Utrecht University

Transition to Circular Textiles in the Netherlands
An innovation systems analysis

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Content

Management summary (1)

- There is a clear mission objective related to the circularity of textiles set by the Dutch government and endorsed by industry
- The innovative activities to complete this mission can be understood as the outcome of a Mission Oriented Innovation System (MIS)
- Three innovative pathways dominate in the MIS: re-use of pre-owned clothes, mechanical and chemical recycling of fibers.
- The re-use pathways is currently sufficiently developed and does not require policy attention except of regular monitoring of progress
- The mechanical and chemical recycling pathways have clear potential but need to develop much better in order to become a viable alternative for virgin fibers
- We observe a waiting game where industry is reluctant to design clothes based on recycled fibers due to volume, quality and price issues while innovative recycling entrepreneurs have a hard time scaling up and increasing performance through a lack of financial resources caused by a lack of demand
- We therefore advice to quickly create demand for recycled fibers by: 1) deals with workwear manufacturers and public procurement of workwear with recycled content, 2) additional deals with fashion brands, 3) color labeling scheme for clothes that indicates circularity to consumer, 4) introduce EPR levies related to the level of circularity, 5) demand minimal percentage of recycled fibers, preferably at EU level, 6) resort to unilateral regulation when deep changes in industry practices do not take place.

Management summary (2)

- In order to be able to meet the demand, it is important that mechanical recycling facilities improve and scale up and that chemical recycling technology is introduced to the market and quickly scales up afterwards
- For this to happen the innovation ecosystems that drive these developments need to perform better.
- Key challenges are the lack of financial resources, knowledge exchange and coordination of innovative activities and building new supply chains.
- First, we propose to introduce a collective EPR scheme with a levy on all clothes sold in the Netherlands to create a flow of financial resources that can be used to invest in upscaling of innovative recycling processes.
- Second, even though several organisations are already trying to facilitate innovative activities, we propose to improve the level of coordination in the innovation ecosystem. The organization that aims to fulfill this role should:
    1. Develop deep knowledge about the emerging innovation ecosystem and function as *the* spokesperson for the emerging sector
    2. Function as a one-stop-shop for circular entrepreneurs and policy makers dedicated to accelerating CE developments in the fashion industry
    3. Facilitate interactive learning in the innovation ecosystem; connect the geographically dispersed innovation hubs
    4. Align supply and demand for circular textiles; facilitate the creation of novel circular supply chains that serve the demands of specific actors in the fashion industry
    5. Improve the legitimacy of the products that come out of the innovation ecosystem through active communication on success cases
    6. Improve the visibility and reputation of Dutch circular textile initiatives to attract new players to the Netherlands
    7. Play an important role in prioritizing the spending of these resources on the different circular activities with the aim to have most impact for every euro spent
    8. Create attention for enabling technologies like tracking and tracing technology

Introduction

- This report analyses the state of the Dutch Mission-oriented Innovation System (MIS) aimed at reaching a circular textile sector in 2050
- The analysis is performed by researchers from Utrecht University and requested by the Ministry of Infrastructure and Water Management of The Netherlands
- We focus especially on all innovation and change activities related to clothing. Activities related to textiles in the furniture sector are not included
- The data are collected through an online workshop with key stakeholders involved in circular textile activities, 20 interviews with a variety of actors, recent sector reports and policy documents, and an analysis of events in this sector reported in industry journals

Our framework: Mission-oriented Innovation System

- We apply a novel framework that is specifically tailored to the needs of analysts and policy makers that aim to understand and intervene in the innovation dynamics related to prioritizing and solving a societal mission
- We coin this the Mission-oriented Innovation System (MIS) and define it as

'the network of agents and set of institutions that contribute to the development and diffusion of innovative solutions with the aim to define, pursue and complete a societal mission'

- Missions typically require integration of a range of technological and non-technological innovations and change in existing practices
- This Mission-oriented Innovation System can be mapped in terms of structure (who is involved in the innovation process) and in terms of how it is functioning
- Nine key processes are used as primary indicators to assess how the MIS is functioning
- A well-functioning MIS leads to faster and more successful completion of the mission
- The framework allows to indicate intervention points that lead to better innovation system functioning and thereby a higher chance to complete the mission in time

Our 6-step approach

- We take a 6-step approach to analyse the MIS focusing on circular textiles

  - Analyse whether a clear mission is present
  - Analyse the structure of the MIS
  - Analyse which innovation trajectories are dominant in the MIS
  - Analyse the development stage of each innovation trajectory
  - Analyse how the innovation system is functioning and determine what hampers progress
  - Reflect on potential interventions to create a better-functioning innovation process

Step 1: Presence of mission

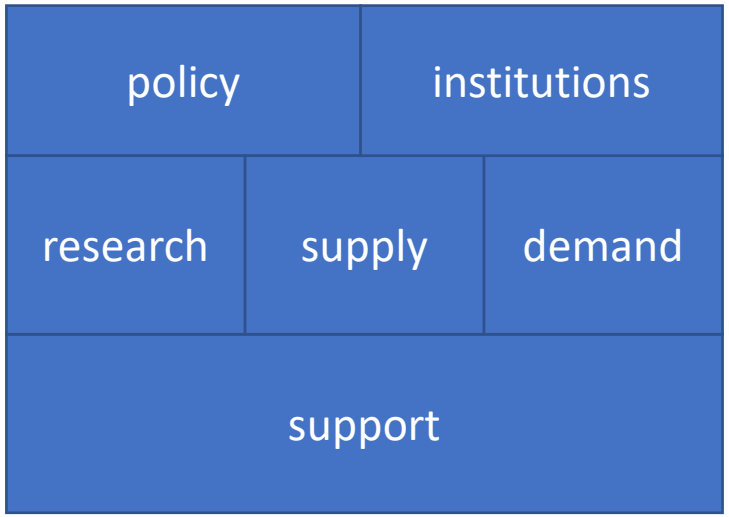
In order to analyse a Mission-oriented Innovation System, a mission needs to be formulated, communicated and picked up by innovating actors

Step 2: Structure of Mission-oriented Innovation System

A MIS consists of actors and institutions that contribute to completing the formulated mission. We label this as MIS structure.

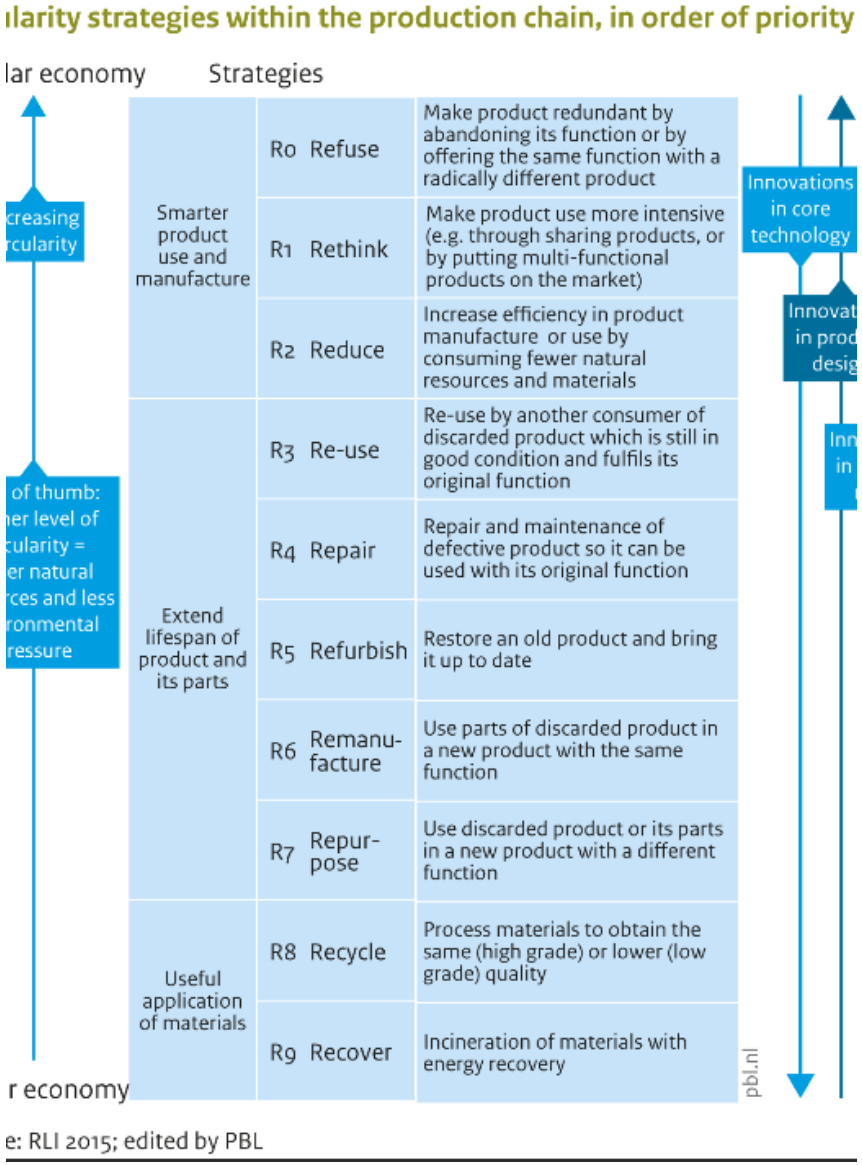
Structural elements of a MIS are:

- Supply of novelty
  - Firms in existing fashion sector that experiment with novel circular practices
  - Entrepreneurs that develop and diffuse novel technologies
- Research: Knowledge institutes, universities of applied science
- Demand: Final consumers, business to business demand in case of working clothes
- Supportive infrastructure: Organisations that contribute to innovation system by coordinating activities, providing guidance, build networks, or finance activities
- Policy and institutions
  - Political and policy actors that influence innovation through laws, regulations, voluntary agreements, mission statements.
  - We distinguish the actors from the rules (institutions) that they develop



