where to implement CE activities to max impact

CE-activities

A CE activity is an activity that moves the firm in the direction of being more circular.

How can we identify, list (typology), and create a theory of CE activities ?

The R-models: From 1 R to 10 Rs

One R: Reduce the use of natural resources: Example Lean Production

Three R: Reduce; Reuse, and Recycle

Four Rs: Reduce, Reuse, Recycle and Recovering

Six Rs: Reduce, Reuse, Recycle, Recovering, Redesign, and Remanufacturing

Ten Rs – see next slide

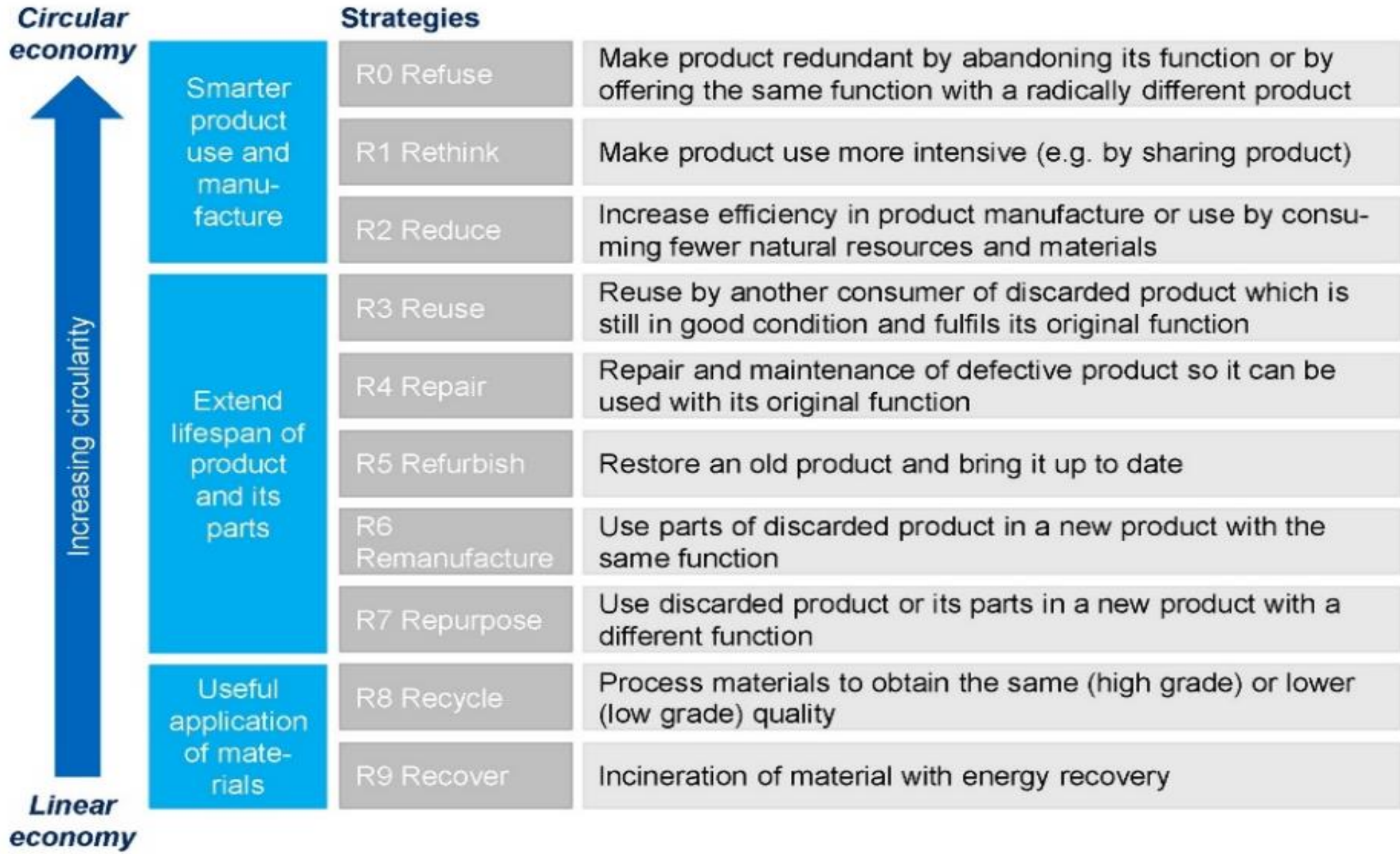


Fig-01 Source: Kirchherr, J., Reike, D., & Hekkert, M. 2017.

