

Hoe digitale technologie gaat helpen om circulair beter te presteren.

Business Software Event – 31 mei 2022 – Arjen Wierikx

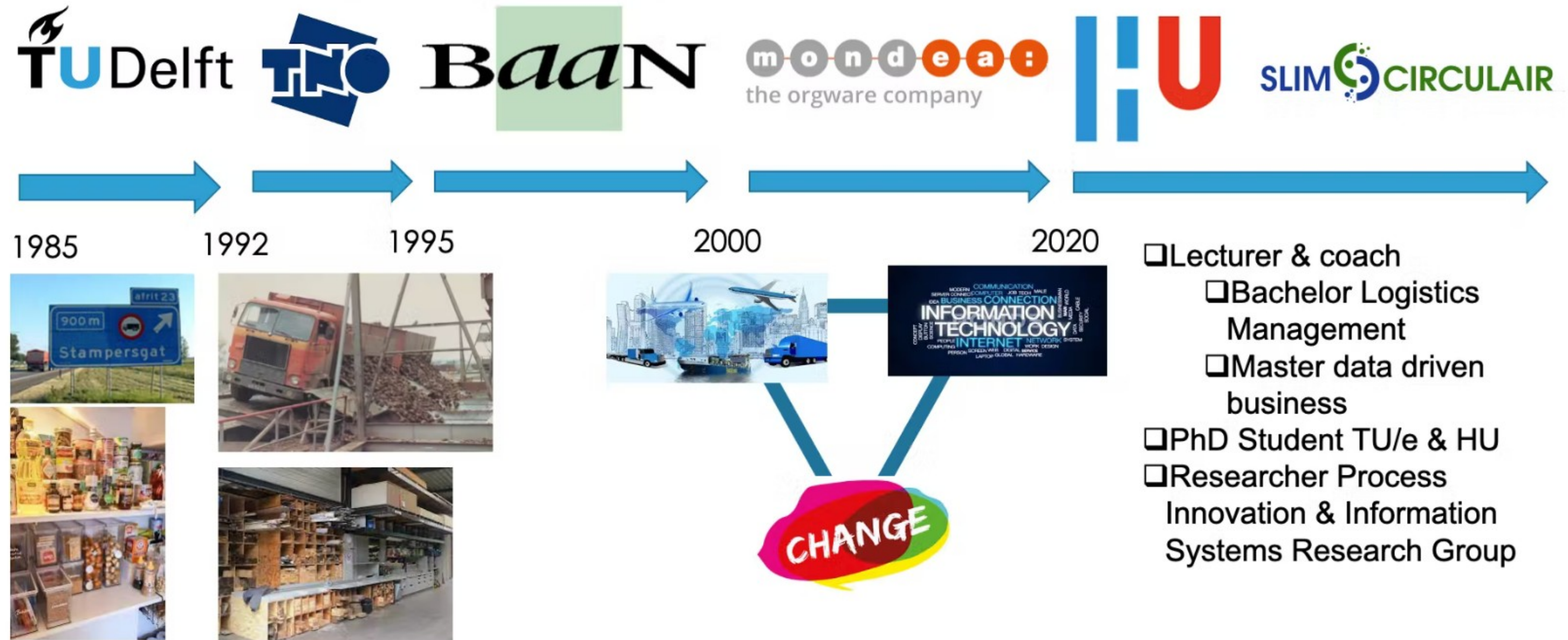
Disclaimer: research in progress

Agenda

- Waar staan u en ik?
- Wat is circulariteit
- Circulaire prestatie
- Digitale technologie en circulaire prestatie
- Het Physical Internet helpt

Short introduction Arjen Wierikx

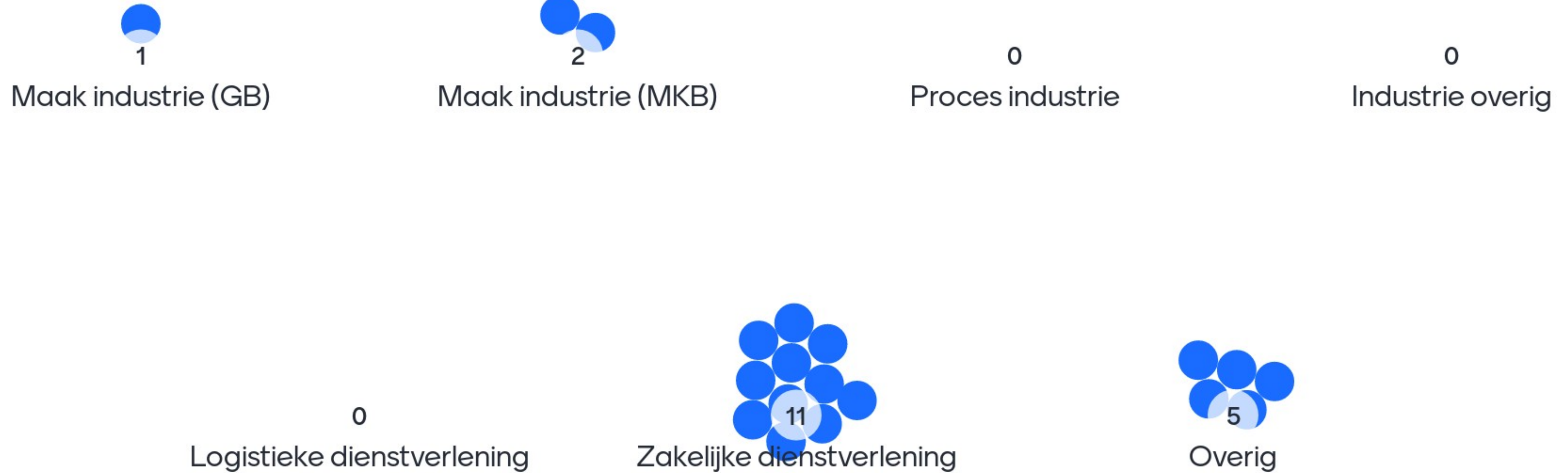
Passion for logistics, allergy to waste



In welke regio zit uw organisatie



Wat voor type bedrijf vertegenwoordigt u?



Wat is uw functie binnen het bedrijf?



Directeur / eigenaar



MT-Lid / manager



teamleider



adviseur

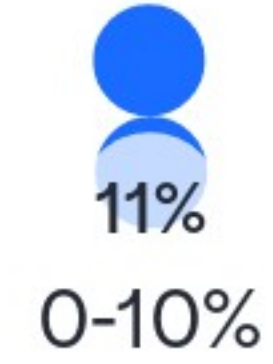
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ondersteunende dienst



anders

Hoe circulair is uw organisatie





Waar staan we?

- Governments around the world announce the ambition to be 100% circular by 2050 (EC, 2011);
- By 2020 the world was 8,6% circular (CGRI, 2020)
- In 2005 the world was 5% circular. An increase of 3,6% in 15 (!) years. (CGRI, 2020)
- If we do not change our behaviour, we will hardly reach 20% in 2050
- What is the point in time company X, Y, Z could say: "now I'm 100% circular"?

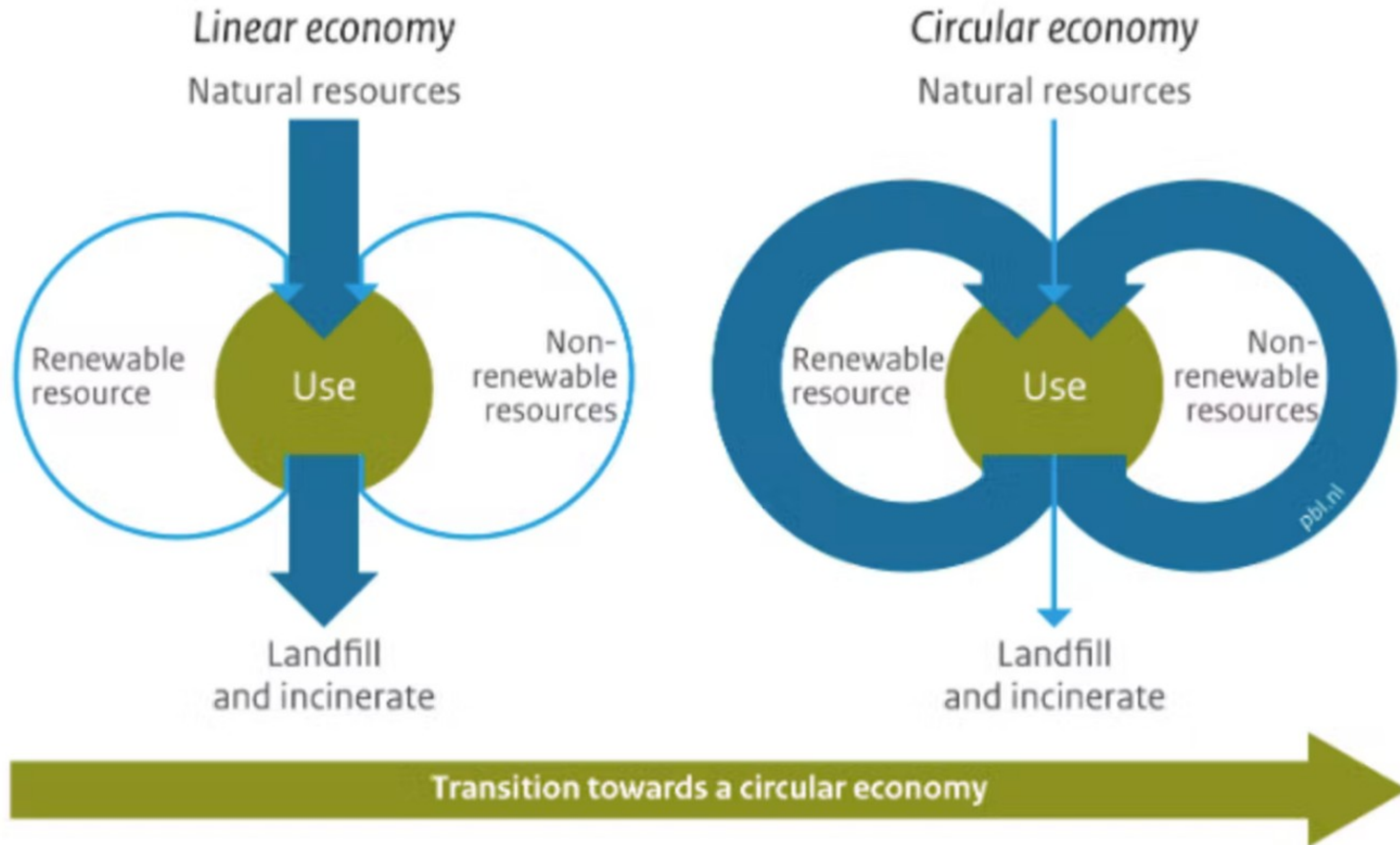
the Netherlands

THE NETHERLANDS IS
24.5% CIRCULAR.

Major overhauls to the framework of the national economy - including jobs - will be necessary to achieve the government's ambitions of a fully circular economy by 2050.