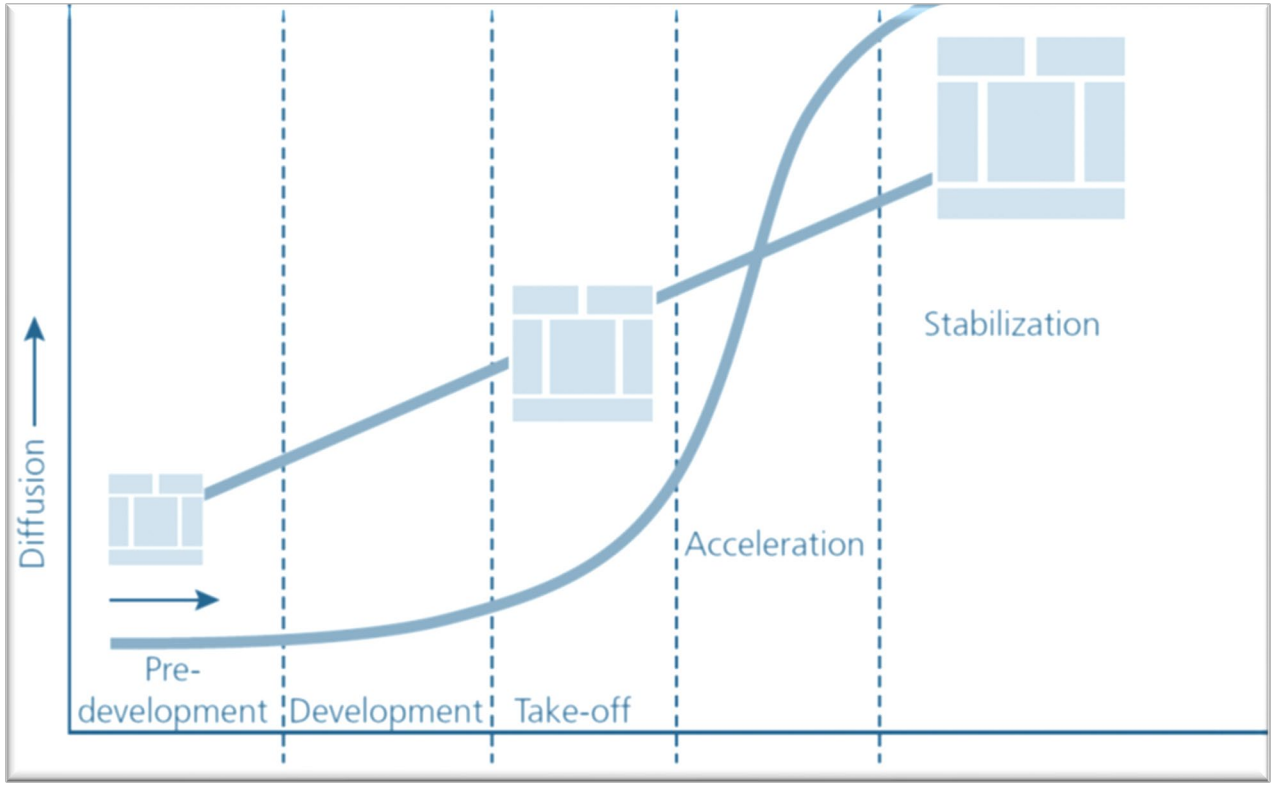
Step 3: Dominant development trajectories

- We use the framework of circularity strategies developed by the Dutch Environmental Assessment Agency PBL, also labeled as 9R framework
- This framework is in line with a recent report of EC (2020) that discerns three basic CE business models:
  - Circular design models (design with R0 – R5 in mind)
  - Optimal use models (R3 – R5)
  - Value recovery models (R6-R8)



Source: PBL, 2018

Step 4: Determine phase of development



- We distinguish between 5 development stages
- Over time a MIS progresses through these development stages
- The structure of the MIS becomes more strongly institutionalized as it develops
- We use indicators for the maturity of technology and market as indicators for MIS development

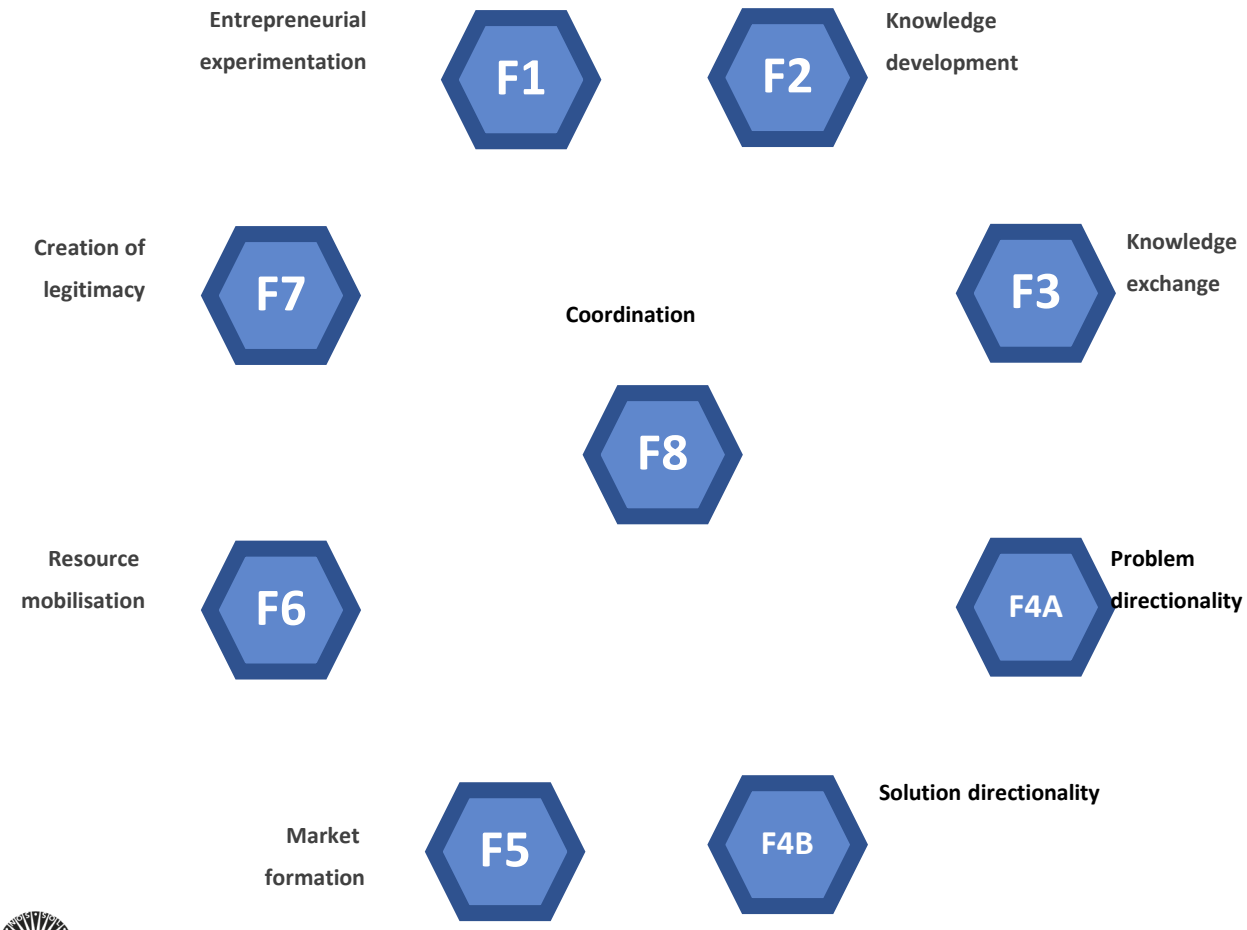
Step 5: Determine MIS functioning

- System functions (F) help to identify bottlenecks in an innovation system
- The system functions represent the processes that contribute to the development, diffusion and use of innovations, influence the build-up of a MIS, and contribute to the completion of the mission
- Each system function may be fulfilled in a variety of ways. The premise is that, in order to properly develop, the system should positively fulfil all systems functions
- The fulfilment of function is rated on a 5 point scale from poor (1), sufficient (3) to excellent (5)

When a MIS functions well

The speed of innovation is high,
innovations are quickly taken up in the market
and targeted at completing the mission

Step 5: Eight functions determine novelty creation



F1: Entrepreneurial experimentation: The innovative activities of entrepreneurs. Their role is to turn newly developed technologies into products or services that represent a business opportunity

F2: Knowledge development: New knowledge production pushing the boundaries of technological possibilities. It can be the result of entrepreneurial activities, but it is mainly done by scientists, universities and research institutes

F3: Knowledge exchange: Network activity that facilitates diffusion of knowledge to relevant actors, such as entrepreneurs

F4: providing directionality: Does the mission impact the innovation activities (4a) and are the options to realize the mission clear and attractive (4b)

F5: Market formation: The activities focussed towards the creation of a market for use of novel technologies and business models

F6: Resource mobilisation: The present and available physical, human and financial resources within the system that are available for innovation

F7: Creation of legitimacy: The creation of legitimacy for the mission and the options to reach the mission

F8: Coordination: Alignment of activities by a wide variety of actors through coordination processes

F9

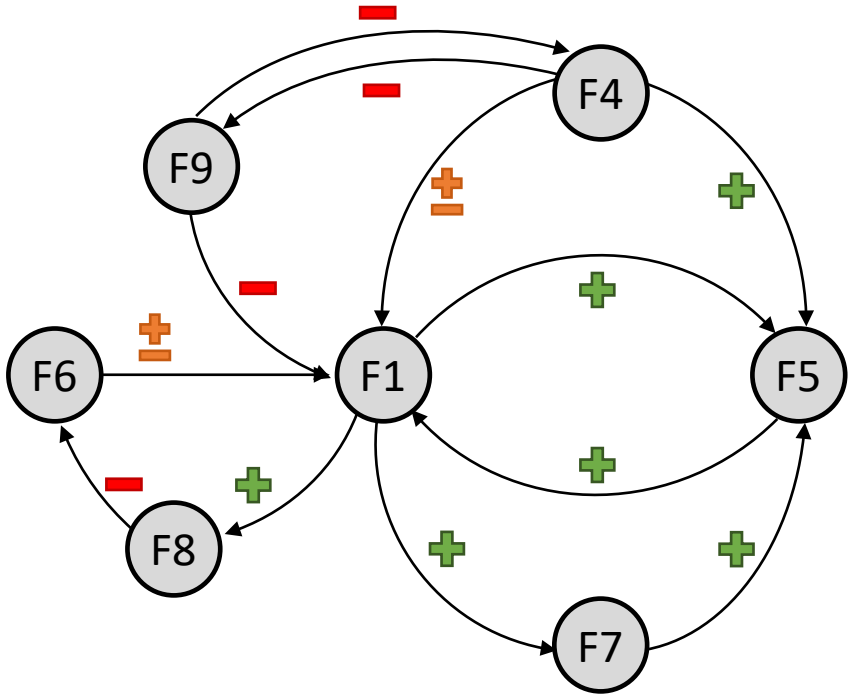
Change in regime practices is key

- Next to the creation and diffusion of novelty it is important that the existing production and consumption systems change their routines and practices in line with the mission objective
- Due to the shear size of current industrial production systems and the long history in which all kind of rules and practices have become deeply engrained, often this is a much slower process than the creation of novelty
- This is 9th function of the MIS: Change in regime practices
- We distinguish three dimensions of change:
    - Increasing awareness that change is necessary
    - Experimentation with novel technologies, business models, new modes of governance in line with mission objective
    - Abandoning practices that are not in line with mission objective

Image: amazon.com

System functions interact

- The dynamics of a MIS are strongly determined by interaction between system functions
- Positive feedback loops lead to fast MIS development
- Negative feedback loops slow down development of MIS and in most extreme case may lead to total stalling of development



Step 6: Interventions

- We identify leverage points (or intervention points) to accelerate innovation system build up and improved functioning
- The intervention points aim to remove blocking mechanisms or obstacles that slow down the development of the MIS and the completion of the mission
- Ideally, we identify leverage points that have a large effect on the innovation system functioning

Inage: wishqatar.com

Data sources used in our analysis

- Review of government and industry documents (initiatives and programs, guidelines, visioning documents, covenants, lobby reports)
- Scan of Lexis Nexis for news related to fashion industry and CE
- Scan of Dutch Fashion magazines e.g., “Textilia” and “Vakblad Vrouwenmode”, and global fashion magazine “Just Style” for CE related events in fashion industry. Time period Oct 2019- Oct 2020;
- Workshop with 13 experts on circular textiles
- 21 additional interviews with experts in the fashion industry

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Results

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Step 1: presence of mission

- The Dutch Government has stated a clear ambition to increase circularity in textile industry
- Mission is well communicated to textile sector
- In their sector plan the textile and fashion sector endorses the ambitions of the Dutch Government

Image: inretail.nl

Policy program circular textile 2020:

Ambition: 50% sustainable material use, of which 30 percent point recycled content; 50% of post consumer waste is recycled

2020 — **2025** — **2030** — **2050**

Ambition: 25% recycled content / sustainable material

30% of post consumer material is recycled

Ambition: 100% circular textiles

“Awareness is key. You cannot get the benefit in turnover figures. We have no second planet. We have to do it. There is no choice.”

