Weaving circularity into the textile industry:

A systemic approach to enable value creation from garment manufacturing waste in India

Master thesis by
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Master Thesis

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Executive summary

The textile industry has become one of the biggest concerns impacting the environment today, especially the waste that it generates (Global Fashion Agenda & The Boston Consulting Group, 2017).
As one of the major textile producers in the world, along with a growing domestic market, India suffers from a double burden of waste coming from both production and consumption activities (Business of Fashion and McKinsey & Company, 2019). The current infrastructure presents a challenge in handling these multiple waste streams, resulting in a substantial volume of waste being mismanaged, harming local communities and the environment (Priya & Gupta, 2020; Swaminathan, 2018).

By employing systemic design, this project aimed to explore a circular approach to this issue, namely to create value from textile waste, and how these activities may be enabled through a communication means. Layers of context variations found in the early phases of the research eventually placed the focus on cotton-based textile waste generated by first-tier garment manufacturers in India as a system of interest.

Through primary and secondary research, further understanding of the system was gathered. Three methods of analysis yielded insights on the stakeholders, (value creation) activities, material flow (i.e., waste and waste-based products), as well as barriers and drivers of value creation in the system.

Leverage points were (co-)identified to discover places to intervene in the system. Ideas collected from creative brainstorming sessions, combined with research insights, produced several potential leverage points that led to the formulation of a design direction and a future vision.

An intervention in the form of an online knowledge base was conceptualised with the intent of closing knowledge gaps on circularity and the textile value chain, in order to propel informed circular actions from a system lens. It is targeted towards (potential) value creators with an existing motivation to create solutions for textile waste. The way of communicating information was built upon learnings from card sorting activities and the Three Horizons framework.

Evaluation with the potential audience showed that the concept provided a valuable knowledge foundation in developing textile waste solutions. Additionally, it highlighted that more interventions would indeed be necessary to translate motivation into action. Learnings from the evaluation sessions were then incorporated into the concept iteration as well as future recommendations for the project.

This project was organised with Enviu as client partner, as part of the Putting Waste to Work project in partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Concordia Textiles, and Purfi Global.

Acknowledgements

This project has been a humbling journey into realms I initially knew little about: textiles, circularity, India, and everything in between. It would have been a far tougher road had I been on my own; fortunately, I wasn't. Therefore, I'd like to take a moment to express my gratitude to those who have been a part of my journey.

My appreciation goes to my supervisors – Holly, Jo, Jiska, and Tanu – for always being present and encouraging, but more importantly, for seeing me in a better light than I often see myself.

Holly, it is inspiring to see your depth of knowledge on textiles and your drive in shifting it for the better. Your thoughtful way of sharing advice always left me overflowing with ideas and critical thoughts to contemplate over. Jo, your warmth and wisdom shine through our virtual meetings. Thank you for being a gentle reminder to also enjoy the ride and to focus on the "next spoon". Jiska, for being a bucketful of positive affirmations. I truly appreciate your trust in me as I approach this project, and your constant efforts to make sure that I receive the support I need. Tanu, the fact that I find myself conversing with you about practically everything under the sun shows how much I enjoy our companionship. I meant it when I said this would have felt impossible without you.

I would also like to thank Enviu for giving me the opportunity to work on an exciting graduation project, which I did not imagine I would travel across continents for. And to the wonderful people at the organisation, especially Elise who became a partner in navigating the world of textile waste in India.

Aside from that, my gratitude goes to everyone who has selflessly lent their hands to participate in the project. From the interviews, brainstorming activities, field visits, to the validation sessions, all of them were essential in bringing the project together.

And to my dear friends, for the occasional check-ins and helpful counsel – both emotional and intellectual – as I worked on the project. Especially to Azhim, Garoa, Mariana, Hilman, Tijmen, Elisabeth, with whom I have shared this journey the most closely.

Most of all, I would like to thank my parents, whose constant and unconditional support in whatever I pursue has led me to where I am today. Along with my brother, with whom I wish to celebrate for getting a degree this year as well.

Having completed this project, I realise that so much still needs to be figured out. So my hope is that you, dear reader, can be one of the many who can continue this work in progress.