Discuss 10 R model

Two Questions

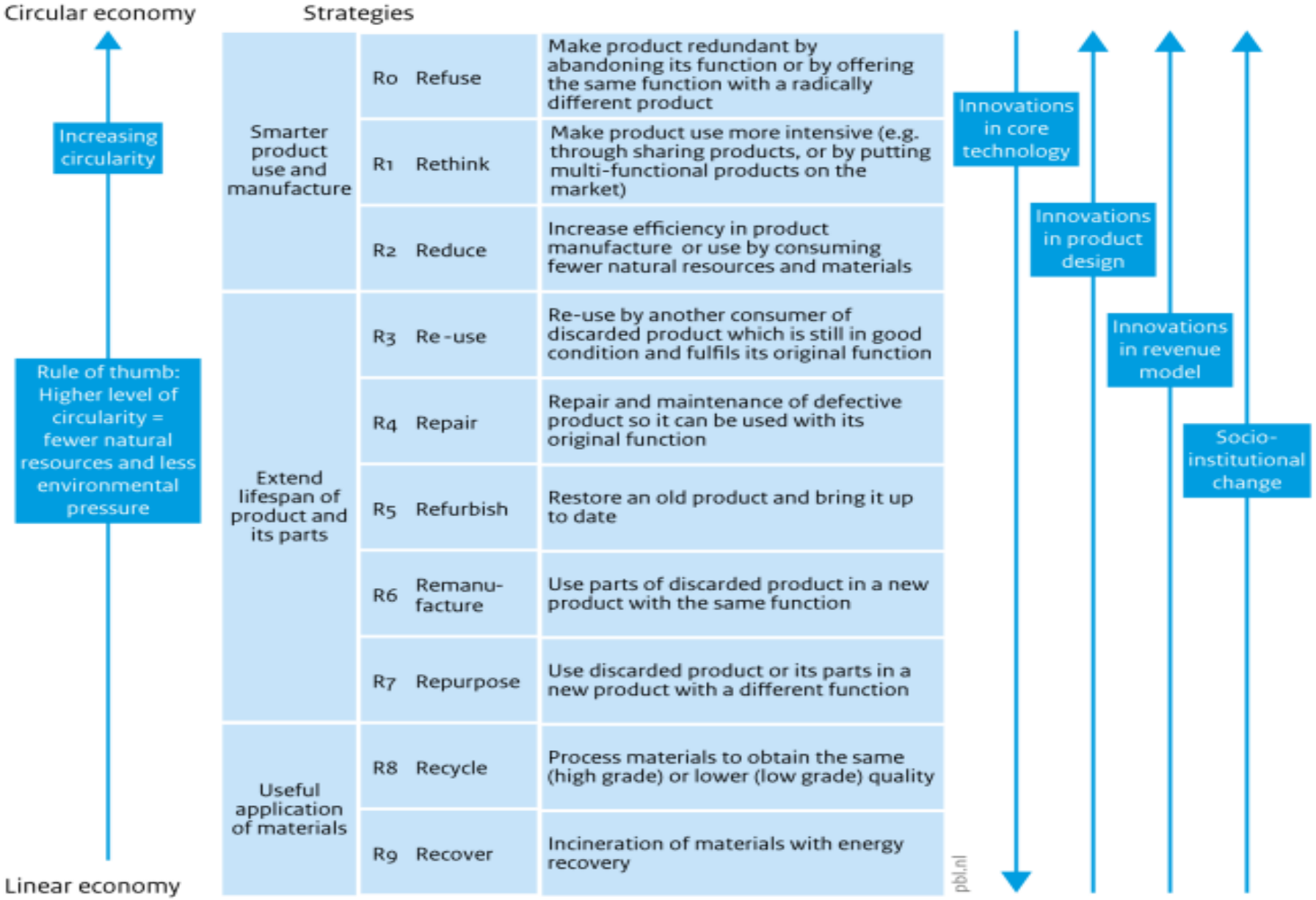
1. Provide examples of actions at each of the 10 Rs – using the garment value chain as the foundation.
2. Are you missing any Rs – are their CE activities that are not included – for example non-material activities