- Dutch brand

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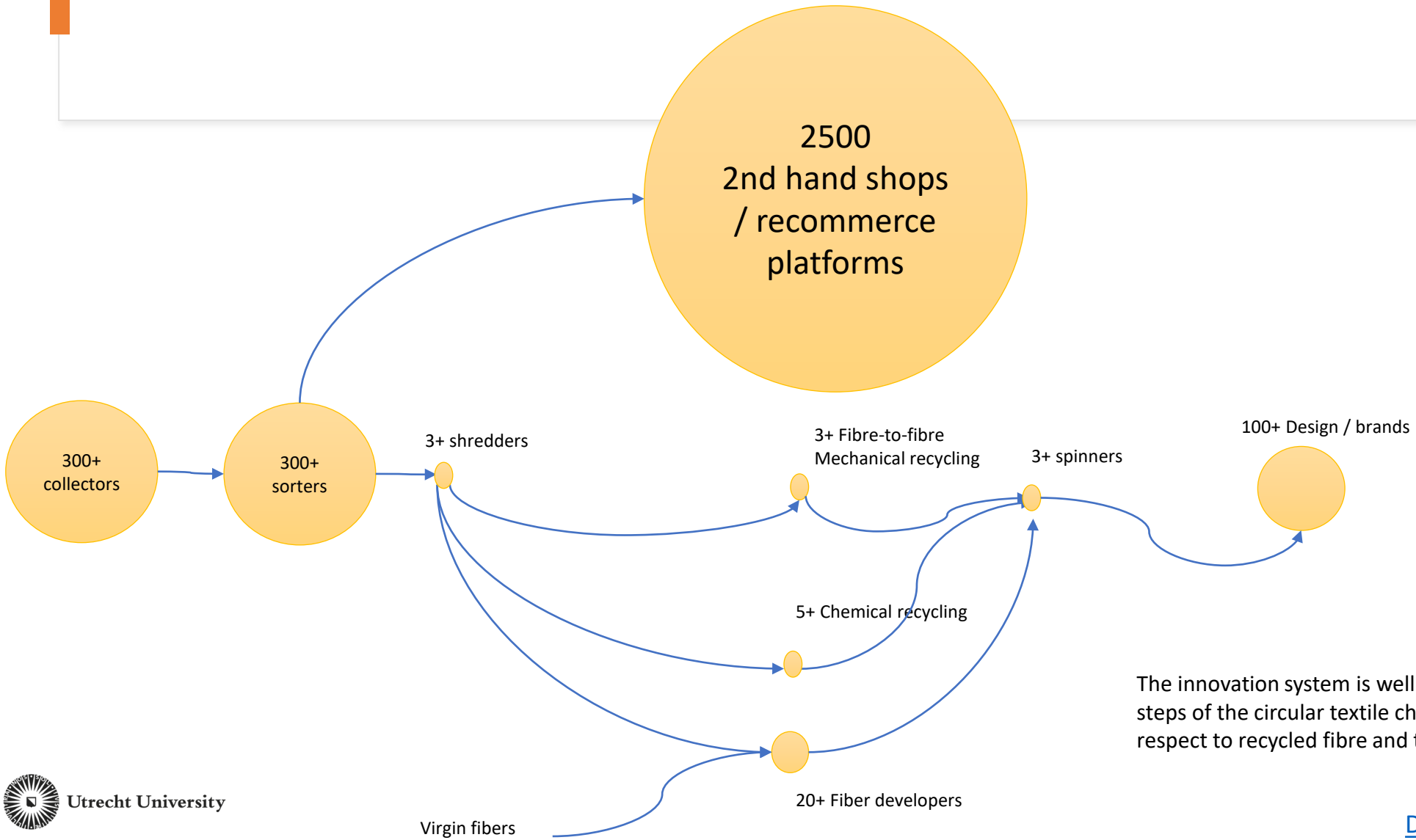
Dutch misson embedded in international context

- The Dutch mission meets large resonance and ever more initiatives in the forms of 'Circular Fashion' events and many voluntary campaigns are realized by industry, researchers and consumers – particularly over the last few years.
- The Circular Fashion Pledge is an initiative launched just after the 50th anniversary of Earth Day
- It aims to address the UN Sustainable Develop Goal (SDG) 12.5 – to substantially reduce waste generation by 2030.
    - Fashion brands can pledge their commitment to at least one of three circular actions:
    - Enable take-back or resale: By the end of 2020, launch at least one method or partnership to enable their customers to send-back or resell their used items
    - Increase recycled content: By the end of 2020, increase the total percentage of certified recycled content or scrap fabric by 10% in their top five selling items
    - Design for durability: By the end of 2020, increase the use of non-blended materials, and/or modularity and repairability in their top five selling items
    - Launched in April 2020, there is a long list of global signatories, most of these are SMEs. 74 signatory brands/retailers from Europe, 38 signatories from North America, 16 signatories from Asia

Step 2: structure of MIS

- We focus specifically on textiles used in clothing and fashion, including workwear.
- This is a major sub-set of the complete circular textile MIS which includes textiles for furniture, automotive industry, etc.
- We focus on the Dutch MIS since the mission is formulated in the Netherlands and endorsed by Dutch industry associations
- The Dutch MIS is strongly influenced by international developments since the fashion industry is a global industry with global rules and practices.
- We therefore do highlight how the Dutch MIS is influenced by global developments

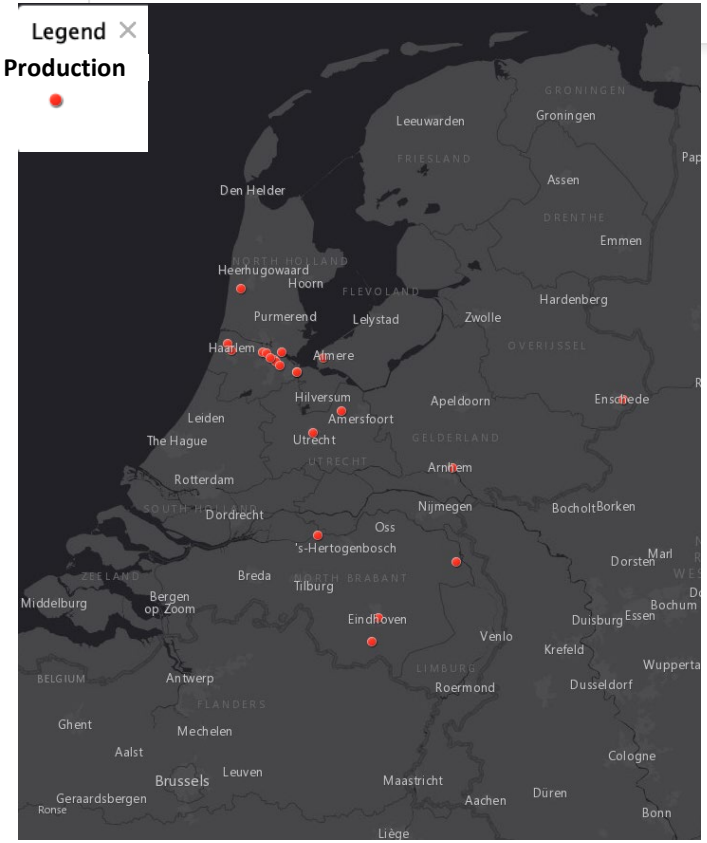
Break-down of entrepreneurial activities in supply chain



The innovation system is well developed for the first and final steps of the circular textile chain, but is les developed with respect to recycled fibre and textile production

Disclaimer / Explanation of numbers

Where are CE activities located?



- **Amsterdam** area is hotspot where design, production and recycling is present,
- **South** of Netherlands also shows promising combination of activities,
- **East** of the Netherlands lacks design but shows clustering of recycling and production activities.

Production is very diverse set of activities, e.g., dyes, knitting, new materials

Step 3: Identification of the dominant trajectories

- Many different strategies are available to reach the circularity mission:
  - From fast fashion to slow fashion (R0 –R2)
  - Re-use of pre-owned clothes (R3)
  - Stronger focus on life-time extension through repair (R5)
  - Design for recycling, refuse hard-to-recycle fiber blends (R8)
  - Closed loop recycling: use of post-consumer textile fibers in new products (R8)
    - **Mechanical recycling of textiles** is the process of recycling the textile fabric back into fibres without the use of any chemicals. This process includes shredding and carding process to extract the fibres from the fabric. Dutch designers, SMEs, and a few brands are refusing certain material inputs (e.g. virgin cotton) in single products or collections
    - **Chemical textile recycling** adopts a series of chemical processes to depolymerize/dissolve the fibre from the fabric into monomer/solvent form to create new fibers
  - Open loop recycling: use of post consumer products into products for other industries (e.g. insulation and board materials)
  - Material substitution: Replace material inputs with high environmental impact by materials with lower impact.