Enjoy the read!
Mutia

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Glossary

Circular economy (CE)	Circular economy is defined by Korhonen et al. (2018) as an economy built from societal production-consumption systems that leverages cyclical materials flows, renewable energy sources, and cascading-type energy flows to optimise the service generated from the linear nature-society-nature material and energy throughput loop.
Downcycling	Downcycling is a catch-all term for with value creation activities that result in products with lower valued applications (Reike et al., 2018).
End-of-life	End-of-life is stage in a product's life cycle when its functionality no longer satisfies the requirements of its user (Jofre & Morioka, 2003).
Leverage point	Leverage point is a place within a system where interventions can be made (Meadows, 2015).
Pre-consumer waste	Pre-consumer waste refers to waste that is produced in the value chain prior to reaching the consumers (Runnel et al., 2017). It can be created before the production process (pre-production) or after (post-production).
Product life cycle	Product life cycle is the series of identified phases in the life of a consumer product (Rink & Swan, 1979).
Post-consumer waste	Post-consumer waste refers to waste produced in the value chain after it has been used by a consumer (Runnel et al., 2017).
Recycling	Recycling refers to (technological) process of capturing the constituent materials of discarded products that no longer maintains its original structure (Reike et al., 2018).
Upcycling	Upcycling is a catch-all term for value creation activities of 'upgrading' the value of discarded products (Reike et al., 2018).
Value creation	In the context of this project, value creation refers to any activity that turns discarded products into outputs with use value. This term is used synonymously with value retention, value capture, or valorisation.
Virgin materials	Virgin material is any unutilised resource that is or has the potential to be a basic material from which a product is made (Park, 2007).
Waste	In the context of this project, waste broadly refers to any material that gets discarded or disposed by its user because its functionality no longer meets their needs.

Chapter 1

Introduction

This chapter sets the context of the project by introducing the problem background, project stakeholders, and the project assignment.

Figure 1. Bales of textile waste at a waste facility in India. Photo by author.

1.1 Problem background

Besides being the second-largest producer of cotton in the world, India has emerged globally as the sixth-largest exporter of textiles and apparel (Ministry of Textiles, 2019). As a manufacturing powerhouse with a growing apparel consumption market (Business of Fashion and McKinsey & Company, 2019), it is one of the countries most affected by the negative impacts of the textile industry, namely the waste it generates (Global Fashion Agenda & The Boston Consulting Group, 2017).

The country bears the weight of textile waste streams from both production and consumption activities. On the one hand, it must deal with pre-consumer waste generated during the production process. Meanwhile, on the post-consumer side, textile waste has become the third-largest source of municipal solid waste in India (Bairagi, 2018).

Especially in today's globally linked economy, issues of textile waste transcend the borders of nations. Adding to domestic waste burdens, India receives an inflow of waste from other countries as it becomes one of the world's largest importers of used clothes and textiles (United Nations, 2021).

The existing waste infrastructure in India is currently lacking the capability to handle the vast amounts of waste that are coming from these multiple streams. Its informal and fragmented nature creates a challenge for textile waste to be collected and utilised in an organised and proper manner (Priya & Gupta, 2020).

As a result, textile waste runs the risk of being mismanaged, where it harms soils and emits pollutant gases that threaten the environment and local communities (Swaminathan, 2018). Landfilling and open-air incineration are two prevalent instances that may lead to these detrimental effects (Swaminathan, 2018). Additionally, this results in lost chances to retain resources in the value chain and maximise its utilisation (Fashion for Good et al., 2022).

The aforementioned issues surrounding textile waste in India highlight the urgency to shift current practices in the industry into a circular direction, where resources are looped back into the value chain instead of being disposed in a linear fashion (Fischer & Pascucci, 2017). This particular project will focus on identifying opportunities to recirculate waste into the value chain as opposed to having its value be lost, or more concerningly, having it cause further socio-environmental harm.

Though the project places a focus on the issue of waste generation, it should be highlighted that achieving circularity also calls for solutions at stages before waste is generated.

1.2 Project stakeholders

The graduation project is organised with Enviu as client partner, a not-for-profit organisation that accelerates systemic change by building and supporting innovations that improve livelihoods and the environment.

With its Reweave programme in India, Enviu is addressing multiple points along the textile value chain to shift it towards a more circular direction. The graduation project is positioned under Reweave, in support of the Putting Waste to Work project.

Putting Waste to Work

Concordia Textiles NV, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and Enviu are working together on the Putting Waste to Work (PWtW) project within the framework of the develoPPP funding programme, which GIZ implements on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The project intends to demonstrate and replicate a scalable and inclusive textile waste value chain in India.