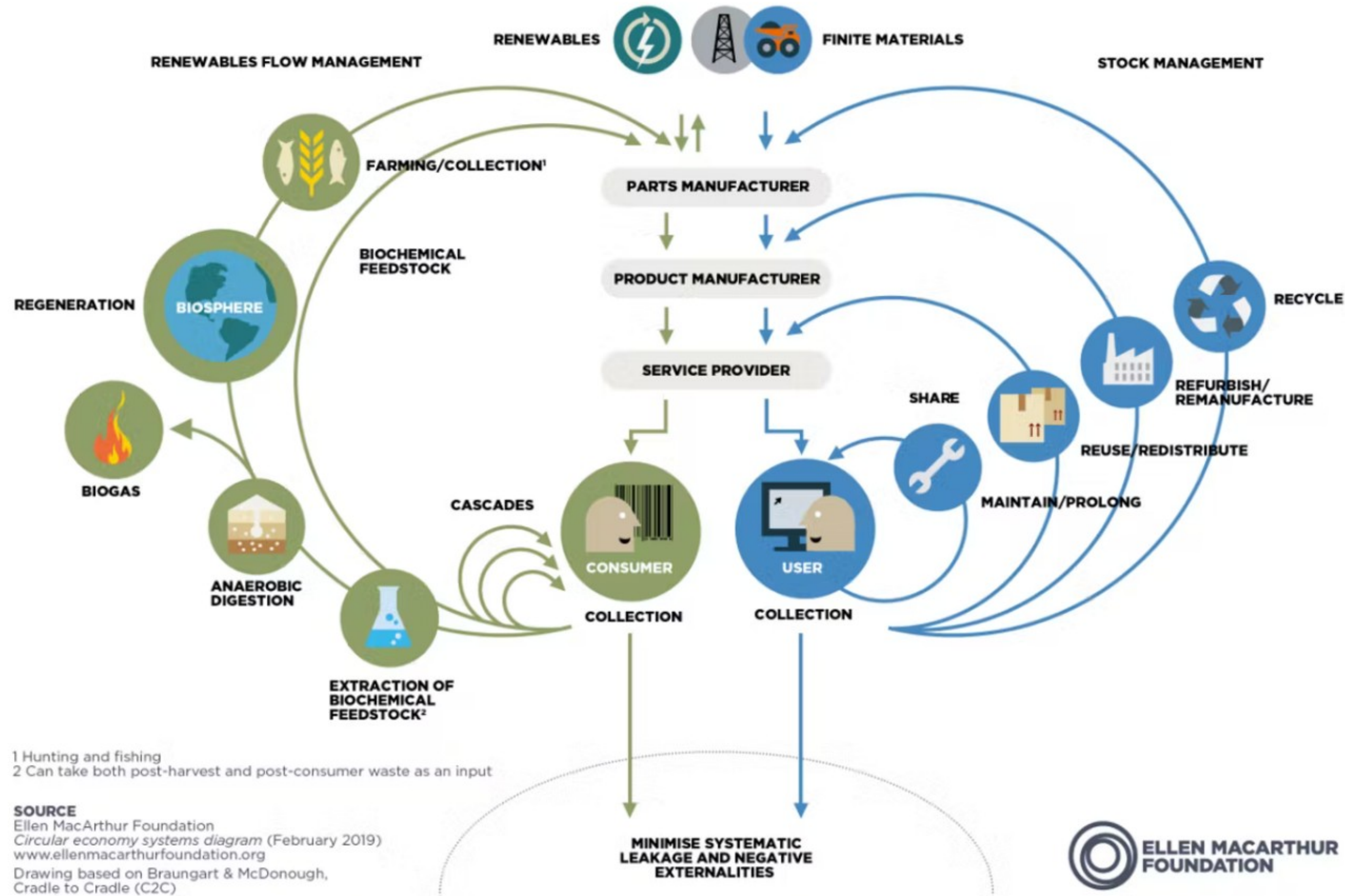
24.5%



Source: PBL 2016

www.pbl.nl

Van Lineair naar circulair



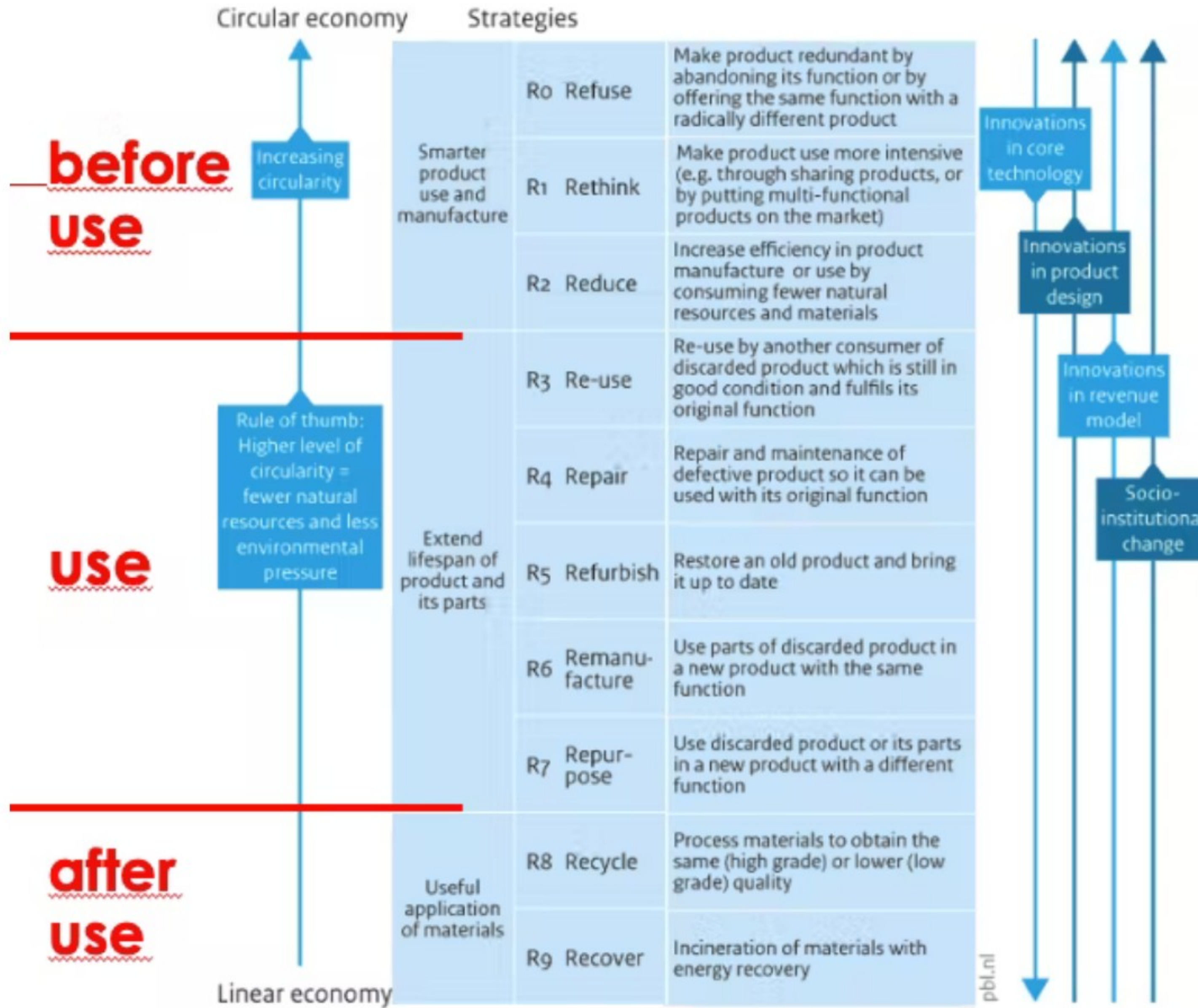
Wat is een
circulaire
economie?
114 definities
(Kirchherr et al.,
2017)

A circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles

– *Ellen MacArthur Foundation (2013)*

De R strategie



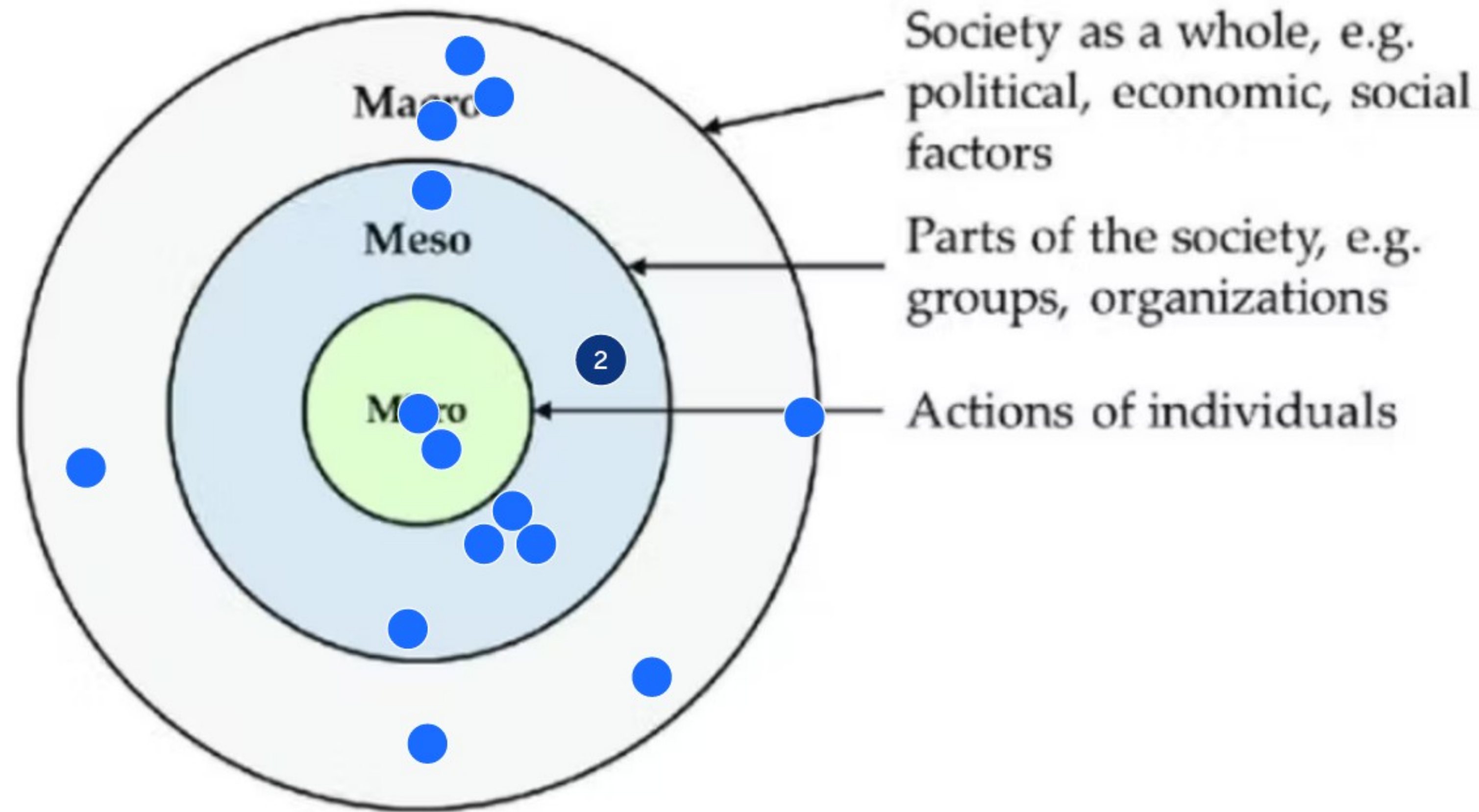


Wat kan ik met die circulaire economie?