Re-use and recycling

In this analysis we focus on three circular strategies that currently dominate the circular textile MIS:

- Re-use: extent lifetime of clothing through re-selling of pre-owned clothes
- Recycling: produce clothing with fibers from post consumer textiles
    - Mechanical recycling
    - Chemical recycling

Out of scope:

- Open loop recycling also receives attention but in this report it is out of scope since it does not contribute to a 100% circular textile industry
- Extent lifetime of clothing through business models that focus on quality, long lifetime, repair and slow fashion due to almost absence of activities in this area
- Material substitution: produce clothing from less polluting fibers. This is an option pursued by some firms but its relation to circular economy is not straight forward

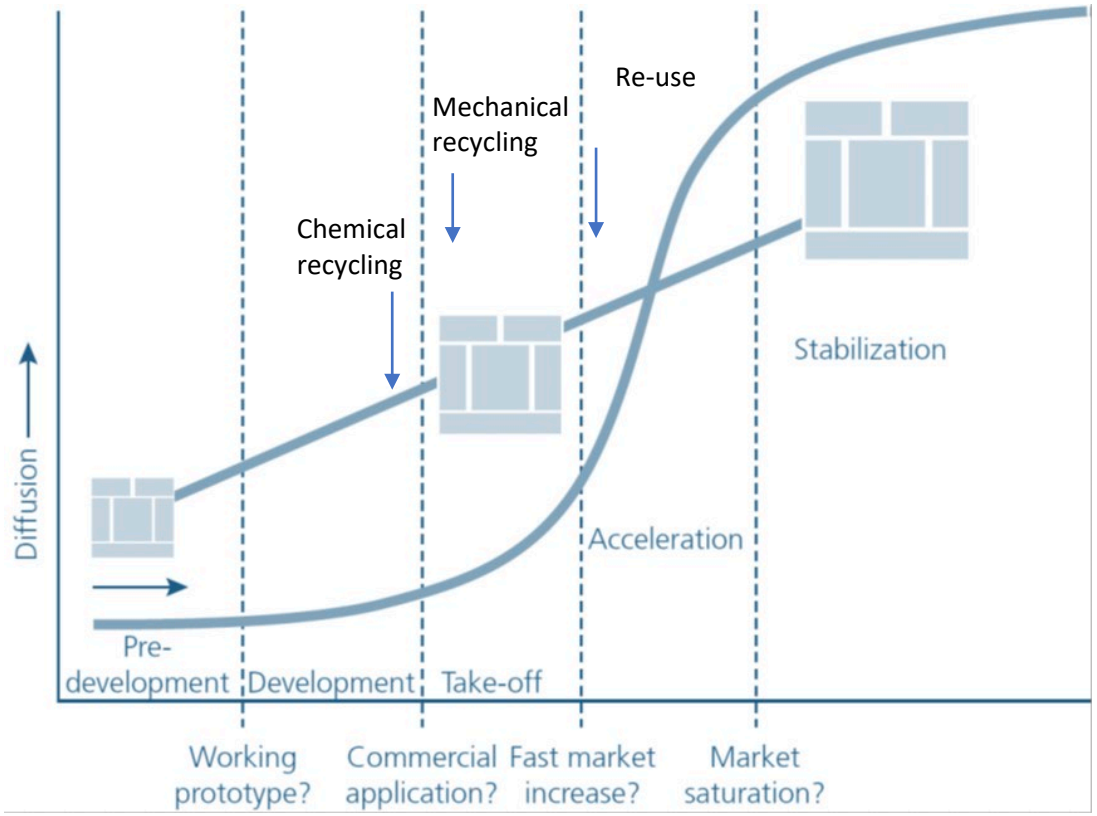
Step 4: Mission-oriented Innovation System: Phase of development

Different dominant trajectories / solutions are in different stages of development:

Re-use/ Recommerce of pre-owned clothes is in the beginning of the acceleration phase: lots of commercial parties active, well functioning market, but still small

Mechanical recycling: **beginning of take off**. First markets are formed but acceleration not yet visible

Chemical recycling: **development phase**. Dutch technology is not yet available on commercial scale but is past demo phase



Step 5: Functioning of MIS

Pre-owned clothes: MIS dynamics are sufficient (1)

- **F1**: While second-hand clothing shops exist for a long time, **entrepreneurial experimentatio**n is now increasing
  - First global brands start offering customers access to used clothes like global VF Group, Tommy Hilfiger, Vivobarefoot
  - Continued growth of online platforms where consumers act as sellers and customers (e.g. The Next Closet, Sharedrobes, United Wardrobe, Vinted, Poshmark) and B2C platforms (e.g. Zalando), accompanied by growth of physical recommerce stores
  - 385 physical stores in 2010 towards 510 physical stores in 2019
  - Growth of total number (including online) of 2nd hand stores in 2019 is 7% towards 2451 stores
  - Peer to peer (P2P/C2C) market is growing and mediating through more traditional online platforms (e.g. Ebay, marktplaats) and the new online platforms (e.g. Vinted)
  - Strong traditional regime player in this trajectory are non-commercial 2nd hand stores ('Kringloopwinkel'), number of stores and processed textile is also growing.
  - However, some recommerce business models are vulnerable in terms of profit margins, e.g. Vinted is not profitable yet due to high investments in marketing campaigns; Kringloopwinkel do hardly attain profits from textile recommerce
  - At the moment 2nd hand stores have excellent access to high quality clothes. They sell at relative low margin, thereby fulfilling important social function. The rise of commercial platforms and brands may jeopardize their business model and societal function

- **F2 + F3: Technological knowledge development and diffusion** is not critical since re-use does not require new technology. There is sufficient experimentation going on to learn about consumer behavior and business models that work
- **F4: Guidance of the search** is sufficient due to increasing expectations that re-use can be a growth market

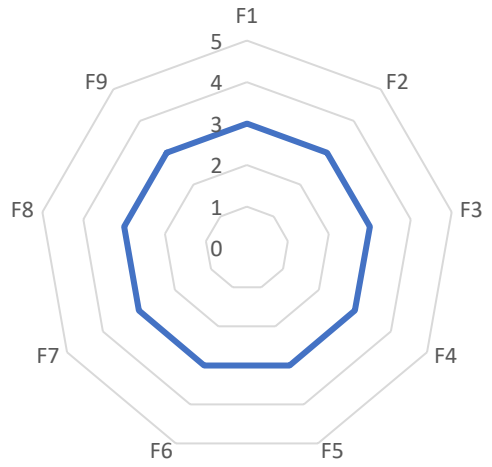
Pre-owned clothes: MIS dynamics are sufficient (2)

- **F5: Market formation** picks up.
  - Especially through the emergence of online platforms. Vinted has unicorn status with value over 1 billion euro
  - Over 3 million Dutch customers make use of platforms
- **F6: Resources mobilization** is sufficient
  - **Financial:** sufficient: investors finance growth of platforms, however smaller vintage stores and 'Kringloopwinkels' have no comparable capital access
  - Material: varying access to high quality clothing, logistics challenge for most new entrants in pre-owned market; challenge Kringloopwinkel have highest access but are increasingly uniting for attaining scale advantages
  - Human: there is enough human capital with the relevant skills
- **F7: Legitimacy** for this pathway is increasing due to successful online platforms and diversification of influential online retailers and brands into re-use of clothes
- **F8:** In terms of **coordination**: Emerging entrepreneurs are coordinating new value chains in order to deliver customer value. More coordination needed between physical pre-owned stores and retail

Pre-owned clothes: MIS dynamics are sufficient (3)

- **F9**: While new entrants clearly boosted the development, now also existing brands and retailers are moving in. We witness **change in regime practices**. Developments are not started due to pressure but due to perceived opportunity
- Key regime players, non-commercial 2nd hand shops, are increasingly forced to experiment with other R-strategies in addition to traditional re-commerce for maintaining profitability

- Overall: we rate all functions of the MIS for this trajectory as sufficient

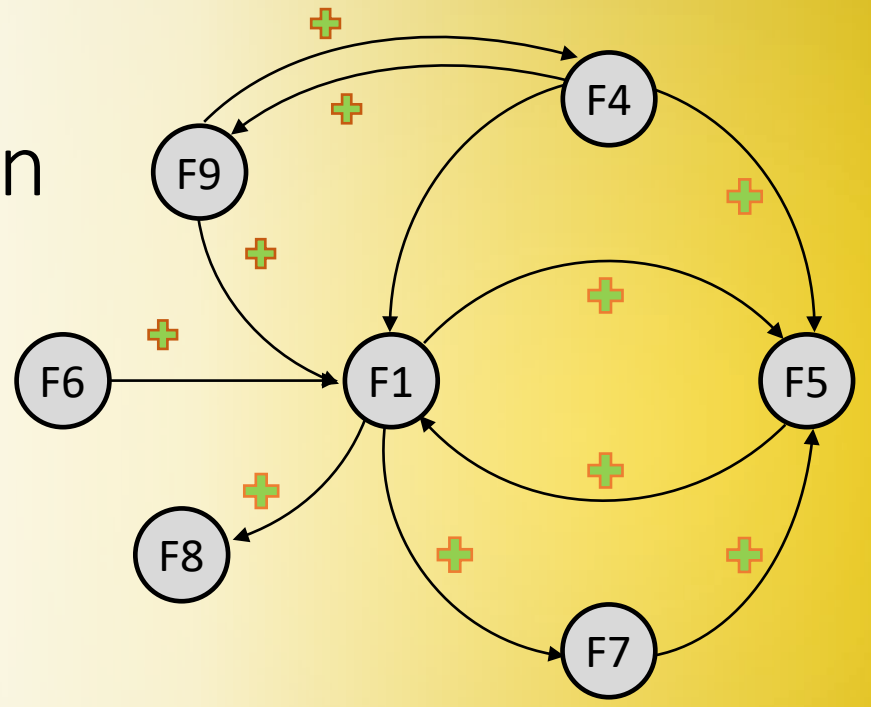


Dutch developments fit in global trend, some examples:

- Dutch second-hand clothes website United Wardrobe is being taken over by Lithuanian peer Vinted. The takeover will push Vinted into first position in the Dutch online second-hand clothes market
- Zalando has launched a new re-sale clothing platform in a bid to “bring pre-owned to the mainstream consumer” in Europe
- H&M' pre-loved' clothing shop debuts in Germany
- ReCircled, a start-up focused on sustainable fashion, has opened factories in the US and Europe to receive and sort returned garments for fashion brands seeking to transition from a linear to circular business model.
- The group (VF Corp) is also continuing to explore circular business models, namely recommerce, rental, and circular design, aiming to lead large-scale commercialisation of circular business models by 2030. It got a recommerce (The North Face Renewed) and a rental (TNF EMEA rental) pilot in the market after just six months.
- H&M's Cos fashion label has launched an online clothing resale platform where shoppers can buy and sell pre-loved clothing. The Resell digital space is for the purchase and sale of Cos clothing only, but H&M says it offers the brand's community the opportunity to "re-invent their wardrobe in a considered and sustainable way".
- H&M Group has partnered with China's largest fashion rental platform YCloset to test subscription rentals in the country, in a move that will allow Chinese consumers to hire apparel from its COS brand.
- Depop, a London startup that has built an app for individuals to post and sell (and mainly resell) items to groups of followers by way of its own and third-party social feeds, has closed a Series C round of $62 million led by General Atlantic.
- The Dow Chemical Company has partnered with national sports agency Sport Singapore (SportSG) on a project to divert 300,000 pairs of shoes away from landfill and drive circular economy solutions in Singapore.