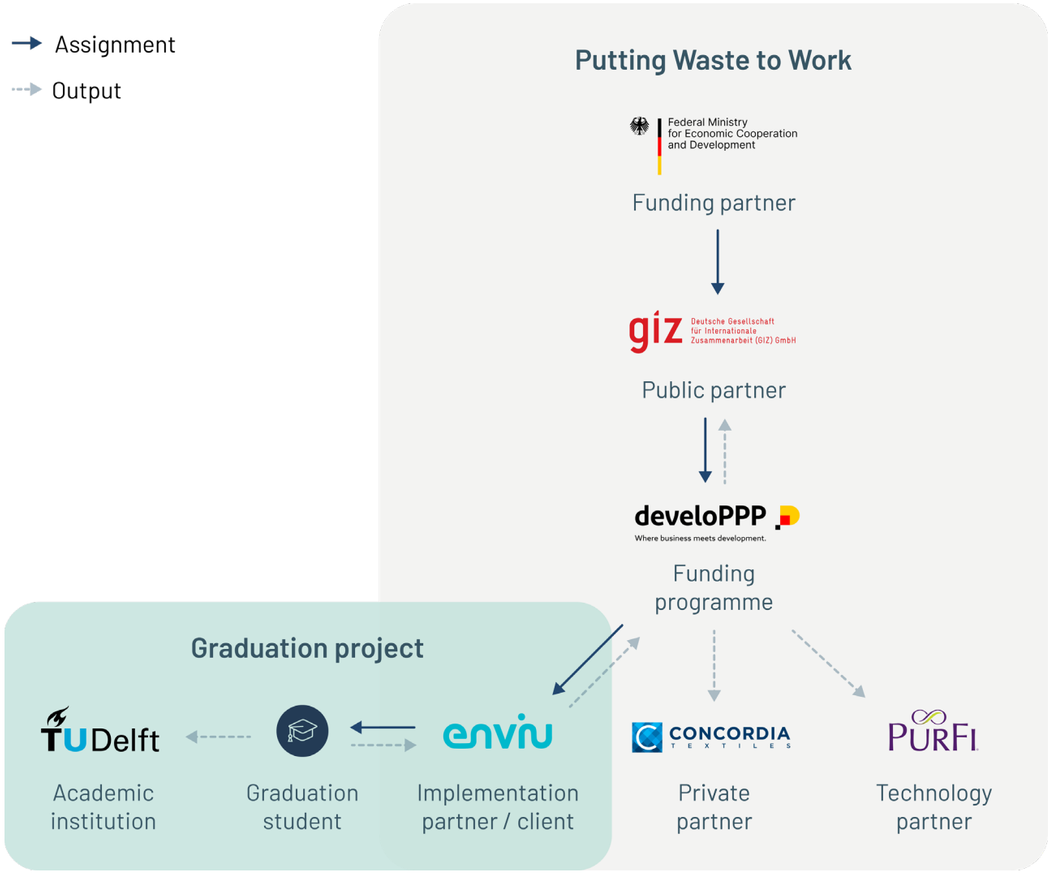


Figure 2. Relations between project stakeholders

Key components of the project include setting up waste sorting infrastructure and technology in India as well as upskilling and building capacities of waste workers. Moreover, it aims to stimulate the growth of solution providers who recycle or re-use textile waste by supporting them in developing approaches to utilise waste.

While Enviu is the direct client, the graduation project considers the interests of the overarching PWtW project, which includes its partner organisations.

Figure 2 provides a visualisation of the relations between the parties involved in this project.

1.3 Project assignment

1.3.1 Project brief

Project brief

Explore circular solutions to generate value from textile waste and identify potential industry stakeholders with value creation capabilities

The above brief was proposed along with the client before the start of the project. The motivation behind the brief came from the PWtW project's objective to stimulate the growth of industry stakeholders who can provide solutions to waste (i.e., solution providers).

The graduation project was tasked to explore ways to generate value from waste and identify industry stakeholders who can create value from waste, whose activities can potentially be stimulated. The graduation project was initially expected to capture and deliver these learnings in a communication means (i.e., a guide) that would be circulated to industry stakeholders as a tool to educate them on how to create value from textile waste. By doing so, it is envisioned that value creation activities may be stimulated and the use of resources (i.e., waste) may be maximised, specifically in recovering its value.

While this initial expected output was taken into account, the graduation project will further explore the direction, approach, output, and target audience that may serve the underlying goal of stimulating value creation activities.