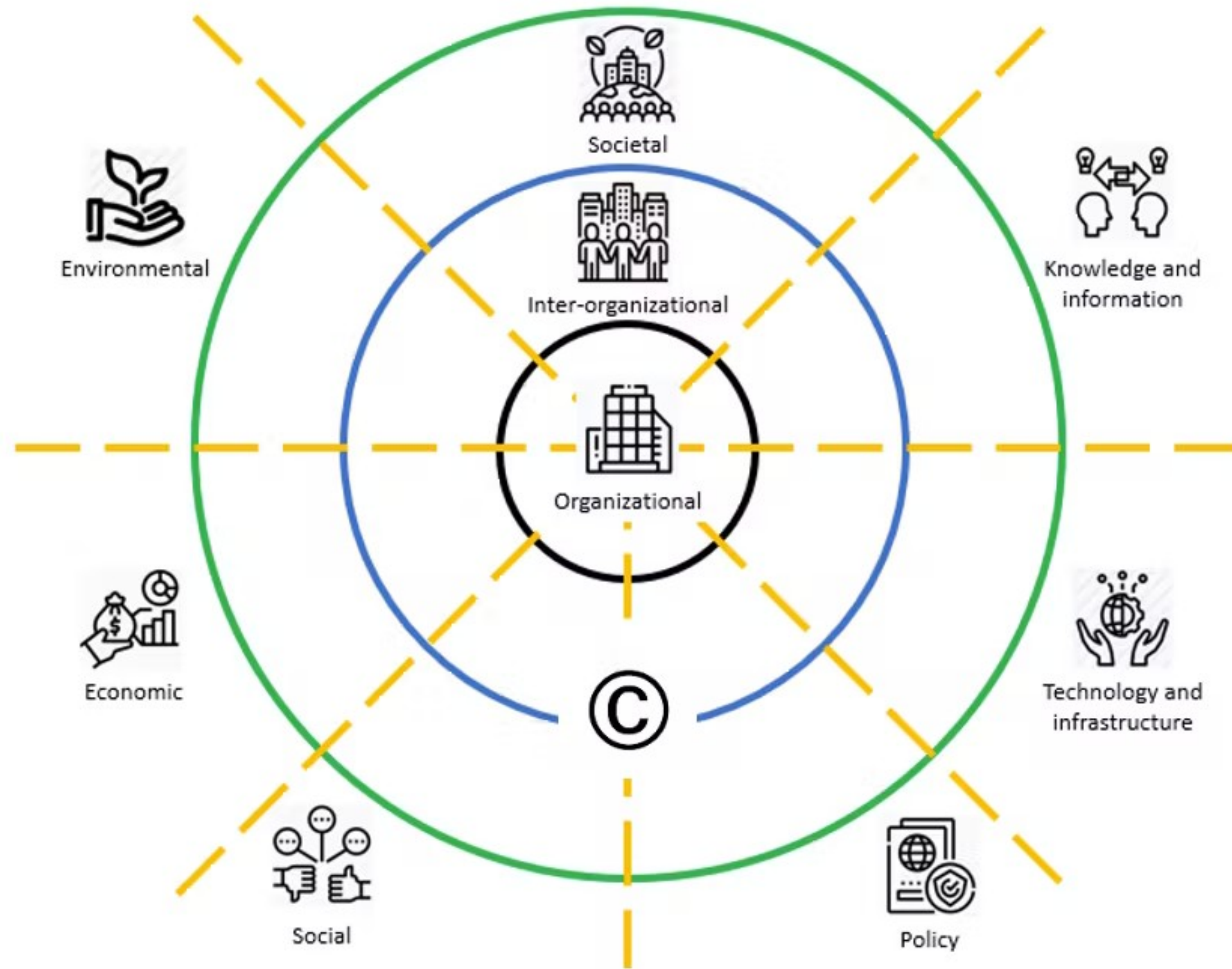
Circular strategies within the production chain, in order of priority
Potting, J., et. al. (2017)



Naar welk denken gaat uw voorkeur uit?



Macro, meso and micro level overview (Javaid, Javed & Kohda, 2019)



Six categories:

1. Economic

Drivers related to the market and financial

2. Environmental

Drivers related to the environment

3. Knowledge & Information

Drivers related to knowledge and information sharing

4. Policy

Drivers related to policy, guidelines and regulations

5. Social

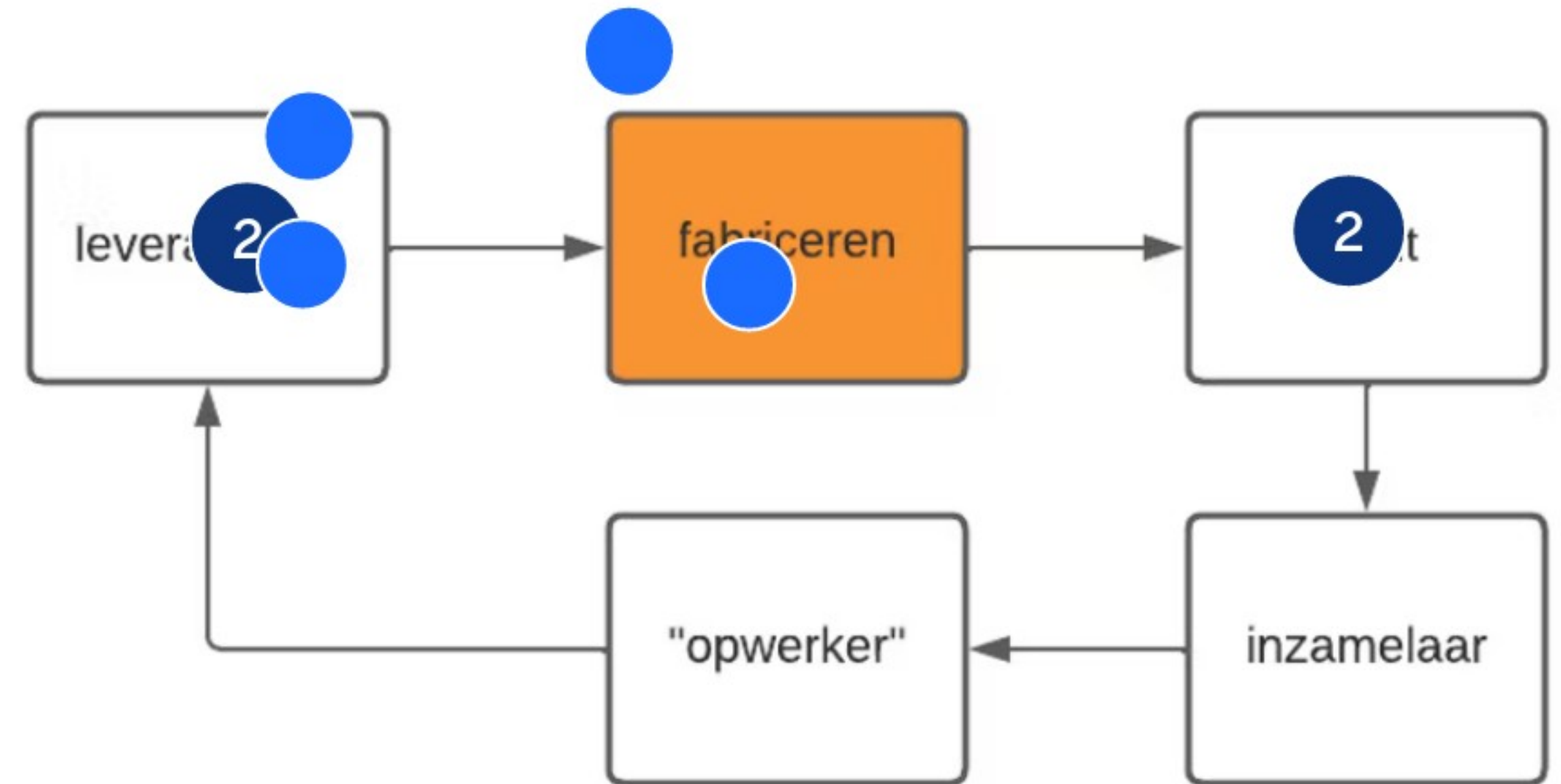
Drivers related to motivation, awareness and pressure

6. Technology & Infrastructure

Drivers related to technologies and physical infrastructure

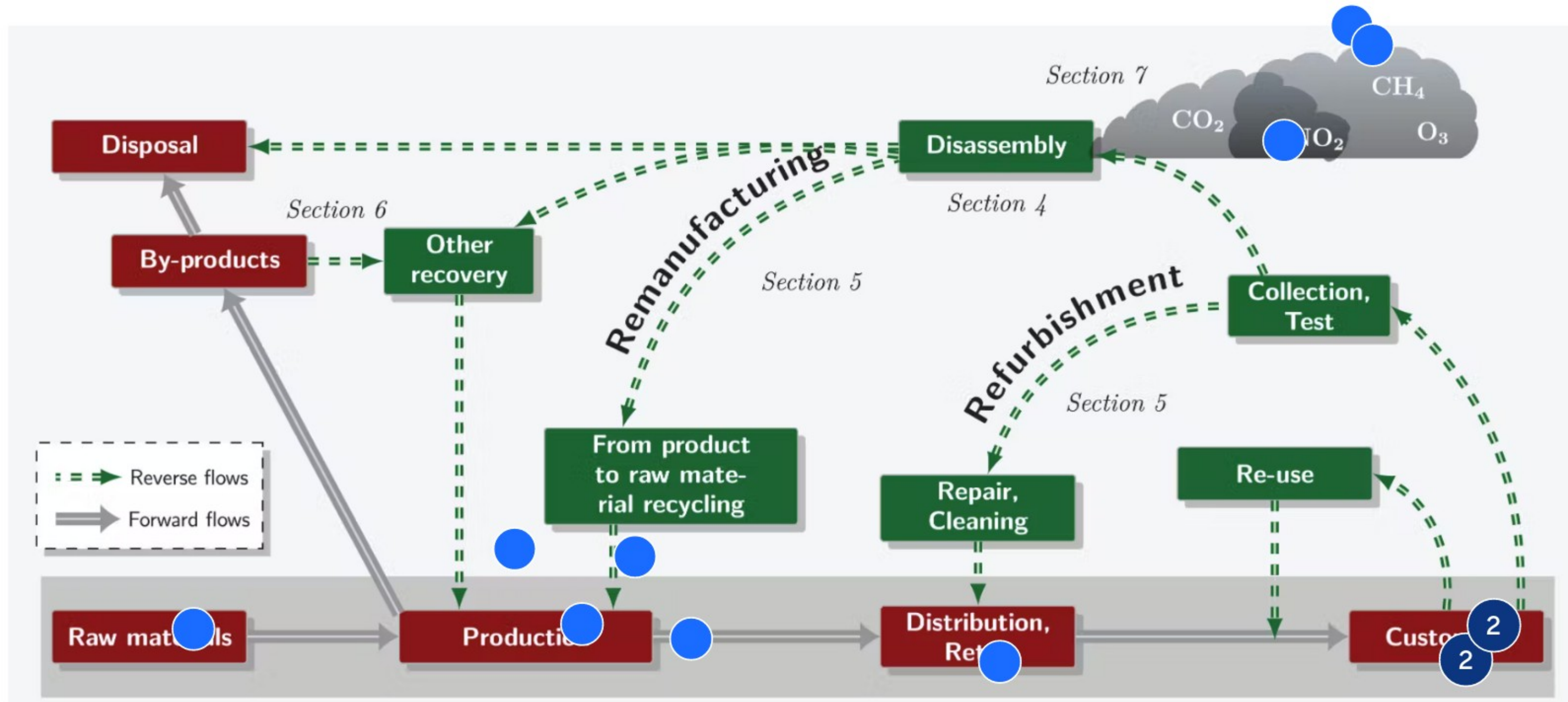
Circular Business Model Drivers - Pieroni et al., 2019

Waar zit u?