Pre-owned clothing shows positive function interaction

- Positive interactions between system functions currently drive developments
- Therefore, there is no immediate need for intervention with the aim to to speed up these developments
- However, the rise of platforms may lead to negative impact on physical stores that fulfill important social function. This may justify policy attention
- We do advice to monitor the developments related to pre-owned clothing on a yearly basis to check whether dynamics stay positive



Mechanical recycling: MIS is emerging, but struggling and vulnerable (1)

F1: Entrepreneurial experimentation

- Collection for mechanical recycling works relatively well, good initiatives for automatic sorting (Wieland)
- A large number of highly motivated firms, mainly SME's, are engaged, but only few are able to produce new fibers
- Much more entrepreneurial experimentation is needed but low incentive to initiate them as business model for these firms is difficult
- Circular supply chain is fragmented in NL. Critical steps like fiber production, spinning and textile production not well populated by entrepreneurs.
- However, commercial spinning mill is planned for 2021
- Production at industrial scale is limited due to low market demand
- Scale-up to industrial size is needed
- Developing new supply chains based on recycled content is challenging
- Innovation system consists of a wide variety of actors (design, production, services, sorting, recycling) and therefore has potential

Mechanical recycling: MIS is emerging, but struggling and vulnerable (2)

F2 & F3: Knowledge development and diffusion

- There are initiatives underway which can improve mechanical recycling, such a new form of mechanical recycling which is done in a wet instead of in a dry state, using enzymes and some chemicals to remove finishes etc. that currently hamper mechanical recycling
- New technologies are being developed that lead to higher-quality yarns (e.g., Purifi process)
- Knowledge is mainly developed by SME's. Not much formal R&D, mostly learning by doing.
- Learnings from the pilot projects must be internalized by firms and used to direct investments into commercial-scale facilities
- Every step from sorting, unravelling, spinning, and pretreatment should be integrated and greatly improved.
- Technical knowledge exchange hardly takes place; there is little collective learning.
- Actors are very protective about their knowledge, especially soft knowledge on production processes and their optimalisation
- This competitive structure relates to the existing fierce competition over resources – those who build up a niche did so with own capital or with enormous time and effort spent to 'get where they are now'
- Parties **want to be open** but feel they **cannot afford** to be open, and are therefore protective about knowledge and other resources obtained
- Limitations to technological innovation: Opportunities for improved sorting using robots still exists, but much will remain a highly-skilled human task

Mechanical recycling: MIS is emerging, but struggling and vulnerable (3)

F4: Guidance of search

- Compared to the rest of the world, Netherlands is ahead with their ambitions; this creates awareness in the sector and influences the search for better recycling practices

F5: Market formation

- Demand from consumers is completely absent
- As a consequence, demand from brands is extremely limited. They show more interest but do not yet order yarns / fabrics based on recycled content
- Most brands outsource material choice to textile producers. They are often in the far east and not focused on Dutch options.
- Companies that produce work clothes provide initial markets
- Complete new supply chains need to be formed; this is challenging since it requires alignment between several players.
- Dutch Circular Textile Valley (DCTV) focuses on matching supply and demand by creating new network linkages

F6: Resources mobilization

- In general, investors may be reluctant to invest in upscaling. Risk due to low market demand is considered too high. Exceptions were identified, where planned industrial-scale facilities had secured investor commitment
- In some cases brands invest in start-ups, sometimes via foundations

F7: Counteract resistance to change

- Legitimacy of recycled fibers is an issue. Too expensive and perceived quality issues.
- Positive: NEN committee has developed a clear definition standard for circular textiles, and is currently developing a standard for verification methods for determining presence of recycled content
- The consumer is currently not involved at all. It requires significant marketing and communication to create consumer awareness and change in attitude. This includes improved communication on the role of the consumer in delivering post-consumer content.

Mechanical recycling: MIS is emerging, but struggling and vulnerable (4)

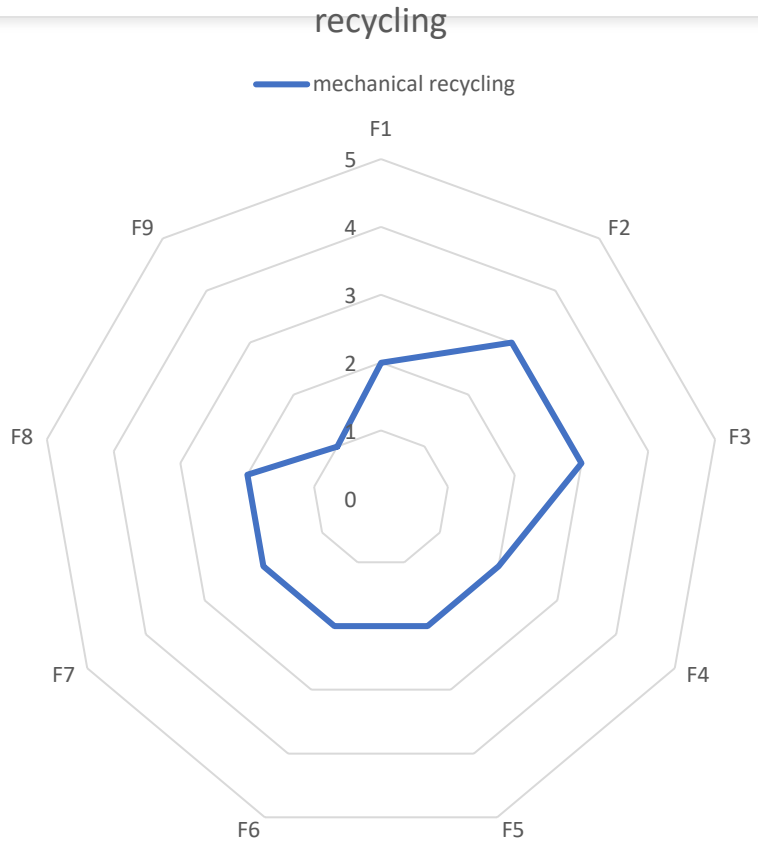
F8: Coordination

- Many interviewees highlight lack of coordination.
- Four hubs have emerged: Tilburg for work clothes, Amsterdam for brands, Twente for recycling technology, and Arnhem for design and natural fibers. Within these hubs some form of coordination takes place.
- However, there is poor interaction between hubs, better interaction needed to facilitate learning.
- The emerging industry
- Government initiatives are more focused on collection than on recycling innovations
- Coordination to link circular entrepreneurs to brands and retail is lacking
- Dutch Circular Textile Valley (DCTV) aims to solve this by accelerating 4 innovators by helping them building a complete supply chain based on their innovation and linking 20 innovators to financers and experts

- **F9: Regime change**
  - Brands and retail now show more interest in recycling technology and initiatives than in 2015
  - However, they are still reluctant to experiment with new designs based on (partly) recycled textile

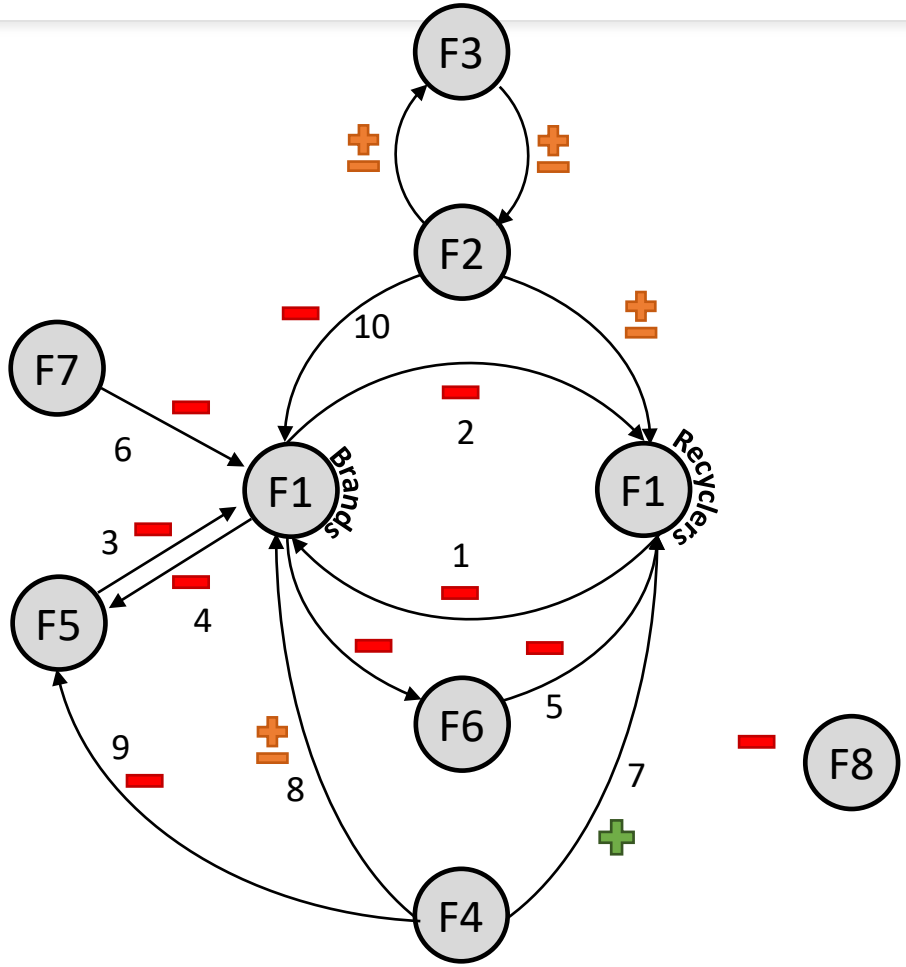
Mechanical recycling: MIS is emerging, but struggling and vulnerable (5)

- We rate the overall functioning of the mechanical trajectory as insufficient in terms of capacity to contribute to completion of the mission
- In order to move to the next phase (full take off and acceleration) the following functions need to be strengthened:
  - F4: Directionality
  - F5: Market formation
  - F6: Resources mobilisation
  - F7: Legitimacy creation
  - F8: Coordination
  - F9: Regime change



Mechanical recycling: MIS is emerging, but struggling and vulnerable (6)

- When we study function interaction, we note many negative feedback loops.
- The core of the problem is a lack of demand for recycled fibres by brands and retail (1). This is strengthened by lack of scale of recycling facilities (2) and lack of consumer demand (3) which is also not stimulated by brands (4)
- The lack of demand makes investments in recycling facilities risky, leading to lack of resources (5)
- Legitimacy (high price, low quality) also contributes negatively (6)
- Directionality is a positive force through government ambitions (7) but this does not effect brands to a large extend (8) and consumers not at all (9)
- Knowledge plays a neutral role but brands suffer from lack of it which also affects their demand (10)
- Poor coordination (F8) affects the whole system in a negative way



Chemical recycling: MIS in its infancy, highly promising but vulnerable (1)

F1: Entrepreneurial experimentation

- There are a few highly innovative start-ups and spin-offs active in this trajectory with entrepreneurial activity rising over the last years (due to knowledge advancement). The number of entrepreneurs are quite low due to high financial barriers to entry
- SaXcell (cellulose fibers from high cotton percentage type post-consumer clothes) stands out in NL and internationally, as their patented technology closes the loop fully without the use of virgin material – fibers as input, fibers as output; activities are planned to scale up to industrial scale over 2-3 years. Worn Again (UK company, more focused on polyester and mixes) is also building a chemical recycling plant in Zaanstad.
- Ioniqua is another promising spin-off focused on polyester, PET is used as input material to produce packaging, research currently focuses on reusing other plastics, potentially for producing fibers; a few incumbents, recently announced to extend polyester recycling activities in NL to include textile recycling
- In Sept 2020, The Fashion for Good consortium initiated the “Full Circle Textiles Project: Scaling Innovations in Cellulosic Recycling” including brands like Laudes Foundation, Birla Cellulose, Kering, PVH Corp.
- A few other Dutch companies are active in combining mechanical and chemical recycling techniques (e.g. depolymerisation) and attain progress in using ‘mixed pre-owned clothes inputs’, e.g. Fast Feet Grinded (pre-owned shoes + PET) and CuRe (sorted coloured polyester). The textile loop can so far not be closed with their outputs (granulates; pellets).