10 R-model

Refuse	Refuse: preventing the use of raw materials;
Rethink	Rethink: Make product use more intensive, e.g. sharing
Reduce	Reduce: reducing the use of raw materials;
Reuse	Reuse: product reuse (second-hand, sharing of products);
Repair	Repair: maintenance and repair;
Refurbish	Refurbish: refurbishing a product;
Remanufacture	Remanufacture: creating new products from (parts of) old products;
Repurpose	Repurpose: product reuse for a different purpose;
Recycle	Recycle: processing and reuse of materials; and
Recover	Recover energy: incineration of residual flows.

Figure 1

Circularity strategies within the production chain, in order of priority

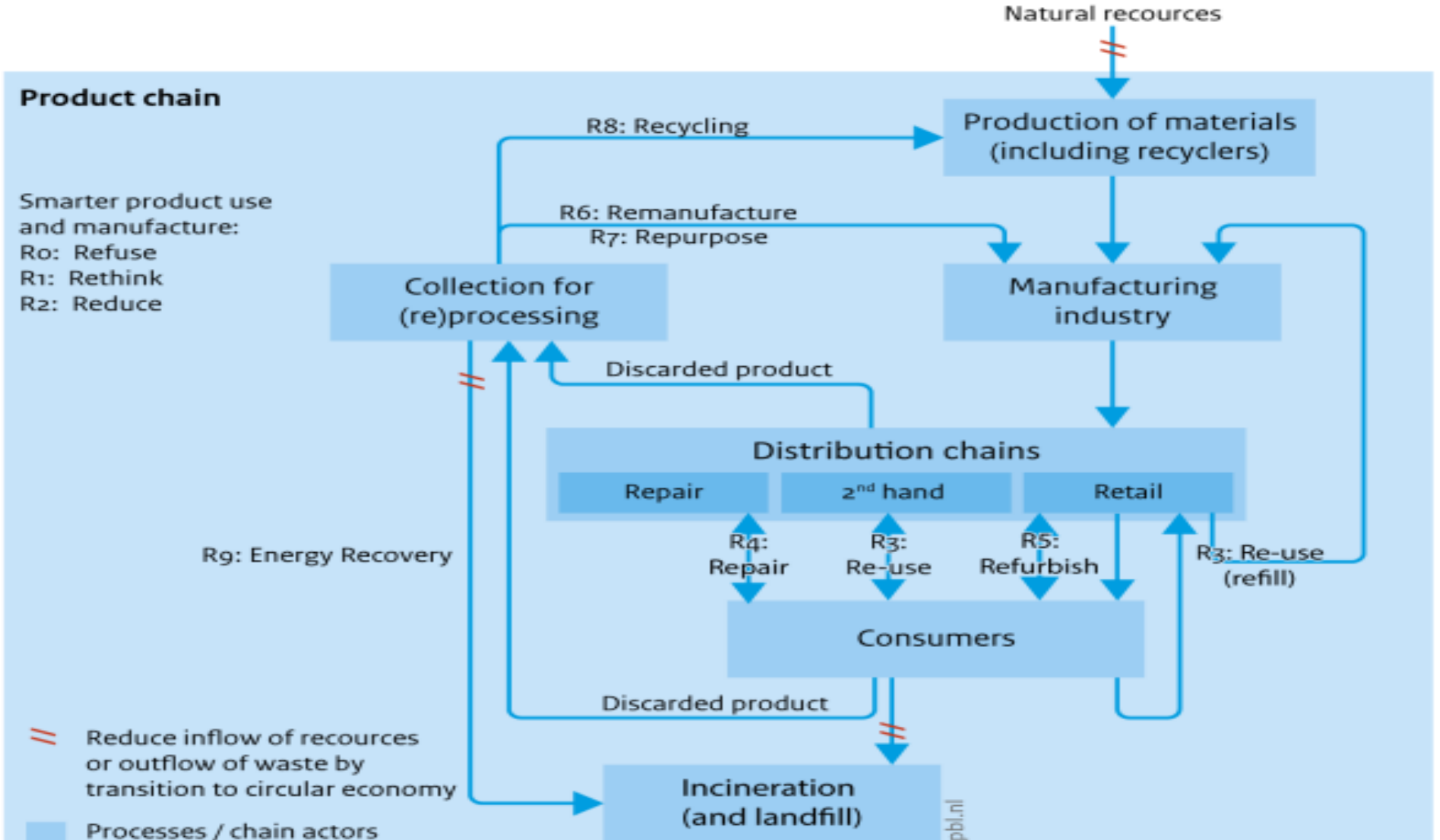


Source: RLI 2015; edited by PBL

Position the 10Rs in the Value Chain

Figure 2.2

Circularity strategies and the role of actors within the production chain

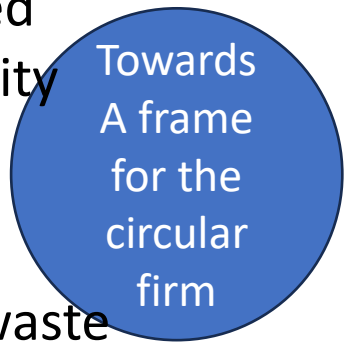


Towards a Theory of Circular Firms embedded in Circular Value Chains.

Summarizing/Integrating the discussion so far, it seems that we have some building blocks for a circular firm and value chain framework

The circular firm with a **dual objective:** Growth and Sustainability(not growth under condition of sustainabilit

The Waste Hierarchy providing **a typology** of circular activities organized according to their impact on sustainability



The circular firm **integrating** the corporate/globalvalue chain with the waste hierarchy

The **VC upgrading** literature orienting the four up activities in a sustainable direction (upgrade in the perspective of sustainability impact)