1.3.2 Research question

Research question

Explore how landfilled and open-air incinerated textile waste in India could be reduced through a communication means that enables value creation activities for cotton-based garment manufacturing waste

The system framing process at the initial stage of the research phase led to the definition of the above research question and several subquestions.

These questions provided an overarching frame of what the project will address, and helped bring down the complexity of the problem space into a more focused area of interest.

The process that led to the formulation of these questions is elaborated in Chapter 3.

Sub research questions

1. What value creation opportunities are possible for cotton-based textile waste* generated by garment manufacturing activities in India?
2. What opportunities and barriers are present in the production of cotton-based garment manufacturing waste and its utilisation?
3. What stakeholders possess the capacity to enable value creation from cotton-based garment manufacturing waste?

** Pure cotton, cotton rich (80% cotton with other blends), pure cotton denim*

Chapter 2

Methodology

This chapter explains the methodology of the project. The complex nature of the problem domain is first described, followed by an elaboration of the systemic design methodology and the process that the project carried out.

2.1 Textile waste as a complex problem

Snowden and Boone (2007) presented the perspective that problems may fall into five different contexts based on the relationships between their causes and effects: simple, complicated, complex, chaotic, and disordered.

A problem that sits in a complex context holds unpredictability, where its answers may be understood in a partial and retrospective manner (Snowden and Boone, 2007). This is the result of the multiple interdependent elements within its system, which interact in a non-deterministic manner (Ladyman et al., 2013; Schueler, 1994).

The textile industry serves as an example of a complex system, where waste is one of the problems it generates. It is a system made up of networks of actors (e.g., individuals, enterprises, institutions), with material artefacts, interactions, and information flowing in between (Markard et al., 2012).

Addressing the textile waste problem requires an approach that recognises this complexity. As a result, this project applied an exploratory, rather than a singular view, to identify potential causes and (desirable) effects of the problem. Eventually, a means (i.e., intervention) to achieve one desired effect was conceptualised.

2.2 Systemic design

With the increasing adoption of design as a problem-solving tool, the discipline has found its way to interact with problems within complex socio-technical systems (Norman & Stappers, 2015). Adapting to the domain's complexity, designers have begun incorporating systems thinking into their approach (Ryan, 2014). Systems thinking is a holistic approach that recognises systems as a collection of components that are interrelated with each other, making it a suitable approach for understanding complex problems (Monat et al., 2015).

Systemic design is where systems thinking and design thinking intersect. It blends the systemic view of complex systems with the intuitive and abductive approaches that characterise design thinking (Pourdehnad, 2011). While there are many other system-level problem-solving methodologies from adjacent domains, the systemic design approach was deemed to be suitable for this project due to the design-grounded approach that it takes.

Given that systemic design is a relatively new discipline, some scholars have suggested embracing a pluralistic approach rather than sticking to a particular paradigm or method (van der Bijl-Brouwer & Malcolm, 2020). The project adopted this perspective by bringing in several existing system-level design methodologies, such as System Oriented Design (Sevaldson, 2013), Design Council's (2021) Systemic Design Framework, and the Systemic Design Toolkit (van Ael et al., 2016). Throughout the process, systems thinking approaches from adjacent fields were also incorporated. The tools and methods applied in the project were chosen based on problem-approach fit, with considerations of the project's constraints.