Chemical recycling: MIS in its infancy, highly promising but vulnerable (2)

F2 and F3: Knowledge development and diffusion

- Knowledge development took off the past years, but knowledge on breakthrough technology is not growing as fast as expected, mainly due to resource and market development constraints (F6, F5), there is a high need for further technological development and for developing knowledge on process optimization for scalability and profitability - this holds for the Dutch and international perspective
- Knowledge exchange is limited and application of IPR (patents) is common; however Dutch players are aware of inputs used by competitors, production capacities, and final product attributes of competitors; players have sufficient overview over the knowledge that is being developed by competitors to position their own activities

F4: Guidance of search

- Guidance of the search is positive as regards the view of the potential of this trajectory - the industry widely agrees that this trajectory is indispensable for a fully circular textile loop
- From the perspective of entrepreneurs this trajectory has seen extremely limited guidance of the search by government as support structures to systematically foster textile chemical recycling are absent
- There is demand for a clear roadmap defining the trajectory, devising targets and providing means to support a clear direction

Chemical recycling: MIS in its infancy, highly promising but vulnerable (3)

F5: Market formation

- There is no specific consumer demand for this solution, however companies active in chemical recycling perceive the interest from brands to grow quite fundamentally.
- Linked to the premature technology, a functioning market is so far absent - this contrasts very sharply with the other two trajectories with existing markets; some brands (Levi's) claim having used chemical recycling for their collections but chemically recycled textiles are almost absent and not traceable on the market;
- There is a specific complication delaying the development of higher market demand:
    - Brands do not want to invest in expensive development if other brands can use the technology later (i.e. desire for exclusive contracts with chemical recyclers);
    - Chemical recyclers on the other hand are dependent on economies of scale for surviving profitably in the market, single brands are too small to have recycling plants run on their input

    --> potential catch-22: brands need to be willing to collaborate for market development to take-off
- In addition the development of this trajectory will be partly dependent on market implementation of tracking and tracing technology , chemical recyclers have need to know exact composition of items used in recycling (see appendix for more information on the importance of tracking and tracing technology)

Chemical recycling: MIS in its infancy, highly promising but vulnerable (4)

F6: Resource Mobilization

- Financial resources are a major issue and threatens development of the trajectory as a whole in NL – there is a very high need for capital
- Dutch chemical recyclers struggle accessing the larger sums of capital required which has held back knowledge development (F2) and in some cases precluded industrial upscaling (F1) within NL (SaXcell); collaborations with brands or foreign supply chain partners have secured a minimum of investment so far
- The negative dynamic of this function relates to the problematic formation as discussed above (F5):
- Essentially market demand is needed to drive further mobilization of resources, more systematic government support could ensure continuous entrepreneurial activity and some protection from corporate interests in vulnerable early development phase and in first industrial scaling phase
- Materials: Chemical recyclers need materials with similar composition wherefore inputs from brands directly (e.g. 10.000 t-shirts, white, 95% cotton) are highly preferably, this link is not yet established
- In the Dutch context human capital is not an issue as there are enough universities and entrepreneurs with potential to deliver breakthrough knowledge

Chemical recycling: MIS in its infancy, highly promising but vulnerable (5)

F7: Creation of legitimacy

- The trajectory is viewed as highly legitimate in terms of high expectations. It is seen as the only technology to really close the loop.
- However, for cotton, the product after chemical recycling is not cotton-like anymore, but more like viscose.
- There are high risk for all the actors involved in chemical recycling implementation – this makes it difficult to legitimize engaging in the vulnerable trajectory;
- There are no evident lobbies against this trajectory, however, chemical recycling can be more energy intensive than mechanical recycling which can affect its legitimacy as a circular and environmentally friendly solution;
- So far the trajectory competes with the mechanical recycling trajectory for attention by 'system support actors', complementarity of the two trajectories needs attention to prevent diverging interest groups and lobbies (e.g. over capital, input materials);
- Legitimacy issues exist with regard to definition and marketing of chemical recycling solutions due to a lack of understanding by consumers and other system actors:
    - Chemical recycling can be based on different inputs, e.g. polyester fibers but also discarded PET drink packaging
    - It is important to distinguish the polyester route from the chemical recycling route of cotton. When the chemical sector moves in, the polyester route may quickly crowd out the cotton recycling route
- Consumers are not aware of this trajectory and will need to be educated to evaluate claims made by brands and retailers selling chemically recycled items, legitimacy could be helped by tracking and tracing technology

Chemical recycling: MIS in its infancy, highly promising but vulnerable (6)

F8: Coordination

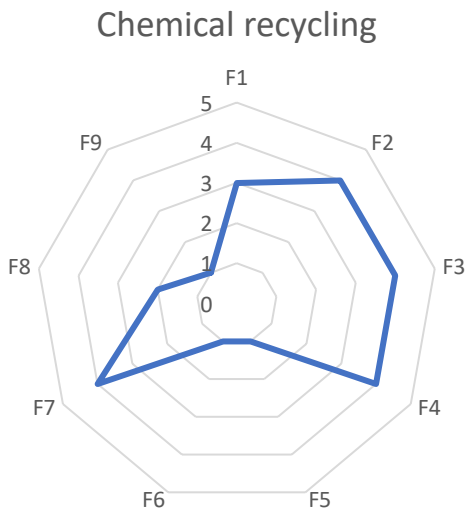
- From the perspective of chemical recyclers and entrepreneur's system coordination is a major issue and is linked to the absence of systematic support mechanisms for this trajectory;
- The existing coordination mechanisms (DCTV, branch organization) are perceived to function insufficiently to coordinate all system actors regarding the direction and diversification of chemical recycling in NL, there is a need for coordination mechanisms also beyond the textile sector to make use of existing knowledge and infrastructure in adjacent sectors (chemistry, bio-chemistry)

F9: Regime change

- Pressure on regime to engage with breakthrough technologies is rising, but there is too little pressure to focus specifically on technologies using exclusively non-virgin materials
- Brands and retailers feel no strong incentives to invest in chemical recycling trajectory (‘waiting game’)

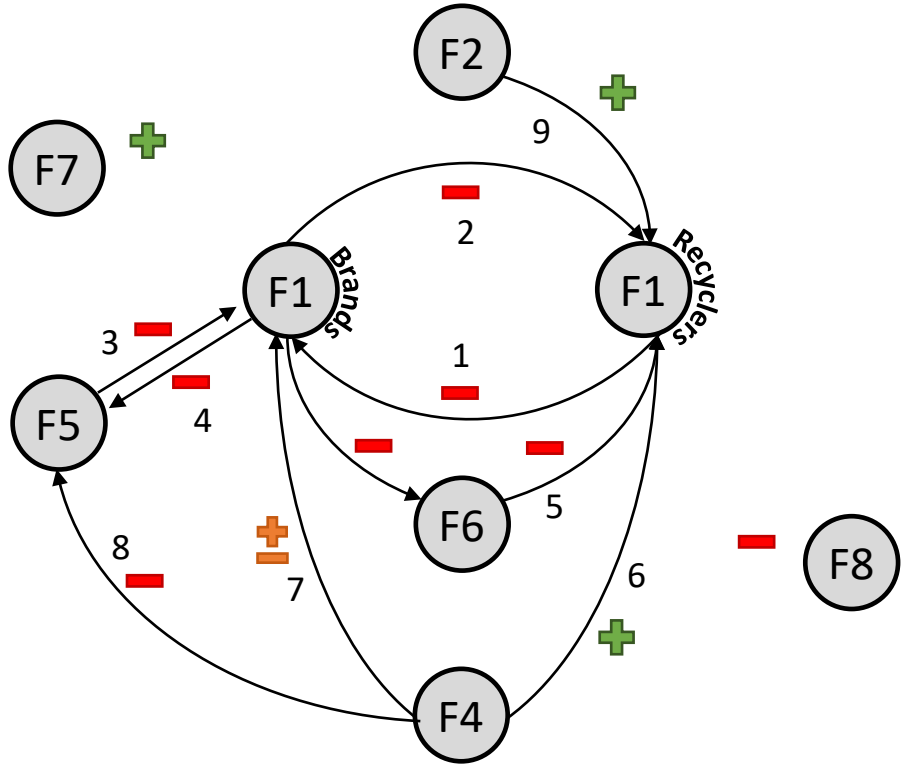
Chemical recycling: MIS in its infancy, highly promising but vulnerable (7)

- The chemical recycling route shows the following functional pattern:
- Large need for resources, but low availability due to high risk investment due to insufficient articulated demand.
- This leads to the following functions that need strengthening:
  - F5 Market formation
  - F6: Resources mobilisation
  - F8: Coordination
  - F9: Regime change



Chemical recycling: MIS in its infancy, highly promising but vulnerable (8)

- When we study function interaction, we note many negative feedback loops.
- The core of the problem is a lack of demand for recycled fibres by brands and retail (1). This is strengthed by lack of scale of recycling facilities (2) and lack of consumer demand (3) which is also not stimulated by brands (4)
- The lack of demand makes investments in recycling facilities risky, leading to lack of resources (5)
- Legitimacy is high but does not set the wheels in motion
- Directionality is a positive force through high expectations (6) however this does not effect neither brands (7) nor consumers (8)
- Knowledge plays a positive role but brands suffer from lack of knowledge which also affects their demand (9)
- Poor coordination (F8) affects the whole system in a negative way



Regime functioning: deep cultural shift is needed

- Brands and retail need major transformation to reach circular mission
- The fashion sector can be characterized by poor supply chain governance. Transparency in supply chain is lacking. Brands and retail lack insight in applied resources, environmental and social impact of their products
- Covenant of textile sector (2016) tries to improve this situation but is without any concrete obligation. Signing the covenant implies for firms doing their own due diligence, setting own targets and to report on target realization. The Covenant is a clear sign that the sector is far from being up for the task
- Interviewees highlight difference between sector “talking” and “walking”. Sector states circular ambitions but faces a major implementation gap
- At the global level the Ellen McArthur Foundation has a positive influence. Brands have signed pledges for change and some brands are experimenting a bit with novel materials, but attention is mainly aimed at replacing cotton and leather by more sustainable but virgin materials (e.g., pineapple leather, algae instead of cotton)
- Brands are either extremely focused on cost price or high quality; recycled fibers are more expensive, and quality is not yet guaranteed.
- Brands feel pressure to improve on many different themes: labor conditions, sustainability; circular is one of the options and it is unclear how to prioritize circularity over other themes.
- Collective insight is emerging that current business model of fashion industry is coming to an end. It has been a race to the bottom and the bottom has been reached

Regime functioning: also upsides

- While the overall culture, routines and practices are far from mission completion, we do observe some positive changes
- Interviewees indicate that brands are showing more awareness towards circular fibers than 5 years ago
- At the international level, several organization aim to create change in the textile sector. Ellen McArthur foundation stands out as change agent. Mostly, pledges are signed where brands promise circular activities.
- Some examples of concrete international initiatives:

  DEMETO is a science-industry collaboration project including large brands (H&M) constructing the first industrial-scale pilot plant for chemical PET recycling (depolymerization).

  Adidas has started a public trial of its endlessly recyclable UltraBOOST DNA LOOP trainer, the company's Made to be Remade system of selling and returning will be launched commercially next year. The trainer is made from one material (TPU) – and is assembled using heat rather than glue.