Steps: Choice of firm/value chain → Map the activities/actors in the corporate and external value chain →Position the 10Rs in the map of the value chain → rank the activities according to circular impact, complexity and costs→Prepare an implementation plan.

Findings from an Empirical CE Study of Firms in Denmark

*What activities are included and implemented

*How far (scope) are they in their adoption

*How engaged (deep) are they in their adoption

*Can specific groups of firms be identified

*What can we learn from this study

Table 1: The Rate (yes/no) of Adoption of CE Activities.

	Yes	No	NA
Minimize resource consumption	70 %	28 %	1 %
Sorting and recycling of waste	92 %	8 %	0 %
Use of recycled materials in production	48 %	39 %	13 %
Extensions of Product Lifecycle	32 %	60 %	8 %
Improvement of Product Repairability	31 %	66 %	3 %
Using sustainability in marketing	68 %	30 %	3 %
Introduction of new sales models	32 %	64 %	3 %

Table 2: The Extent of Adoption of CE-Activities

	To high extent	To some extent	To less extent	Not at all	Don't know	NA
Minimize resource consumption	61 %	26 %	11 %	3 %	0 %	1 %
Sorting and recycling of waste	50 %	29 %	13 %	8 %	0 %	0 %
Use of recycled materials in production	14 %	16 %	18 %	17 %	22 %	13 %
Extensions of Product Lifecycle	7 %	15 %	11 %	28 %	32 %	8 %
Improvement of Product Repairability	9 %	15 %	7 %	19 %	47 %	3 %
Using sustainability in marketing	16 %	27 %	24 %	27 %	3 %	3 %
Introduction of new sales models	5 %	11 %	16 %	36 %	28 %	3 %

Table 3. The 10R-model (waste Hierarchy) and the position of the Seven CE activities of this Study.