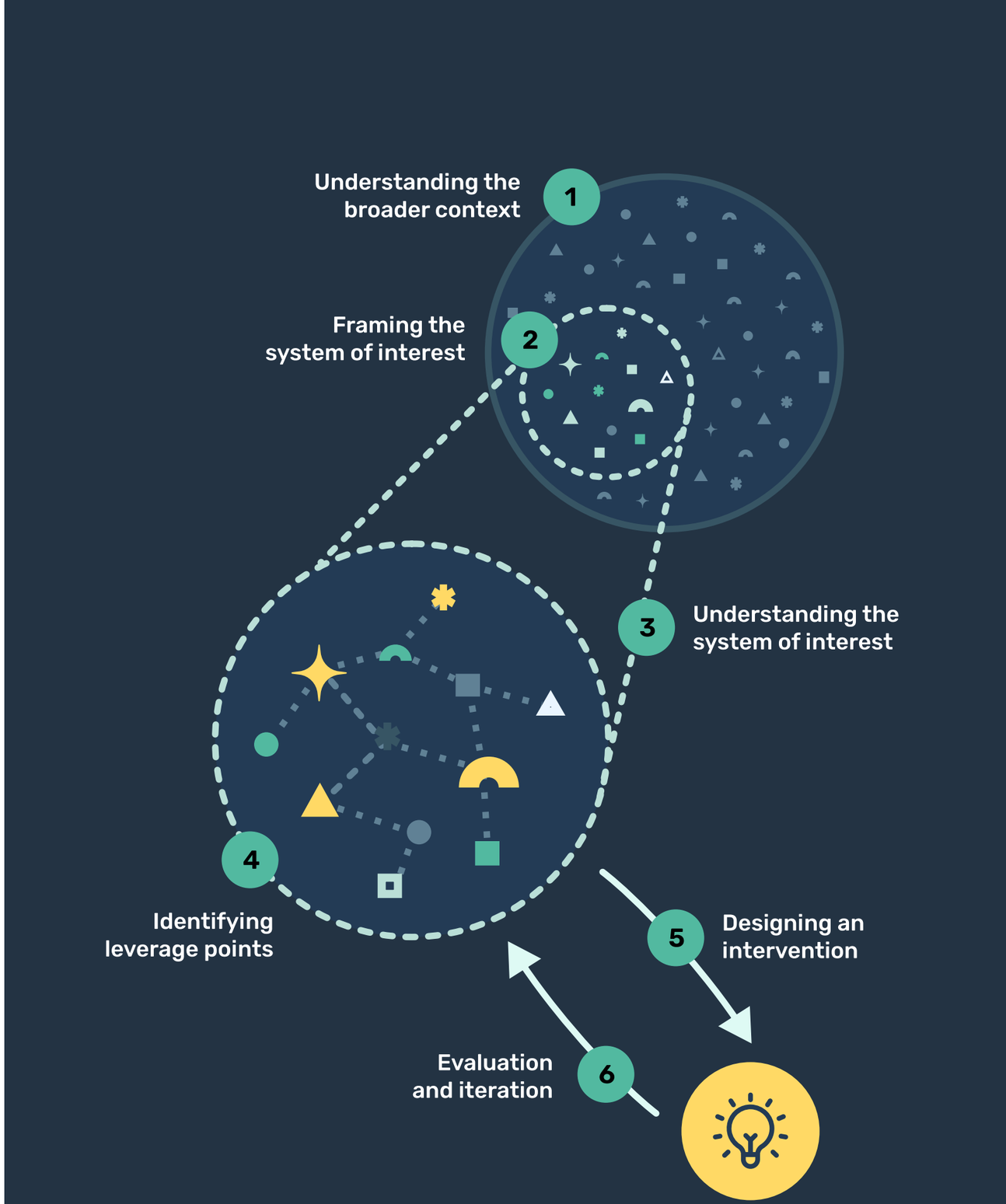


Figure 3. Project approach

2.3 Design process

One aspect that characterised the project was the incremental problem reframing, with each reframe narrowing down the problem scope. In this project, reframing activities took place at the brief formulation, system framing, leverage point selection, and intervention design phases. The following is the process that the project went through:

1. Understanding the broader context

The process started with an exploration of knowledge relating to textile (waste), circular economy, and the context of India. It revealed the variety of contexts in which the problem domain sits, highlighting both its scale and complexity. This phase was concluded with a perceptual framing of the problem area and a theoretical understanding of circularity in the context of the textile industry.

Methods and tools
Expert interviews, literature review, contextual variation identification

2. Framing the system

This phase focused on framing the broader problem context into a system of interest. This was done by choosing one aspect of each identified context variation as a system boundary, which collectively framed the system of interest. Besides delineating the system of interest, this phase also resulted in the formulation of the research question and its subquestions.

Methods and tools
System framing, research (problem) framing

3. Understanding the system of interest

Further context understanding was gathered with a more directed focus on the system of interest. Several methods of analysis were then applied to understand the socio-technical aspects of the system of interest, namely: stakeholders and their activities, the flow of waste(-based) materials, and barriers and drivers of value creation.

Preliminary insights from these sensemaking activities were integrated into a system map, which was then evaluated by subject matter experts. A field study conducted later in the project further enhanced and validated the insights.

Methods and tools
Literature review, primary interviews, secondary interview analysis, field research, stakeholder mapping, flow mapping, affinity mapping, insights validation, system visualisation

4. Identifying leverage points

Ideas for potential leverage points, or places in a system where interventions can be made were then collected through creative brainstorming sessions. The magnitude and complexity of change of the ideas were then assessed using the Iceberg model (Ellis & Black, 2018), in addition to considerations of other frameworks of systems change such as Meadows' (1999) leverage points and Williamson's (2000) institutional analysis.