  Napapijri launches the Circular Series "firstever" collection of 100% recyclable jackets, all constructed using Econyl regenerated nylon, made from waste materials including discarded fishing nets.

  French Clerici Tessuto has partnered with environmental organisation Parley for the Oceans to manufacture luxury fabrics using a Global Recycle Standard (GRS) polyester yarn created from upcycled plastic debris from beaches, islands and coastal communities.

  Levis Strauss & Co has launched jeans with organic cotton and the newly patented Circulose fibre made from cotton recycled from discarded textiles, in collaboration with Re:newcell

  Lycra launches its first branded elastane made with pre-consumer content. The company plans to convert the majority of Coolmax and Thermolite fibre products to recycled PET, rather than using virgin polymer, by the end of 2021.

  Finnish sustainable fibre producer Spinnova has launched a fully circular, subscription-based takeback and reuse concept as part of its collaboration with sustainable outdoor brand Bergans.

  Swedish fashion retailer H&M Group is to launch the first collection featuring the newly-patented material Circulose. The group's upcoming Conscious Exclusive collection will feature the material, made from recycled cotton, marking the first time chemically recycled fibres are used in garments sold at scale, H&M says. H&M) says its Weekday brand has become the first globally to create a garment with new sustainable fabric developed by Finnish start-up Infinited Fiber Company (IFC).

6. Intervention: unlocking the waiting game

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Intervention: Unlocking the waiting game

- The use of pre-owned clothes shows fairly positive dynamics. This does not require significant policy attention.
- We propose to point the attention to accelerating the development and diffusion of mechanical and chemical recycling technology and the application of recycled fibres in garments.
- The results presented so far indicate a **waiting game** that slows down the progress towards a circular textile sector. To simplify the waiting game:
  - The innovation ecosystem that develops novel fabrics based on recycled post consumer clothes does not yet deliver what is needed for large brands and retailers to shift. This relates to costs, quality and volume
  - The actors in the innovation ecosystem can not deliver due to lack of demand which limits their access to financial resources and constrains their scaling up possibilities
- The interventions should therefore be targeted at unlocking the waiting game
- We propose a two step intervention strategy to unlock the waiting game

Target both supply and demand of circular textile

Create demand: Put pressure on the key players in the existing industry (brands and retail) to shift towards circular business models

Create supply: Improve functioning of the emerging ecosystem that focuses on mechanical and chemical recycling.

Image:milkmeg.com

Create demand through pressure on regime

Create demand through pressure on regime

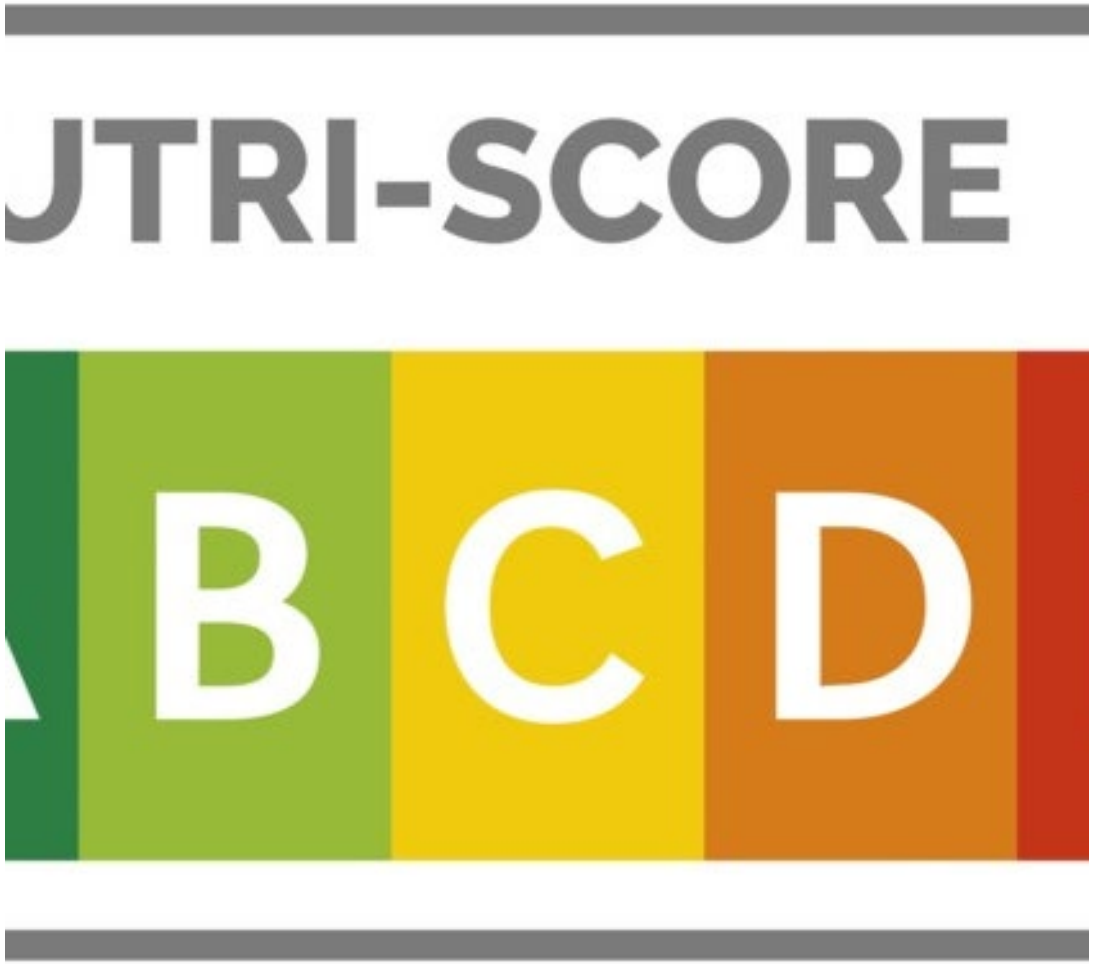
- The textile and fashion industry is a global industry that is governed by global rules of the game
- Unfortunately, these rules of the game are only very sparsely focused on sustainability aspects and even less on circularity
- For the Dutch government it is very difficult to change the global sectoral rules.
- And yet: when the industry does not shift to circularity, there is no fertile ground to grow new supply chains based on recycled content
- On the next slide we propose a multi step approach to put pressure on the regime to change current practices and create a demand for recycled fibres

A multi step approach to the creation of demand

1. Use the workwear clothes market to create a first demand for circular textiles. The transparency in this market is much better than in global fashion and the clients have a stronger focus on social and environmental sustainability. Create deals with workwear suppliers like the denim deal (below)
2. Make full potential of public procurement opportunities. Become the most demanding customer in the sector in terms of recycled content
3. Continue with making deals with front runner firms like done in the green deal circular denim – jeans producers promised to produce 3 million pairs of jeans with 20% post consumer fibres. This facilitates the rise of new supply chain

Image: stocksy United

4. Put pressure on the global industry to become transparent to consumers about the material choices that are made.
    - A majority of the resources in the fashion industry are spent on marketing. Image is everything. We therefore propose to start a mandatory clearly visible labelling system on all clothes sold in the NL in analogy to the nutri-score labels.
    - Red labels indicate no transparency and / or unsustainable sourcing of materials while a green label indicates that the supply chain is transparent and partly circular.
    - The Dutch experience with energy labels on kitchen appliances taught us that high end producers do not like to be associated with a red label that signals inferior quality to customers. Introduction of energy labels quickly led to massive investments in energy efficiency improvement by global players.
    - The energy label scheme also taught us that it is important to make the criteria more stringent over time: we call this tie-wrap policy
    - It is advisable to quickly create a NEN norm for the labelling scheme and aim to get the same norm adopted for the European market



5. Introduce an EPR system that is related to the labelling scheme. Red label implies the maximum EPR levy while green labels can be exempted from the levy or even receive a subsidy to compensate for the increased material costs
   - Also design for recycling can be rewarded with a more positive colour. E.g. mono materials and clear labelling of the material content
   - The EPR levy must be very steep to have a likely effect on the behaviour of producers. When the levy is not very steep, it is merely an instrument for resources mobilisation to develop and upscale the much needed innovative recycling technology

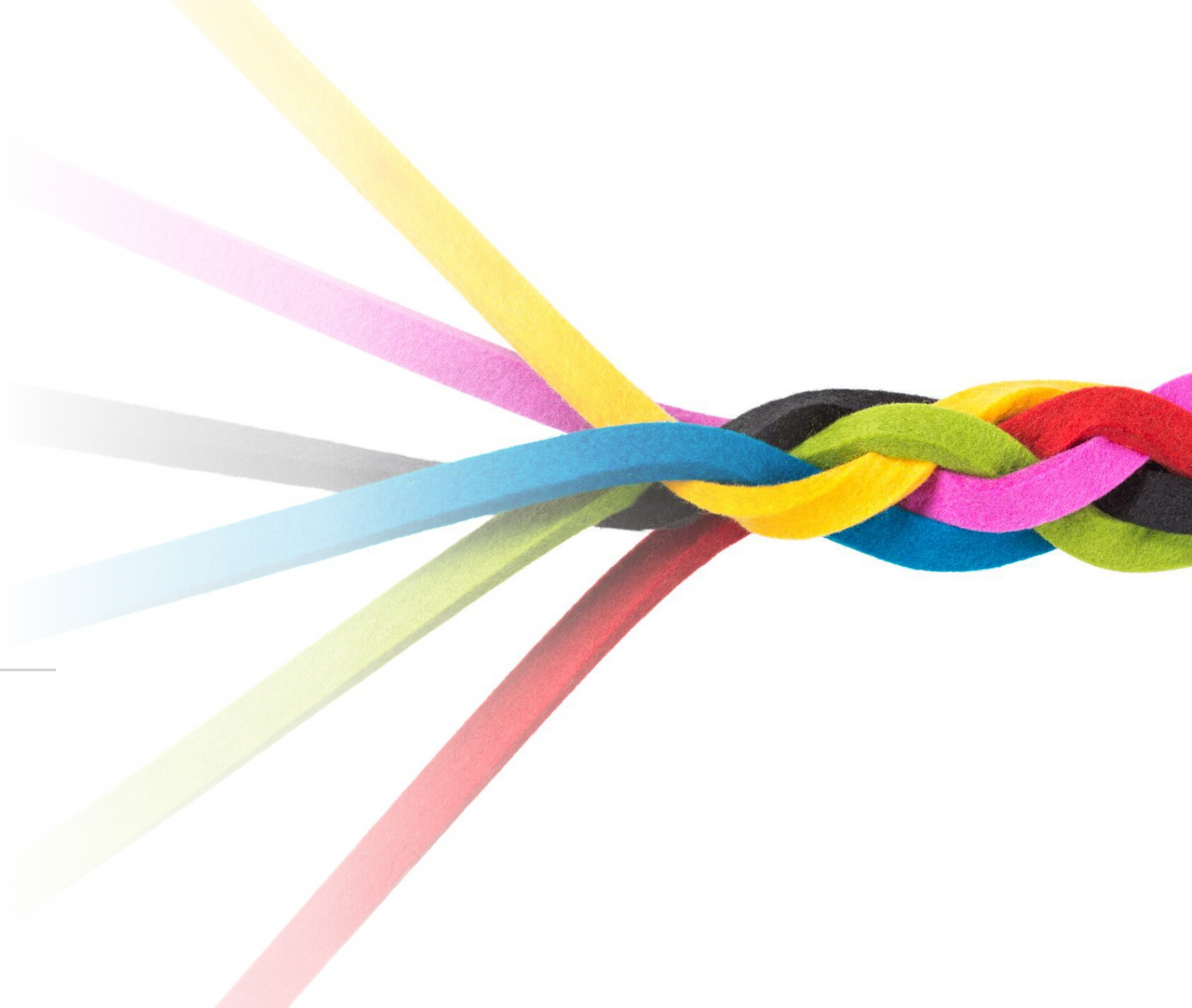
Image: 123RF.com

6. Most interviewees indicate that the most effective policy measure is imposing mandatory percentages of recycled fibre content in clothes sold in the Netherlands. While the outcome is effective, it is a much harder measure to implement in a national context. We propose to investigate whether this measure is possible at the European level.