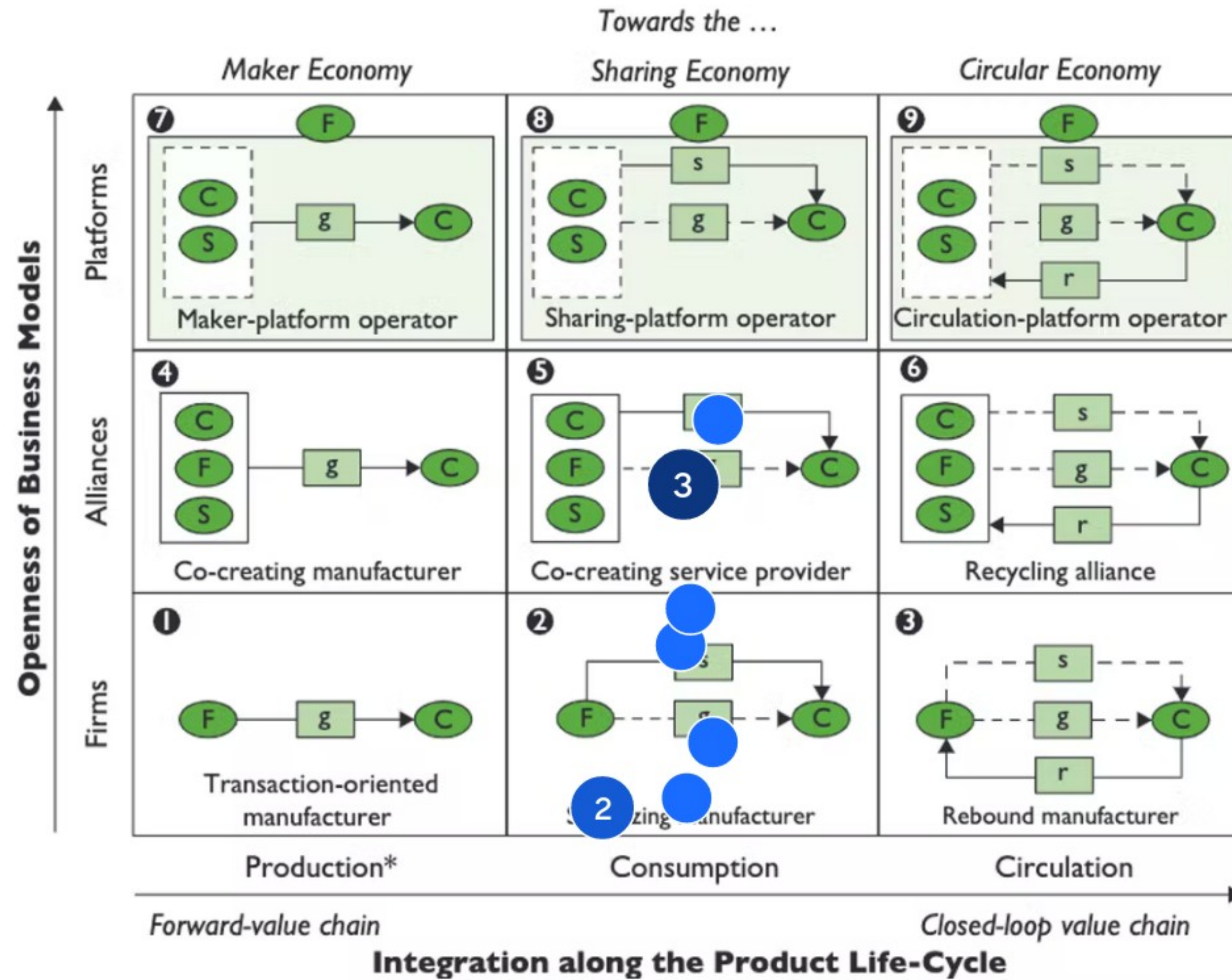


En waar bevindt uw onderneming zich hier?

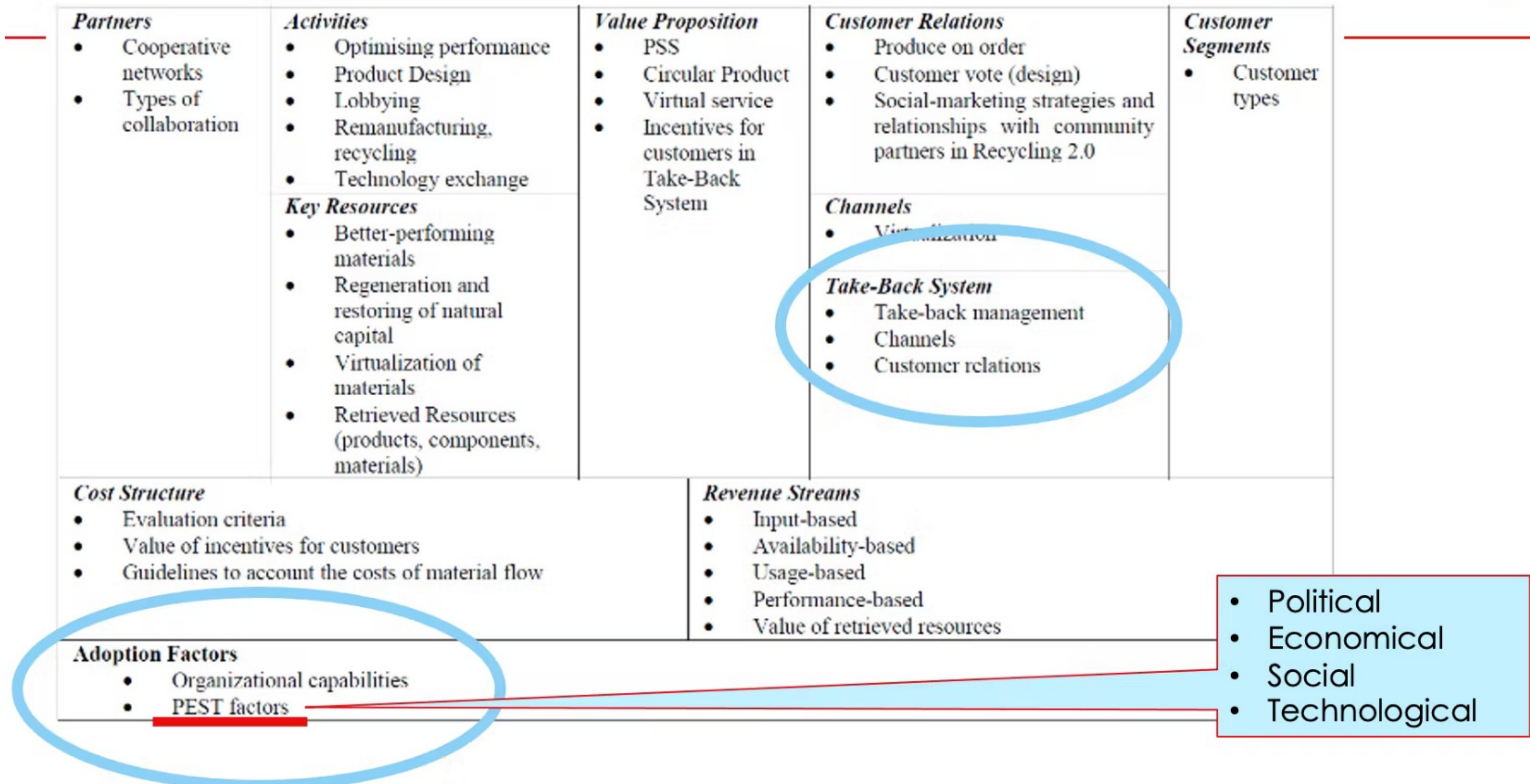
(Suzanne et al., 2020)



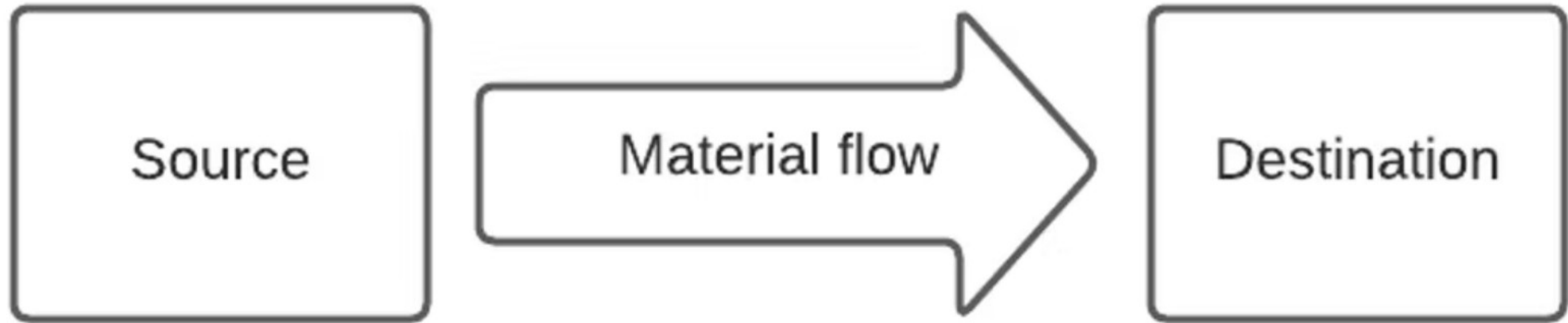
In welk vak zit uw onderneming nu?



In een
circulaire
economie kun
je bedrijven
niet meer in
isolement
bekijken
Kortmann & Piller
(2016)



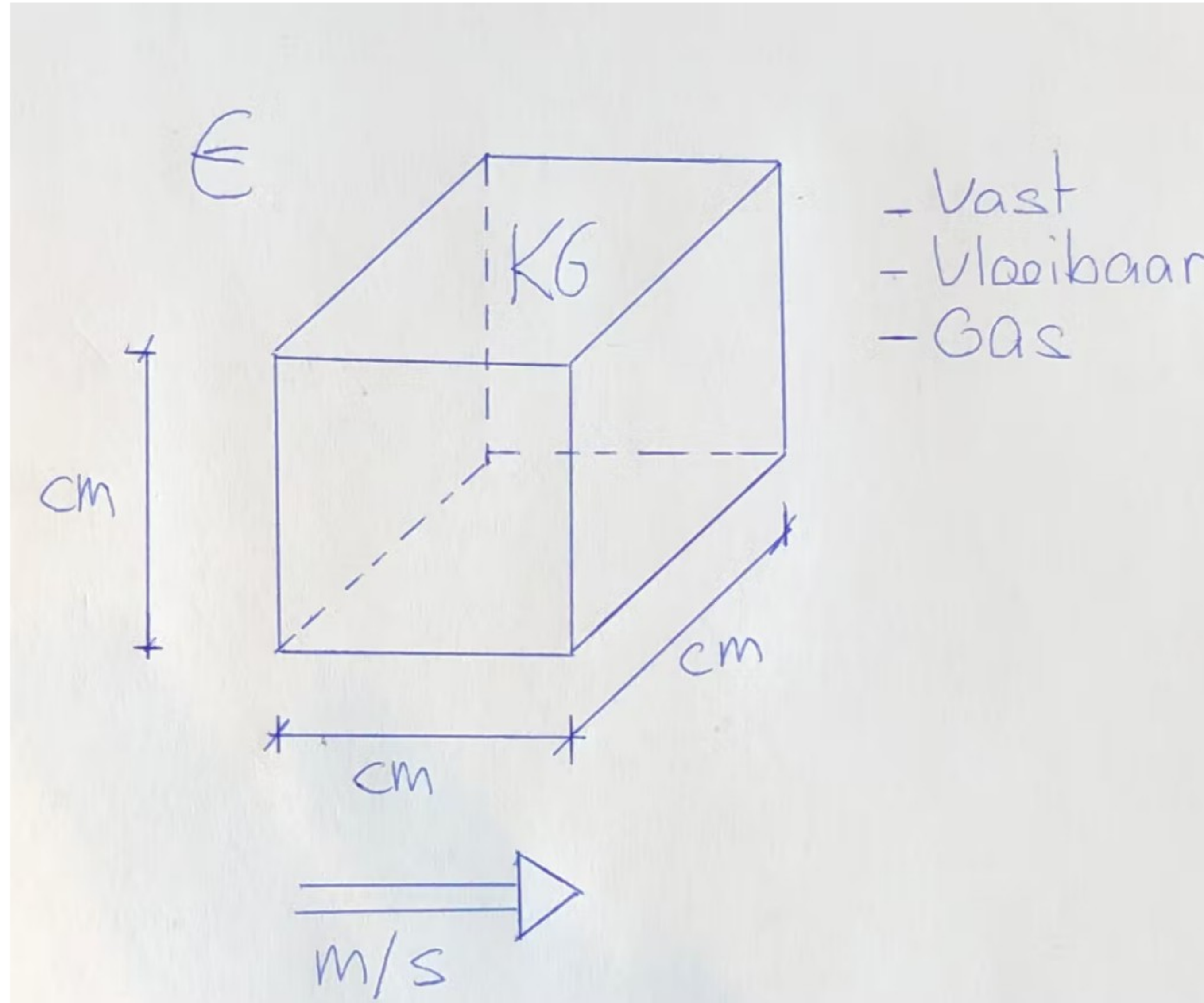
Circular Business Model Canvas (Lewandowski, 2015 / Osterwalder & Pigneur, 2010)