Research insights and ideas from the sessions led to the identification of potential leverage points and the formulation of a design direction. Additionally, a future vision was created to set the context for the design direction and depict its desired endpoint.

Methods and tools
Creative brainstorming (co-creation), opportunity mapping & analysis, future visioning

5. Designing an intervention

The design direction served as a starting point for this phase. A leverage point that pertains to knowledge was chosen, where an intervention was further designed. The target audience, form, approach, and design principles of the intervention were conceptualised in this phase.

Card sorting activities (Spencer, 2009) were employed to understand the mental model of the target audience in building knowledge and solving problems. Its results, as well as the Three Horizons framework (Sharpe et al., 2016), served as a basis for designing the information architecture of the intervention.

A user flow map was then used to elaborate on the stages of interaction. Lastly, the form of the intervention was made tangible through an interactive prototype.

Methods and tools
Intervention design, card sorting, information architecture, user flow mapping, prototyping

6. Evaluation and iteration

The intervention concept was subjected to evaluation with those considered as the target audience. This activity emphasised on assessing the concept's value and problem-concept fit. The design principles were used to measure the extent to which the intervention concept fulfils its intended aims, while the value of the concept was evaluated by soliciting ideas on possible use cases and types of audience that might find it useful. The resulting insights were then translated into points of improvement for iterating the concept.

Methods and tools
Concept evaluation and iteration

Chapter 3

Circular economy in the textile industry

This chapter elaborates on what circular economy is, its frameworks, and the key practices for its implementation in the textile industry.