R-no	R-categories	R-text	Explanation	CE-activity in this study	Adoption Rate/High Degree (%)
R1	Smarter Product Use and Manufacture	Refuse (redundant or redesign)	Make products redundant or redesign products with the same function.		
R2		Rethink	Make product use more intensive (e.g., sharing)/Reverse logistics/Servitization	*Introduction of New Sales Modes	32/5
R3		Reduce/Reuse	Reduce the use of natural resources	*Minimize Resource Use	70/61
R4	Extend Lifespan of products and its parts	Re-use	Use discarded products by other users/for other products	*Extensions of Product Lifecycle	32/7
R5		Repair	Repair to use the original function/Marketing to guide consumers	*Improvement of Product Repairability *Use sustainability in your marketing	31/9 68/16
R6		Refurbish	Restore an old product		
R7		Remanufacture	Use parts of discarded products in a new product with the same function		
R8		Re-purpose	Use discarded products or its parts in a new product with a different function		
R9	Useful Application of Materials	Recycle	Process materials to obtain higher or lower quality	*Use of recycled materials in production *Sorting and Recycling of Waste	48/14 92/50
R10		Recover +end of life	Incineration (burning) of materials with energy recovery		

Table 6. Summary of Findings from Class Analysis *

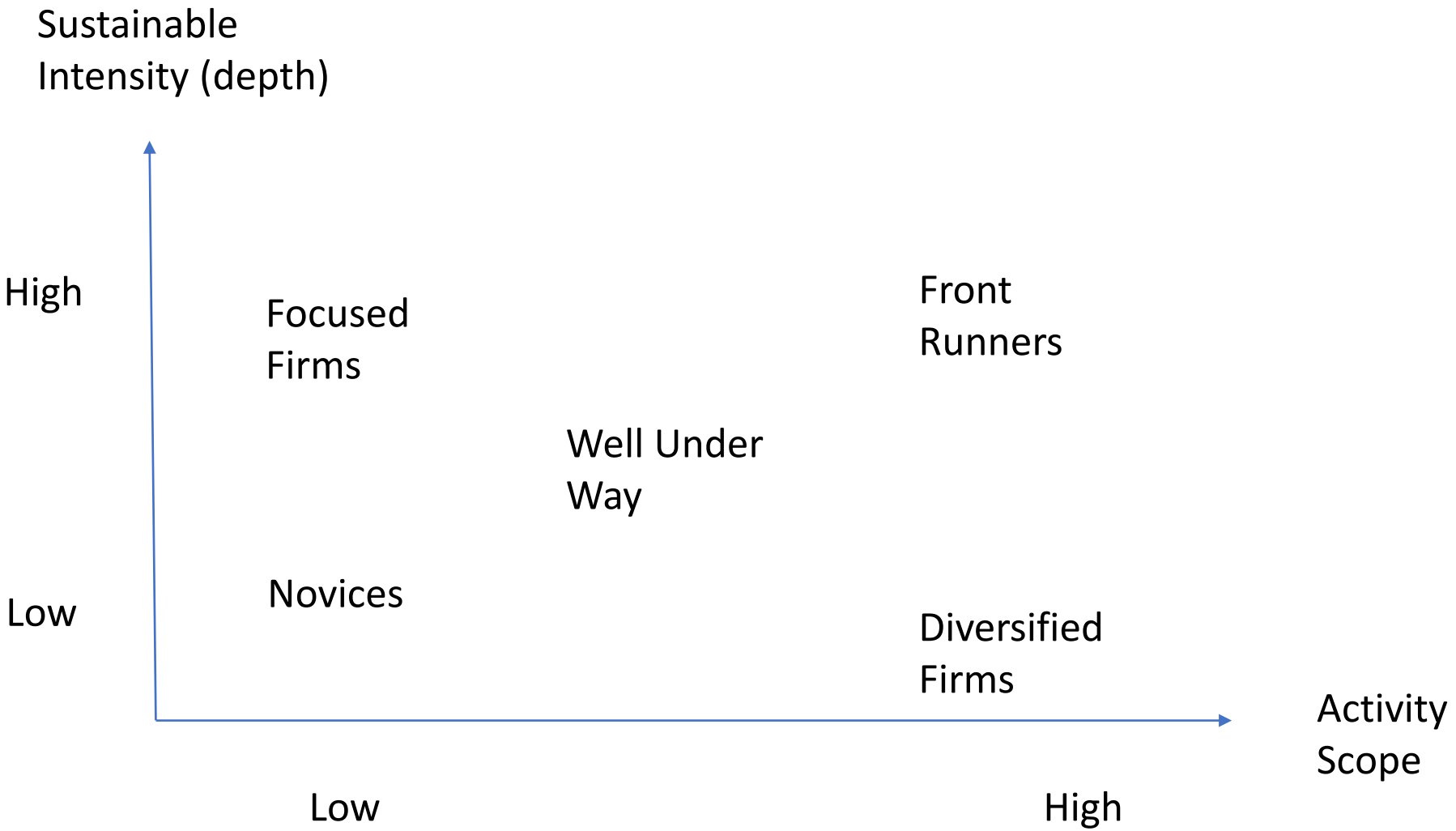
1	Number of Class	Class 1	Class 2	Class 3	Class 4
2	Name of Class	Novices	Recyclers	Frontrunners	Laggards
3	Size of Class (% of firms)	39.3	25.9	13.0	21.8
4	Average Implementation Probability (high, some, and less) (%)	53.1 (2)	52.3 (3)	91.5 (1)	44.8 (4)
5	Average Implementation Probability (high)	28.8 (2)	32.7 (1)	13.2 (3)	8.0 (4)
6	Average Implementation Probability (lower-order activities)	93.5 (3)	96.9 (2)	100 (1)	85.2 (4)
7	Average Implementation Probability (higher-order activities)	32.9 (2)	30.0 (3)	87.3 (1)	25.0 (4)
8	Average Non-Implementation Probability (not at all)	37.1 (4)	4.1 (2)	2.2 (1)	14.2 (3)
9	Average Non-Implementation Probability (not relevant)	9.9 (2)	43.7 (4)	4.1 (1)	41.0 (3)
10.	Average of dominant probabilities across higher-order activities (%)	52.4	65.5	68.6	61.5