Materiaal stromen gaan van bron naar bestemming

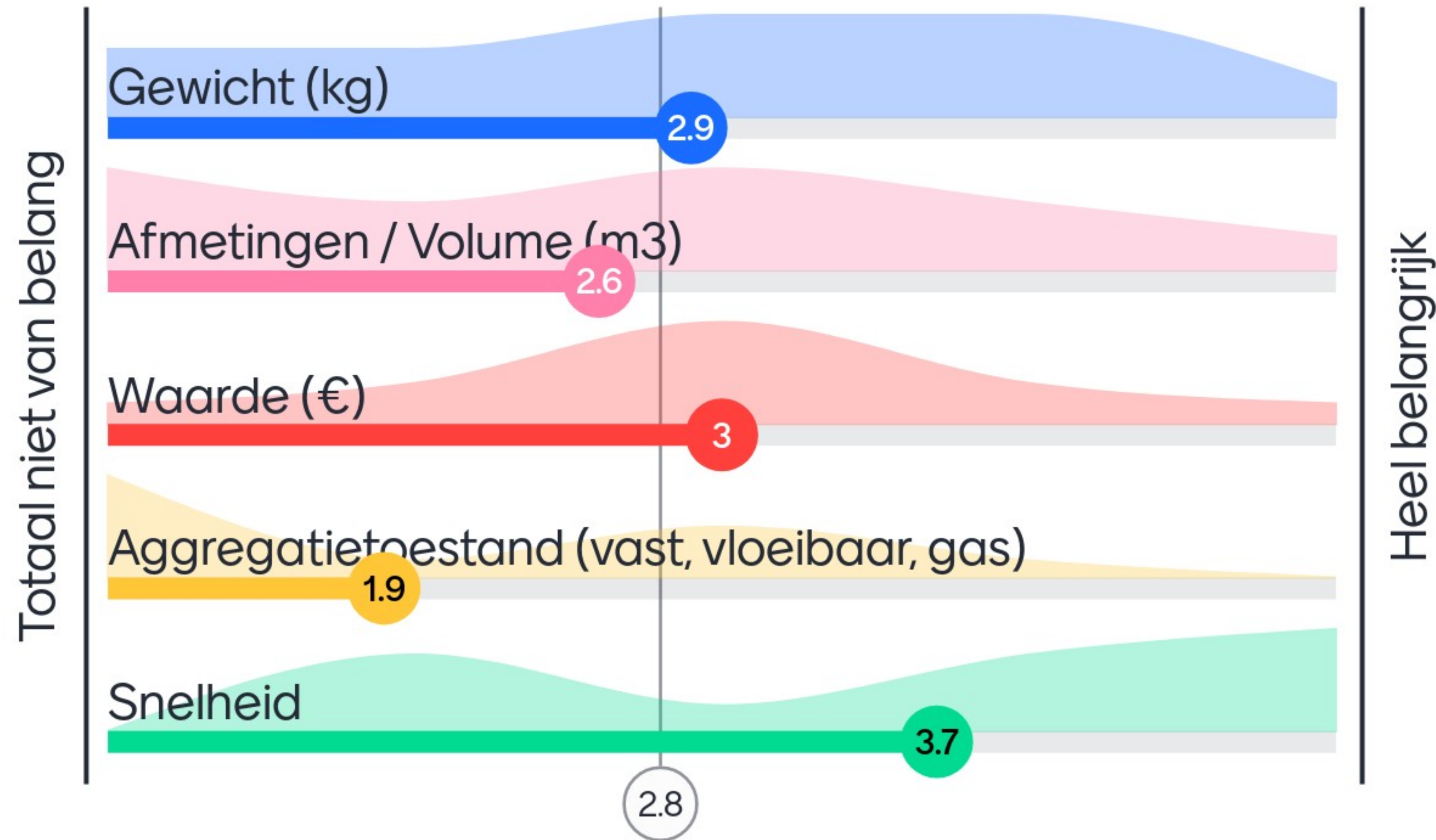
Wat zijn EIGENSCHAPPEN van de MATERIAALSTROOM?

doorloop distributie
just in time soortgelijk gewicht
transformeren te veel plastic
loop herkomst
zolang geen groei gelijk
fysieke beweging
geen idee



Eigenschappen van een materiaalstroom

Welk belang kent u toe aan de eigenschap van de materiaalstroom (in relatie tot circulariteit)?



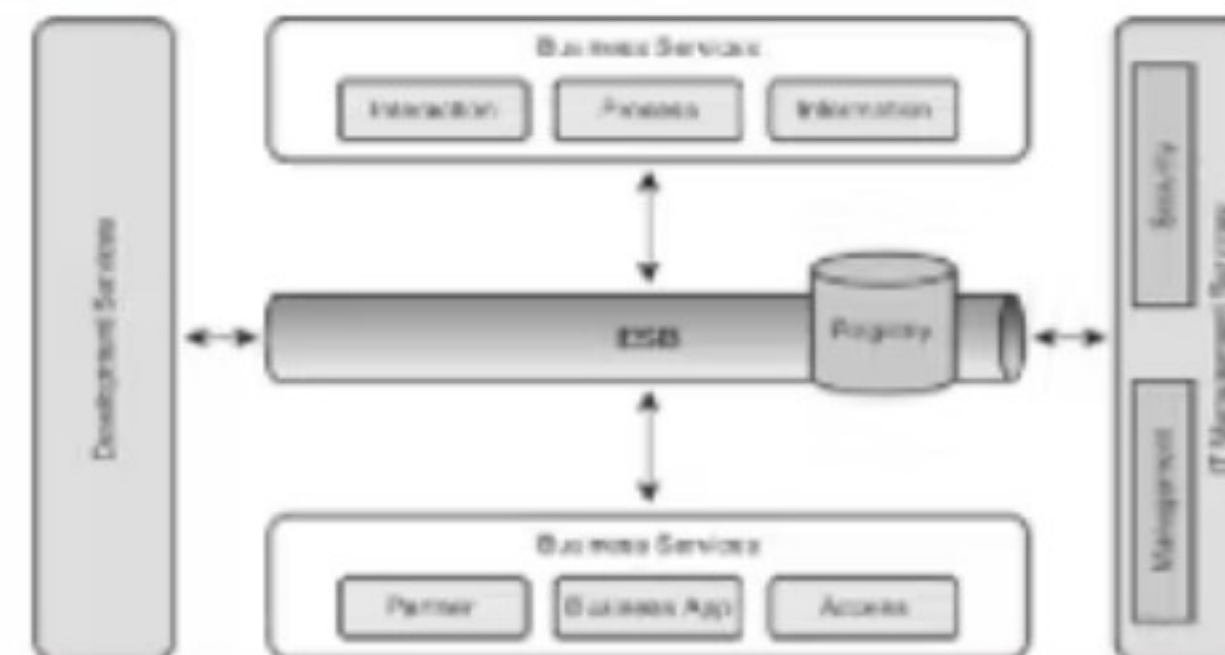
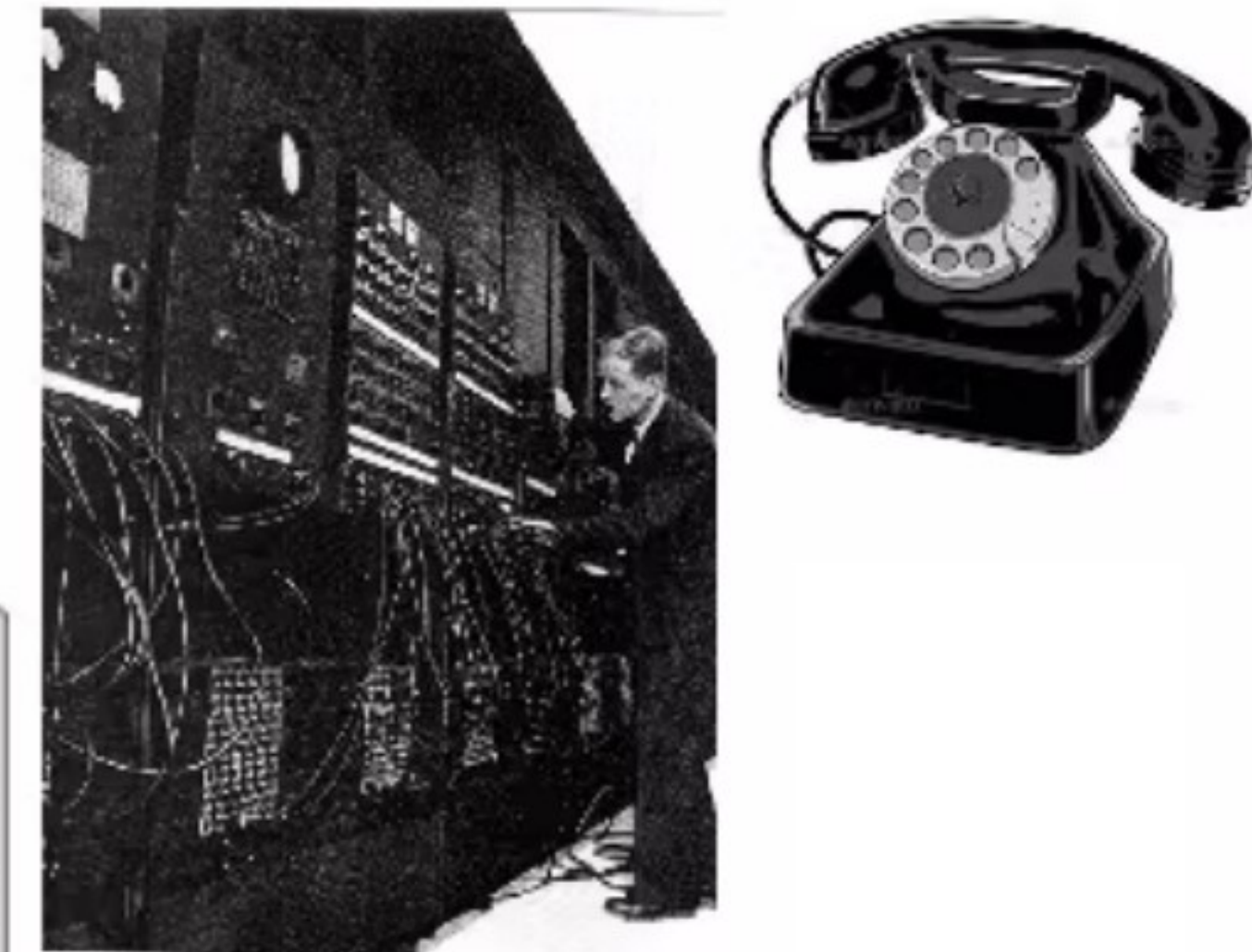
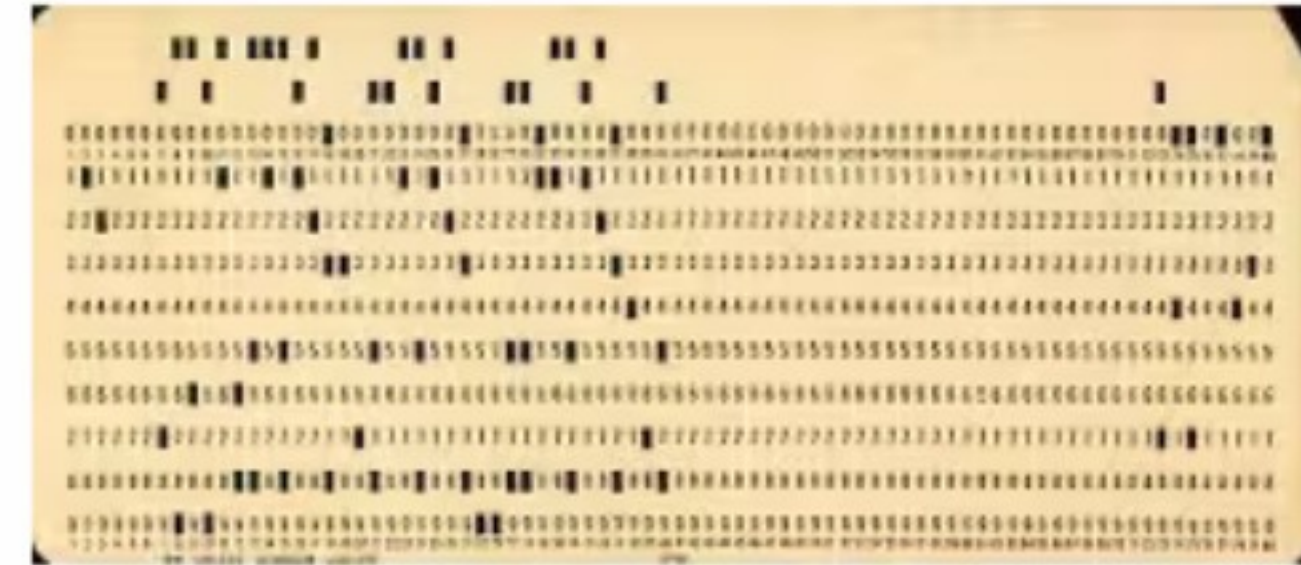
Material flows are triggered by information delivered through an information carrier