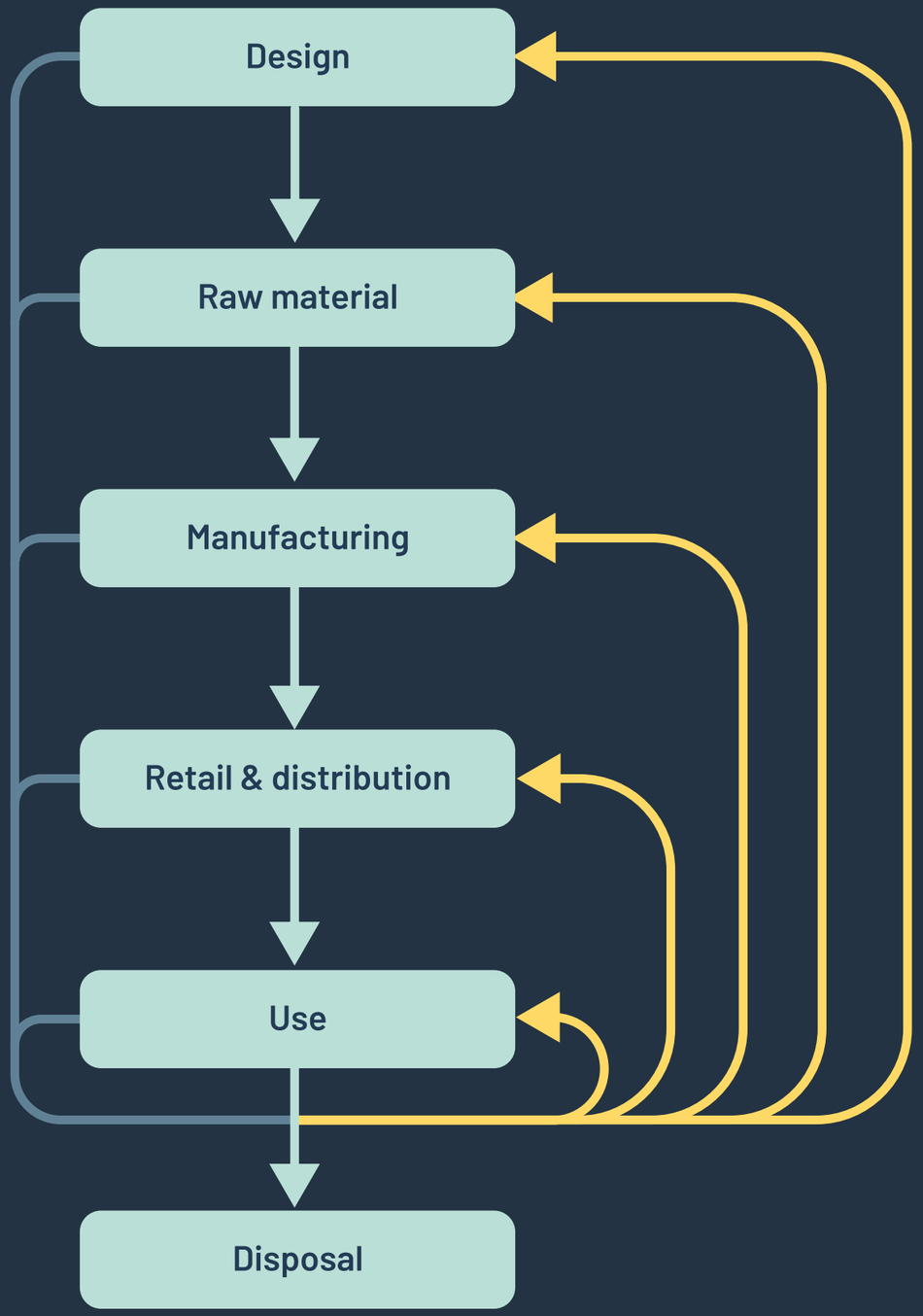


Figure 4. Simplified illustration of circular economy

3.1 Circular economy as an alternative paradigm

The linear "take-make-waste" production-consumption system is currently growing in an unsustainable manner, as it collides with the socio-environmental systems that serve as its vessel (Korhonen et al., 2018). While the negative impacts of an industry need to be viewed from environmental, economic, and social dimensions (Thangavel & Duraisamy, 2014), this chapter will concentrate on the environmental issues surrounding the textile industry as it is where this project's emphasis lies.

The textile industry impacts the environment in four areas: energy consumption, water and chemical consumption, direct CO2 emissions, and solid waste (Koszewska, 2018). As the problem of solid waste becomes the focus of the project, how it manifests within the Indian context will be discussed in more detail in the next chapter.

Circular economy (CE) proposes an alternative to the linear system, which aligns economic growth with environmental sustainability (Geissdoerfer, 2017). Several academics have pointed out that the concept of CE remains subject to multiple definitions, with ideas coming from various schools of thought (Korhonen et al., 2018; Lieder & Rashid, 2016), and the various interpretations that this literature review found echoed this argument. This literature review will take the definition of CE from Korhonen et al. (2018), who have examined these various interpretations.

CE is defined as an economy built from societal production-consumption systems that leverages cyclical materials flows, renewable energy sources, and cascading-type energy flows to optimise the service generated from the linear nature-society-nature material and energy throughput loop (Korhonen et al., 2018). It contributes to all three elements of sustainable development – economic, ecological, and social – by limiting the flow to nature's bandwidth and reproduction rates (Korhonen et al., 2018).

Due to CE being an emerging concept, this project will consider the similarities and contrasts between CE definitions and frameworks and apply them in the context of the Indian textile industry. Exploring the semantics of CE, however, necessitates a realm of research and expertise that falls outside this project.

3.2 Circular economy frameworks

3.2.1 R frameworks

The R frameworks propose hierarchies of implementing CE in retaining the value of a product, from the most to the least circular (Kristensen & Mosgaard, 2020).

Though the research found variations of the R frameworks (e.g., 3R, 4R, 6R), the 10R framework by Reike et al. (2018) is among the most recently conceptualised and provides a broader categorisation of value retention options. Figure 5 depicts how the 10R framework spans across the value chain.

The following are the value retention strategies in the 10R framework, which are clustered into three material loops:

Short loops: User choices recycling

Activities linked to alternative consumer or customer actions

- **Refuse (R0)**: Employing consumption and production activities to prevent waste creation
- **Reduce (R1)**: Eliminating waste creation through the use of fewer resources or longer product use
- **Resell/re-use (R2)**: Bringing products back to be used for the same purpose after initial use
- **Repair (R3)**: Bringing a product back into its original function to extend its lifetime

Medium long loops: Product upgrading / up-cycling

Activities linked to acts of upgrading used products

- **Refurbish (R4)**: Replacing or repairing components of a product by retaining its overall structure
- **Remanufacture (R5)**: Disassembling the full structure of a product, and when necessary, replacing or repairing it in an industrial process
- **Repurpose (R6)**: Reusing discarded products or components and adapting them to another function

Long loops: Down-cycling

Activities linked to aggregate material flows, frequently resulting in lesser valued re-applications

- **Recycle materials (R7)**: Processing of mixed waste streams using technology to capture (nearly) pure materials
- **Recover (R8)**: Capturing the embodied energy in waste into energy or biomass by means of incineration
- **Re-mine (R9)**: Retrieving materials after the landfilling of products or components