Table 4. The Breath and Intensity of CE Implementation among the Firms

		Breadth	
		Low (1-4 CE activities)	High (5-7 CE-activities)
Intensity	High (3rd quantile)	**Cell 3** 53 (34.87%)	**Cell 6** 21 (13.82%)
	Medium (2nd quantile)	**Cell 2** 7 (4.61%)	**Cell 5** 31(20.40%)
	Low (1st quantile)	**Cell 1** 1 (0.66%)	**Cell 4** 39 (25.66%)

Strategies
1. Focused (cell 3)
2. Diversified (cell 4+5)
3. Advanced (cell 6)

Figure 2. Sustainable Intensity and Acitivity Scope



CE Activity Issues – qualifying the R-models

*Higher and lower order CE activity: Complexity of implementation

*Circularity level: Many CE activities can be implemented at different circularity level, e.g. low energy bulbs versus green energy., i.e. a CE activity can have both a lower and higher order level

*Circularity impact: Different CE-activities have different impact, but no clear pattern related to the adoption.

*Ordering the CE activities along the value chain provides a better link to the theory of the firm

*We need to go beyond barriers, motives, strategies, and business models and have more Insight into what firms actually do.

Table 8. Complexity Level and Governance of CE Activities

Internal/External Governance→ Complexity Level ↓	Internal Capability Based Solution	External Market/Partnership Based Solution
High Complexity	Redesign Products	Sales Modes with Reverse Distribution
Low Complexity	Recycle Scrap Internally	Selling Scrap on the Market

Higher complexity often requires collaboration with external partners

CE Strategies

Three overall CE strategies/pathways:

1. Efficiency, i.e. produce by using less natural resources (efficiency to reduce)
2. Innovation, i.e. produce using redesigned process and products
3. Extend, i.e. recycle to keep resources in the resource loop