INTERNATIONAL MORSE CODE

MORSE CODE, A TYPE OF COMMUNICATION USING A STANDARDIZED SEQUENCE OF DOTS AND DASHES TO TRANSMIT TEXT INFORMATION, HAS BEEN USED SINCE THE EARLY 19TH CENTURY. IT WAS FIRST INVENTED BY ALEXANDER STEPHEN MORSE IN 1844 AND WAS ACTIVELY USED IN SHIPPING AND AIRCRAFT COMMUNICATIONS UNTIL THE 1970S.

A ·—	M —·—	Y —·—·
B —···	N —·	Z —···
C —·—·	O ———	1 —·—·—
D —··	P —···	2 —··—·
E ·	Q —·—·	3 —··—·
F —···	R —··	4 —··—·
G —·—	S —··	5 —··—·
H —···	T —	6 —··—·
I ··	U —··	7 —··—·
J —·—·	V —···	8 —··—·
K —···	W —··—	9 —··—·
L —···	X —···	0 —··—·



Digital Technology is the application of a systematic technique, method, or approach, involving the recording or storing of data as a series of the numbers 1 and 0 in order to solve a problem

– *The author*

Lenzen van digitale technologie

- Ondersteunen van *business functions* (Belik et al., 2019)
- *Historische* lens (Visser & van Goor, 2019);
- Digitale technologie *element* lens (Nambisan, 2017);
- *Front & Base* technologie lens (Frank et al., 2019);
- *Architectonische lagen* lens (Pagoropoulos et al., 2017);
- *Digitale functie* lens (Liu et al., 2022).

DATA



SORTED



ARRANGED



PRESENTED VISUALLY



EXPLAINED WITH A STORY

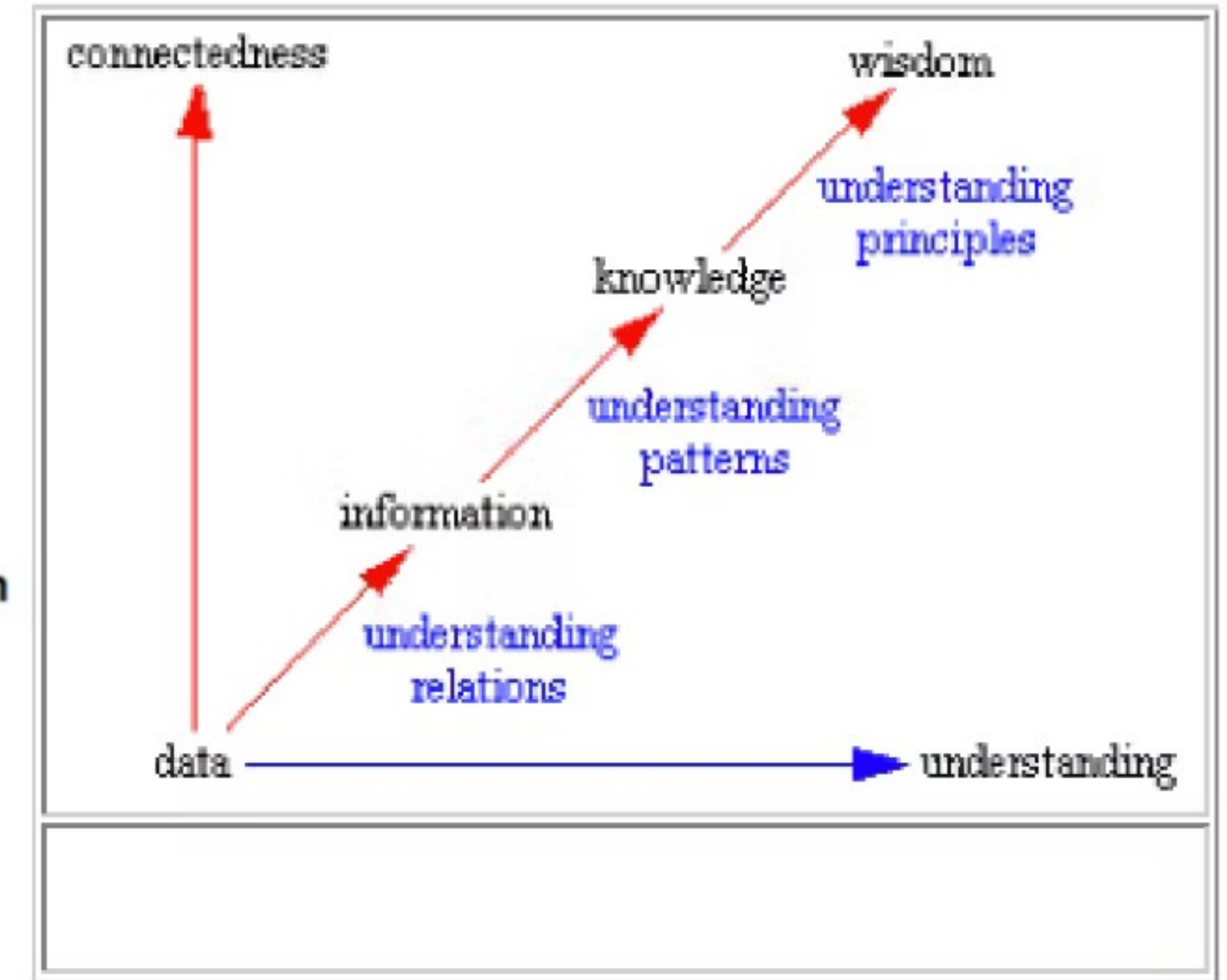
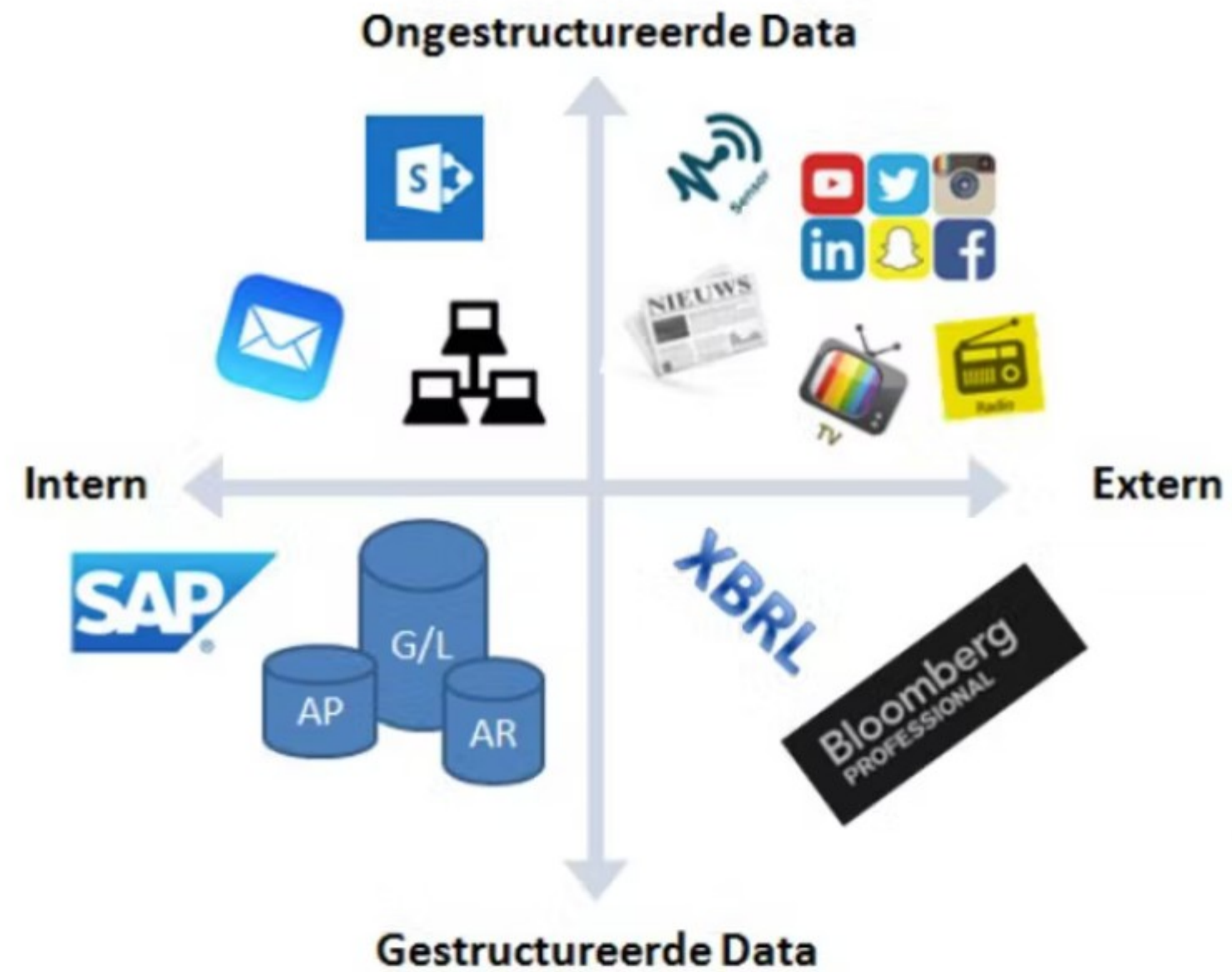


Figure 2. Transition through understanding

Informatie wordt afgeleid van data

A collection of 15 circles, 8 blue and 7 green, scattered on a light purple background. The circles are of two colors: blue and green. There are 8 blue circles and 7 green circles. They are scattered across the frame, with some appearing in pairs or small groups and others isolated. Each circle has a thick black outline. The background is a solid, light purple color.

A complex phylogenetic tree diagram illustrating evolutionary relationships. The tree features a central vertical backbone with numerous horizontal branches extending to the left and right. At the end of each branch is a circular node, colored either blue or green. The nodes are distributed across the entire height and width of the diagram, representing different species or groups. The branching pattern shows a hierarchical structure, with some nodes being more closely related than others.