7. While harmonizing policies at EU level is better in terms of market size, it is also a great way to delay action since harmonizing rules at an international level is a slow process. We therefore propose to start with National policies and upscale to international level later.

Image: 123rf.com

Create supply through ecosystem coordination



Ecosystem coordination

- The recycling innovation ecosystem in NL is promising but not yet delivering
- Dutch Circular Textile Valley (DCTV) is a new organisation subsidized by the Dutch Government as a means to accelerate sorting, mechanical and chemical recycling. A main aim of DCTV is to develop new circular business cases by bringing different actors in new supply chains together.
- Apart from DCTV also other actors have taken initiatives to create a better functioning ecosystem (circle economy, regio deal) but interviewees indicate that the emerging ecosystem is still quite scattered and better **coordination and collective strategizing** is necessary.
- DCTV is in a good starting position to take on a coordinating role since it is a joint initiative by different actors that aim to accelerate the circular fashion transition; however, it needs to step up and professionalize in order to take on this role
- Interviewees indicate that DCTV has managed to attain progress on important aspects, but they would like to see this organisation to become more active and more dominant
- This requires more structural capacity in terms of human resources within DCTV and to bring in more technological expertise as interviewees indicate that DCTV lacks sufficient technical expertise which prevents setting of clear targets and procedures

What should a system coordinator do?

- Many interviewees indicate that the development of a new circular textiles sector requires much more coordination efforts than currently takes place
- A dedicated system coordinator or transition intermediary should fulfill the following roles
    1. Develop deep knowledge about the emerging innovation ecosystem and function as *the* spokesperson for the emerging sector
    2. Function as a one-stop-shop for circular entrepreneurs and policy makers dedicated to accelerating CE developments in the fashion industry
    3. Facilitate interactive learning in the innovation ecosystem; connect the geographically dispersed innovation hubs
    4. Align supply and demand for circular textiles; facilitate the creation of novel circular supply chains that serve the demands of specific actors in the fashion industry
    5. Improve the legitimacy of the products that come out of the innovation ecosystem through active communication on success cases
    6. Improve the visibility and reputation of Dutch circular textile initiatives to attract new players to the Netherlands
    7. Facilitate the mobilization of financial resources for the emerging sector from EPR system (see next slide)
    8. Play an important role in prioritizing the spending of these resources from the EPR system on the different circular activities with the aim to have most impact for every euro spent
    9. Create attention for enabling technologies like tracking and tracing technology

Create supply through mobilizing financial capital

Create supply through mobilizing financial capital

- Actors in the innovation ecosystems around mechanical and chemical recycling are constrained in their growth potential through a lack of financial capital.
- We suggest to quickly set up a mandatory **Extended Producer Responsibility** system - levy on clothes to internalize the costs of circular strategies - with the unconventional goal to mobilize sufficient financial resources to finance upscaling of the innovative activities related to mechanical and chemical recycling and the emergence of new circularity enabling activities.
- The resources may also be used to finance high R strategies like combined repair and 2nd hand stores (ambachtswinkels)
- It is important that a governance system is created to allocate the resources in the most effective way. Focus on maximum impact.
- We therefore propose that allocation of financial resources is closely aligned to the needs of the innovating actors in the innovation ecosystem. The innovation system coordinator, for e.g. DCTV, can play an important role in this

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Pitfalls of Extended Producer Responsibility

- The Netherlands have the tradition to create collective arrangements regarding EPR. The sector collectively negotiates the terms of the EPR scheme and also collectively organise the necessary actions
- While this collective effort is effective and efficient in terms of organizing a waste collection infrastructure, recent experiences also show downsides
- The most important one is that collective EPR systems tend to focus primarily on organizing the recycling process – sometimes with an emphasis on low quality recycling with low environmental gain - and lack attention for higher R strategies like prevention and product re-use.
- Another disadvantage is that individual firms are not incentivised to develop innovative business models to live up to the EPR goals. They leave all activities to external organizations that organize the recycling process.
- Therefore, current EPR schemes do not lead to deep changes in industry practices
- It is therefore very important to include higher R strategies in the EPR instrument and when it is not possible to agree on deep changes in industry practices it is better to develop a unilateral binding regulatory framework.

Why reshoring?

- Some interviewees were critical about a focusing on building Dutch industry related to production of fabrics based on recycled content. They stressed that the fashion industry is global in nature and also that reshoring may have negative social effects in other parts of the world
- From an innovation perspective there are clear arguments for local industry build up:
    1. Innovation develops much more quickly when innovators are embedded in a local stimulating environment with access to nearby knowledge, financial and human capital.
    2. History has shown that new industries often develop in local clusters
    3. In order to live up to mission ambitions, the Dutch government has many options to influence local conditions. The influence on global innovation activities is very limited
    4. From a logistical point of view it makes sense to locate production close to the input sources. The Dutch collection system provides excellent resources
    5. It is important to develop complete new supply chains based on recycled content. Spatial proximity facilitates the build up of these supply chains.
    6. Knowledge on recycling will eventually spill over to other regions in the world.
- Developments however do not need to be restricted to the Netherlands. When potential exists to quickly develop new supply chains based on international availability of resources and capacity, this may be a preferable route in some cases

Conclusions

- The transition to a circular textile sector is a challenging process of change
- Current policy is a great first step and already sets activities in motion but to complete the mission more is needed
- We propose a 2 step approach:
    1. **Create demand**
        - Put severe pressure on the fashion sector to start using recycled content in their products via labels, steep EPR tariffs or mandatory recycled content
        - use full potential of public procurement related to workwear
        - Continue with recycled content deals

    2. **Create supply**
        - Create a well functioning ecosystem that develops new textiles based on recycled fibres.
        - Facilitate the coordination of innovation activities
        - Invest much more resources in new circular technology and innovators using an EPR scheme
- When this is done well, the Netherlands are in a good position to also benefit economically from this shift through a good starting position in recycling technology and entrepreneurship

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appendices

Key system enabler: tracking and tracing technology

- Several system actors have emphasized the need to have clear labelling for circular items for a better communication with consumers. So far, a standard and certification exclusive to circular clothing items does not exist
- The experts we engaged with signaled that tracking and tracing technology will come to play a key role for the three trajectories
- Tracking and tracing can be essential in providing full supply chain transparency, but above will enable new ways of communicating and interacting with the consumer; It will be a key driver technology in attaining higher efficiencies for some of the new business models in circular fashion
- With the help of tracking and tracing the exact fiber composition of clothing items, colour composition, washing cycles, wearing time, etc. can all be known, next to this elements such as production location and time, retailing point, and any other stages in the lifecycle of a clothing item can be identified
- Different technologies exist for the three key elements which are standardized to various degrees. Especially the last category (digital link) needs a standardization process, the other two have relatively mature standards
- THE UNECE is currently involved in trying to define a framework together with the industry in order to accelerate the process standardization and to reach a more harmonized application in the industry
- A better harmonization is especially required in the future for practical and efficiency reasons, think of clothing stores which sell 40 different brands, or think of the costs of developing sorting machines which can recognize every existing type of label in the market.
- In the longer-run the digital link could come to replace printed labels on clothing items, however : there are potentially ethical issues with this enabling technology as it will tap fundamentally into consumer privacy
- There is also an issue in making the codes, labels or chips circular, invisible and comfortable

Key system enabler: tracking and tracing technology

- WHY IS IT IMPORTANT FOR THE THREE TRAJECTORIES?
- Important for recommerce trajectory, not to be reliant of consumers own assessment of quality of clothes ; also important for related trajectories such as renting clothes to be able to assess quality
    - Pilots show that when consumers act as sellers they tend to embellish/overestimate the quality of clothes (‘still good quality), while in a position as consumer/receiver they would not give the same attribute (i.e. ‘not such good quality’)
- For mechanical recyclers it is key because they have little automation of the various sorting steps preceding the machine-based mechanical recycling processes, especially with the growing volumes (also of low quality clothes) they need such automation for better sorting efficiencies.
- Chemical recyclers have an equally high, if not higher need for this technology (given the state of their technologies so far), as they are reliant on knowing the exact clothes composition (fabrics), and colours for their recycling process, and they need to attain exact percentages of inputs (98% cotton)
- Above all it is THE link that will enable smart dealing with inputs over the entire lifecycle of garments in different types of circular business models, because the viability of inducing ‘a next circular loop’ for an item will largely depend on the item production (composition), its quality and managing the way and time it is worn
    - Across the value chain, it needs to be determined ‘when an item needs to be recollected from the consumer to be still suitable for a new loop X within the clothing industry’
    - Tracking and tracing will hence also enable to determine if mechanical or chemical recycling is the better option given the state of the item
    - It will be the missing link for the consumer who has so far faced information asymmetries and would be able to know the exact product composition, production places, the colours, this could give the conscious consumer real decision power and the effort of navigation between labels is lifted

Image: prweb.com

Back to system coordination

Back to chemical recycling

Explanation of numbers in supply chain analysis

- It is very difficult to get a precise overview of the supply chain. There is no single trustworthy source of information
- Many arbitrary choices need to be made in order to present a figure as in slide 24. One of these choices is whether we count firms, subsidiaries or locations of activities. Some companies have several subsidiaries with different specializations. These subsidiaries may run different activities at different locations. E.g. BKN kringloopwinkels consists of 66 members which run 200 stores. We used the figure of 200 but it is also defendable to use the number 1 or 66.
- The number of collectors was hard to determine. There are several dedicated waste companies and organisations like Leger des Heils who focus on collection. However, collection also takes place at kringloopwinkels. These also do light sorting. We counted all of these locations as collectors and sorters.
- There are only a few organizations that are really specialized in sorting and develop technology to improve sorting.
- Another problem is that many firms state on their website that they do processing steps related to mechanical recycling. However, for some cases we know that in reality they actually outsource these processes.
- Given the issues stated above, the numbers on slide 24 need to be interpreted with caution.
- To monitor progress in this sector, to understand the needs of the sector in terms of further development, and to engage in to new activities with firms in this sector, it is important that a trustworthy overview of all activities and all organizations in the sector is present and easy to access for all interested parties.