A complex phylogenetic tree with 15 tips. The tips are colored either blue or green. Two tips are highlighted with a green halo: one at the top right and one at the bottom left. The tree structure is intricate, with multiple branching points and a central horizontal segment.

In 2020, the world will produce 64 zettabytes of digital data (10^{21} (1 sextillion) bytes)

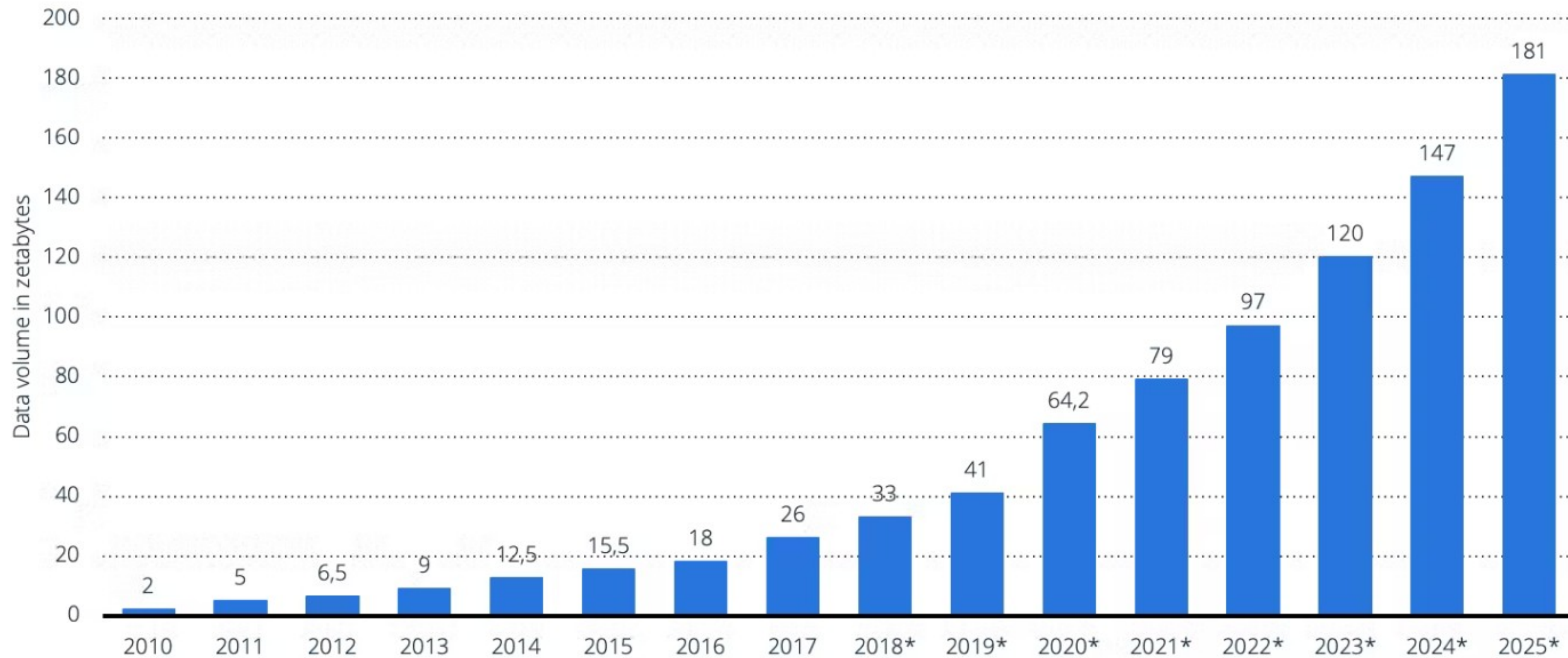


- B Byte
- KB Kilobyte
- MB Megabyte
- GB Gigabyte
- TB Terabyte
- PB Petabyte
- EB Exabyte
- ZB Zetabyte
- YB Yottabyte

- By 2025, 75 billion devices will be interconnected (Statista, 2016)
- 1.5 trillion photos are taken every day (van Beek, 2020)
- Only 1% of the data is used, 25%-37% is potentially valuable (van Beek, 2020)

Volume of data/information created, captured, copied, and consumed worldwide from 2010 to 2025 (in zettabytes)

Amount of data created, consumed, and stored 2010-2025

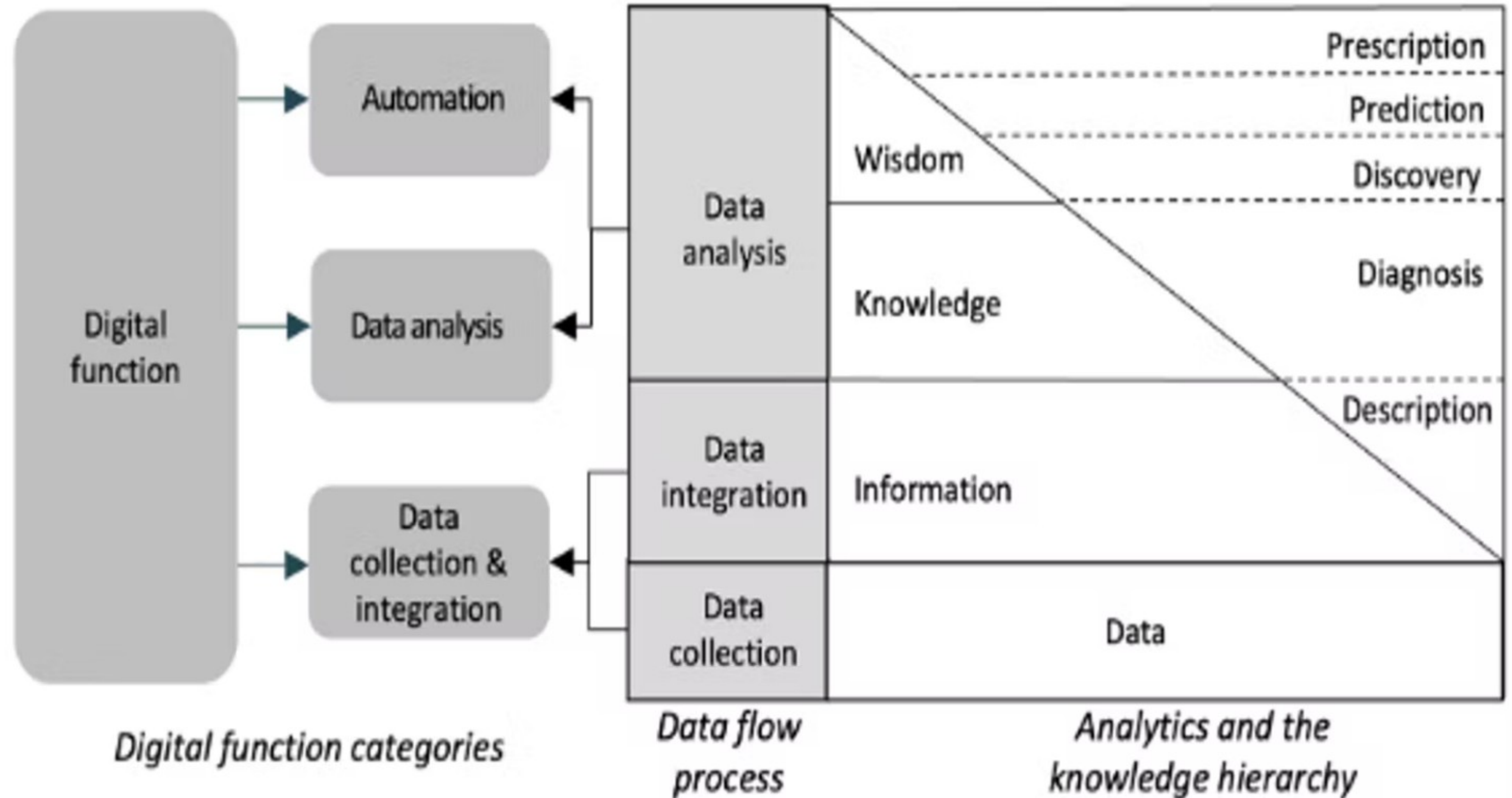


Note(s): Worldwide; 2010 to 2020

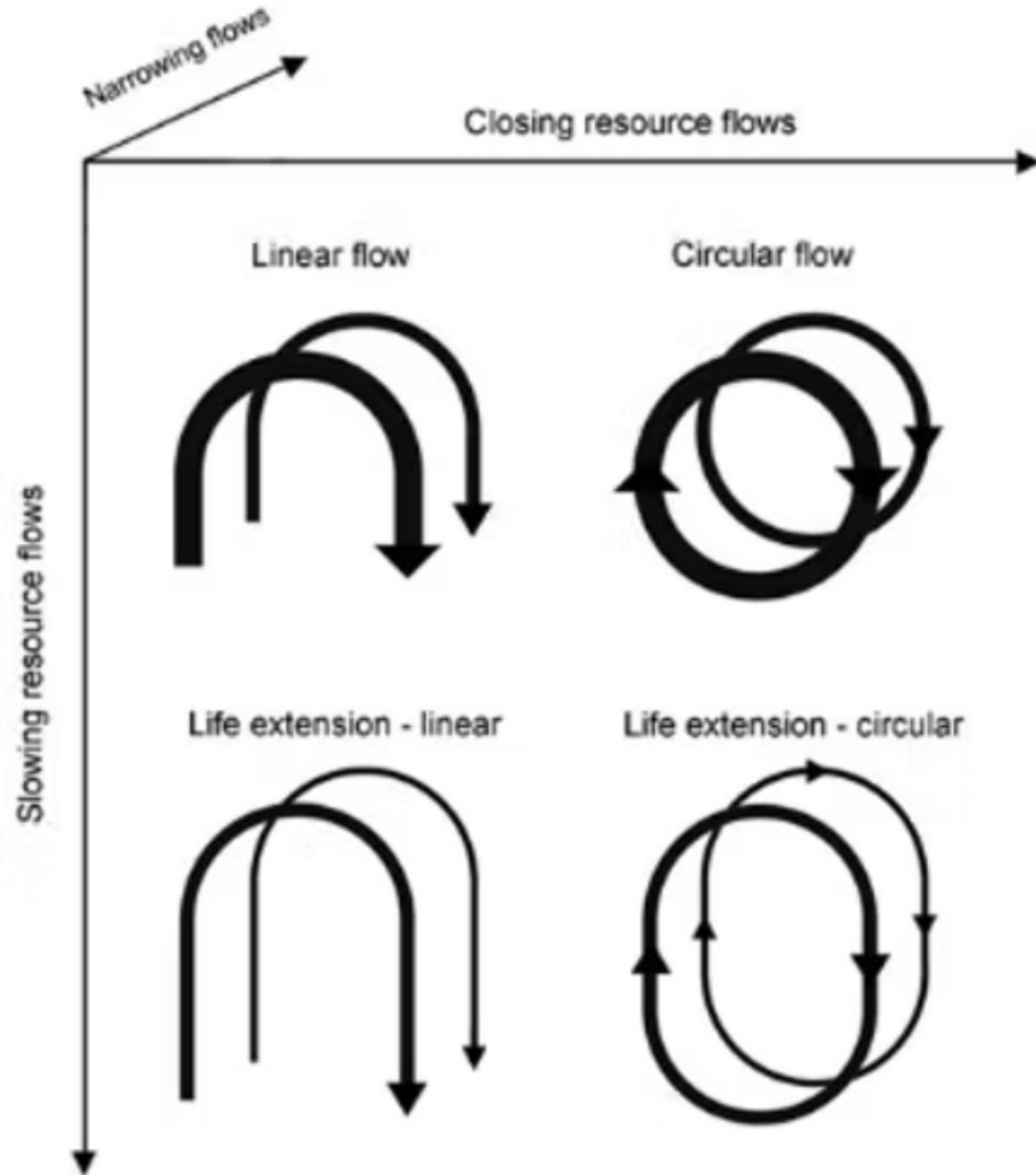
Further information regarding this statistic can be found on [page 8](#).

Source(s): IDC; Seagate; Statista estimates; [ID 871513](#)

- Auto-plan
- Auto-control
- Sort and classify
- Optimize
- Innovate
- Forecast
- Connect
- Assess
- Detect
- Track & Trace
- Monitor
- Share
- Collect



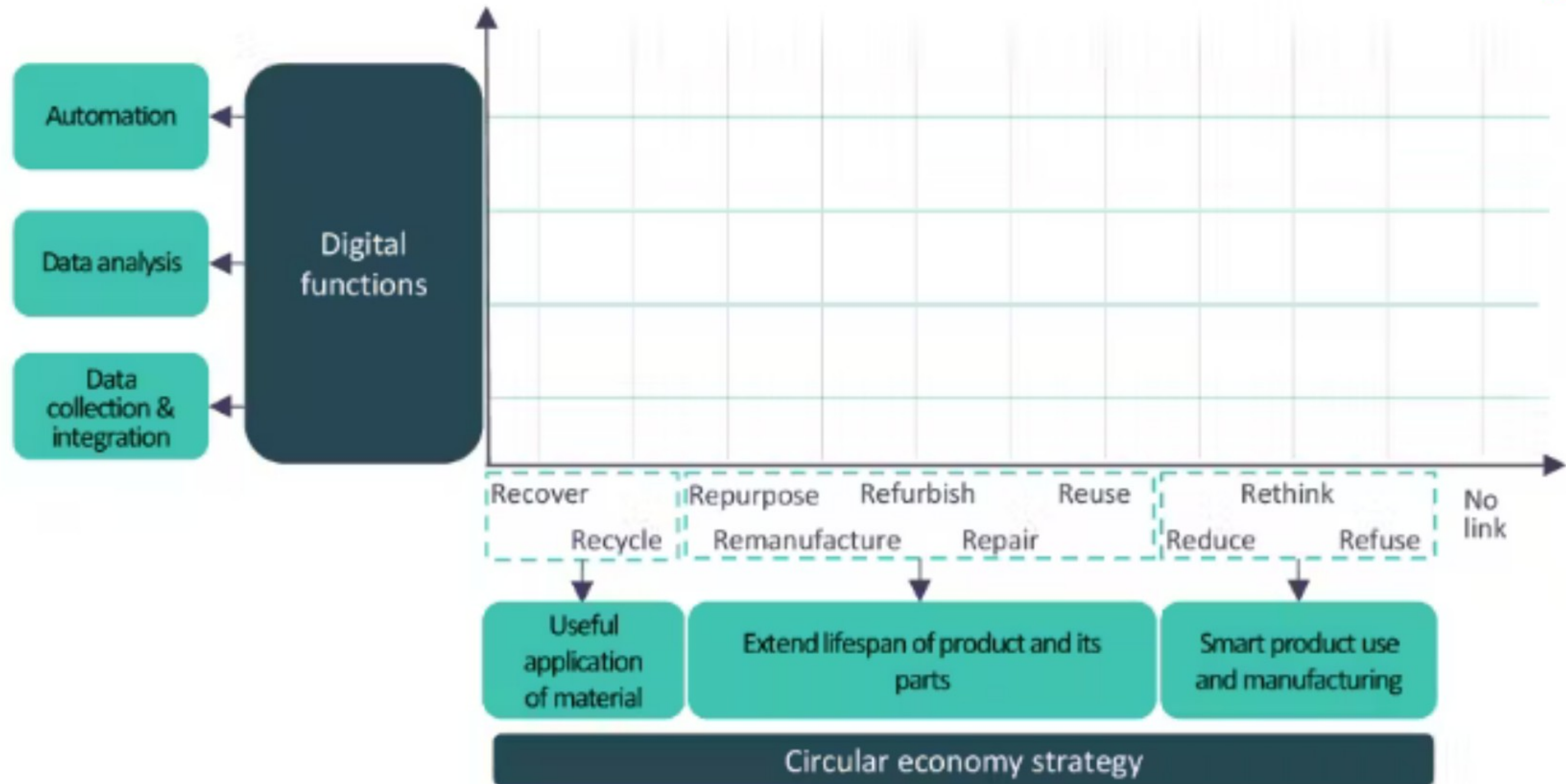
Digitale functie categorieën (Kristoffersen et. al., 2020, Siow et al., 2018 en Liu et al., 2022)



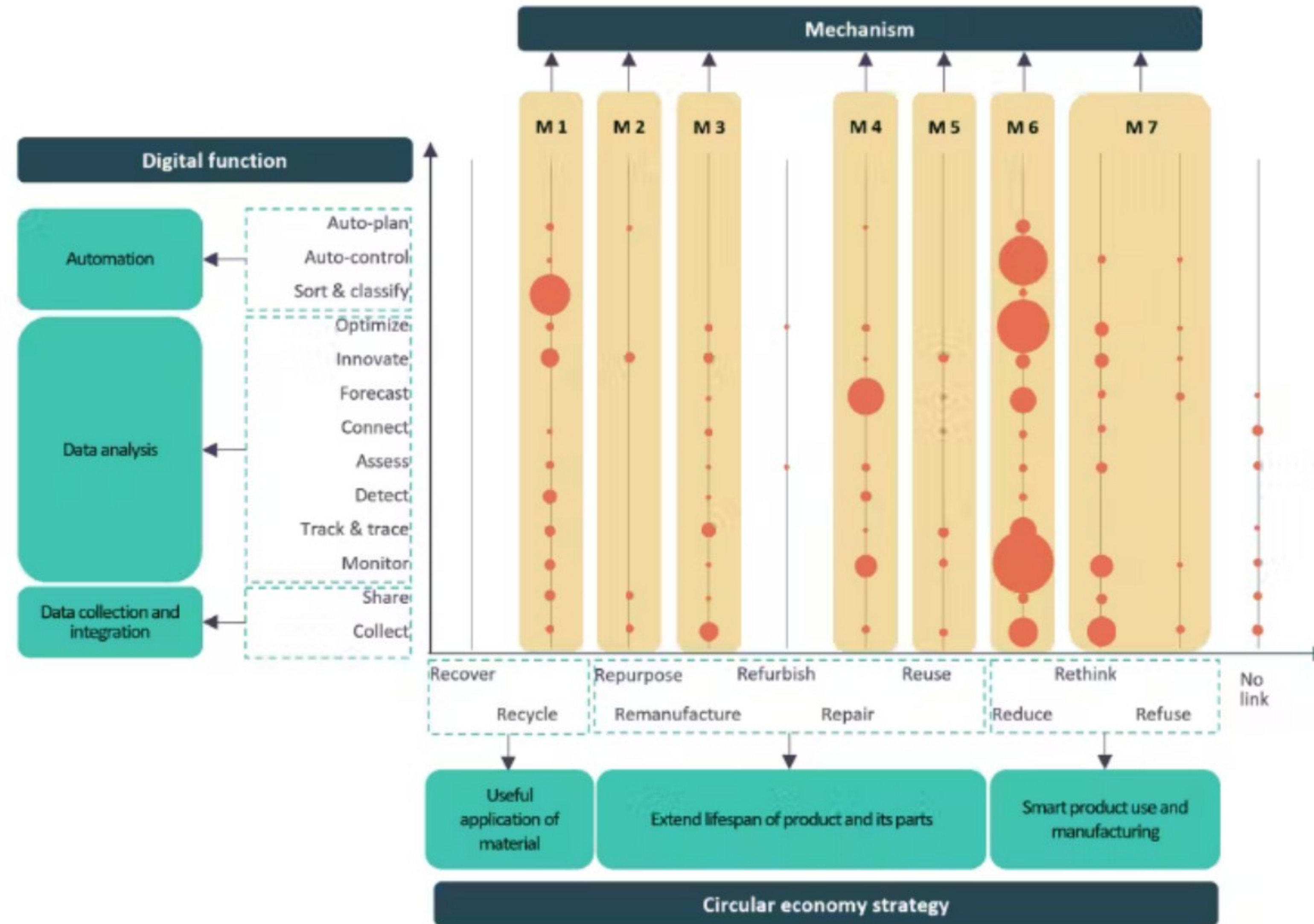
Circulariteit gaat over Materiaalstromen:

- Verkleinen
- Vertragen
- Sluiten

Bocken et al. (2016)



Mechanismen (Liu et al., 2022)



Mechanismen (Liu et al., 2022)

Table 3. Application of the framework to the seven contributions of the Sustainability special issue 'Circular Economy in the Digital Age'.

Article	Digital Technology	Lifecycle Phase	Circular Economy 4R Strategy	Circular Economy Practice	Sustainability Performance
Green Transition: The Frontier of the Digidigital Economy Evidenced from a Systematic Literature Review [66]	Internet of Things Big Data and Analytics (based on quantum computing)	Design Manufacturing Usage End of use	Reduce Recycling	Eco-design New business models based on servitization Value chain reconfiguration	Reduce the pace of emissions to a value lower than the rate at which natural systems can absorb them. Recycle resources at a pace higher than waste generation.
Digital Twins for the Circular Economy [67]	Digital Twins	Design Manufacturing Distribution Usage End of Use	Reuse Remanufacturing Recycling	Product design Servitized business models (sharing) Circular value chain coordination	Reduce the consumption of natural resources by optimizing product design based on digital twins. Reduce waste generation by increasing remanufacturing and recycling, thanks to improved decision-making enabled by digital twins. Economic benefits from the optimization of resources during the product life cycle.
Omni-Chanel Network Design towards Circular Economy under Inventory Share Policies [68]	Internet of Things	Distribution	Reduce	Value chain optimization	Savings in holding and transportation costs due to the optimization of inventory share policies. Reduce CO ₂ over-production and transportation emissions due to the optimization of inventory share policies.
Circularity for Electric and Electronic Equipment (EEE), the Edge and Distributed Ledger (Edge and DL) Model [69]	Blockchain	Manufacturing Distribution End of use	Remanufacturing Recycling	Value chain	Reduce waste generation, especially for electrical and electronic equipment (WEEE).

Article	Digital Technology	Lifecycle Phase	Circular Economy 4R Strategy	Circular Economy Practice	Sustainability Performance
Circular Digital Built Environment: An Emerging Framework [70]	Internet of Things Big Data and Analytics 3D Printing Blockchain	Design Manufacturing (construction and assembly) Usage End of use	Reduce Reuse Recycling	Design for green buildings (long life, reversibility, improvements in efficiency) Circular value chain collaboration	Regenerate resources (using renewable resources). Narrow resource flows (resource efficiency). Slow resource loops (intensify usage and extend service life). Close the loop.
Using Internet of Things and Distributed Ledger Technology for Digital Circular Economy Enablement: The Case of Electronic Equipment [71]	Internet of Things Blockchain Big Data and Analytics	Distribution Usage End of use	Reduce Reuse Remanufacturing Recycling	Servitized business models Value chain management coordination	Prevent electronic waste generation. Prevent adverse environmental and human health effects due to inappropriate disposal and recycling of WEEE (e.g., related to the illegal exportation of e-waste to developing countries that use child labor and whose dismantling practices create hazardous pollution). Increase compliance with legislative requirements, such as the WEEE directive.
Industry 4.0 and Smart Data as Enablers of the Circular Economy in Manufacturing: Product Re-engineering with Circular Eco-design [72]	Internet of Things Big Data and Analytics	Design Manufacturing Distribution	Reduce	Eco-design	Reduce the environmental impact of the product (ceramic tiles), thanks to eco-design informed by the IoT and Big Data Analytics.

Bressanelli et al., 2022

Alle beetjes helpen

- 90% van alle bedrijven zijn MKB bedrijven (Dey et al, 2022);
- MKB bedrijven veroorzaken 60-70% van de industriële vervuiling (Dey et al, 2022).
- Adoptie digitale technologie in MKB blijkt lastig (evofenedex)

**Dank voor uw
aandacht en input**

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