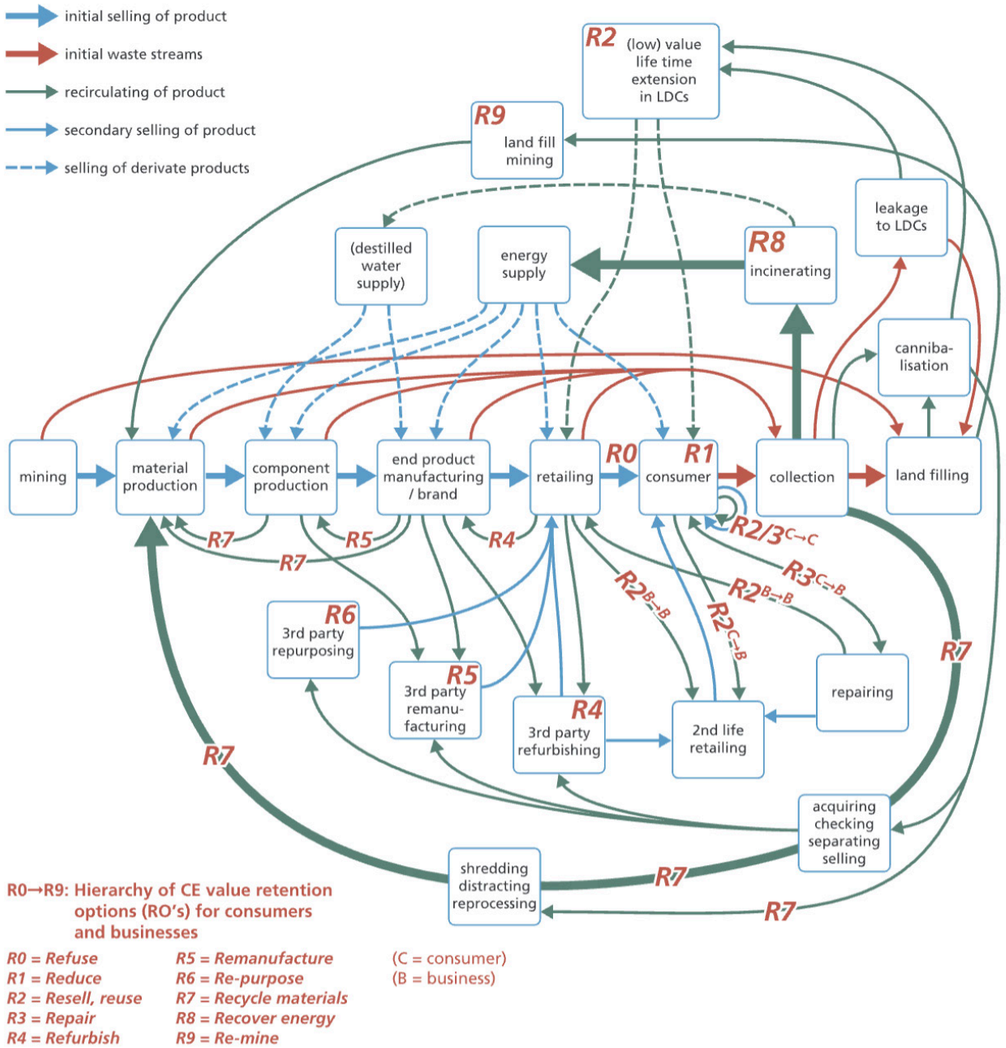


Figure 5. Mapping of value retention options of the 10R framework (Reike et al., 2018)

3.2.2 Value cascading

Several scholars have linked CE to cascading, which brings the concept of value into the picture. Cascading is understood as a principle of retaining the added value of materials for as long as possible, by diverting them into as high-valued applications as possible (Campbell-Johnston et al., 2020; Kirchherr, 2017).

The resource spiral is a perspective that combines the concepts of cascading and product life cycles (Hall, 2021). A material may travel up or down the loop as it approaches the point of disposal, depending on the value retention method. Figure 6 provides an illustration of the resource spiral.

It should be noted that the concept of value is complex in itself; in the context of textiles, it may be defined in terms of economic value, fibre quality, visual appeal, or recyclability (Hall, 2021). The value, or worth of a material, is likewise relativistic, which may translate to different perceptions of what is considered "waste" and what can be done with it (Bramston & Maycroft, 2014).

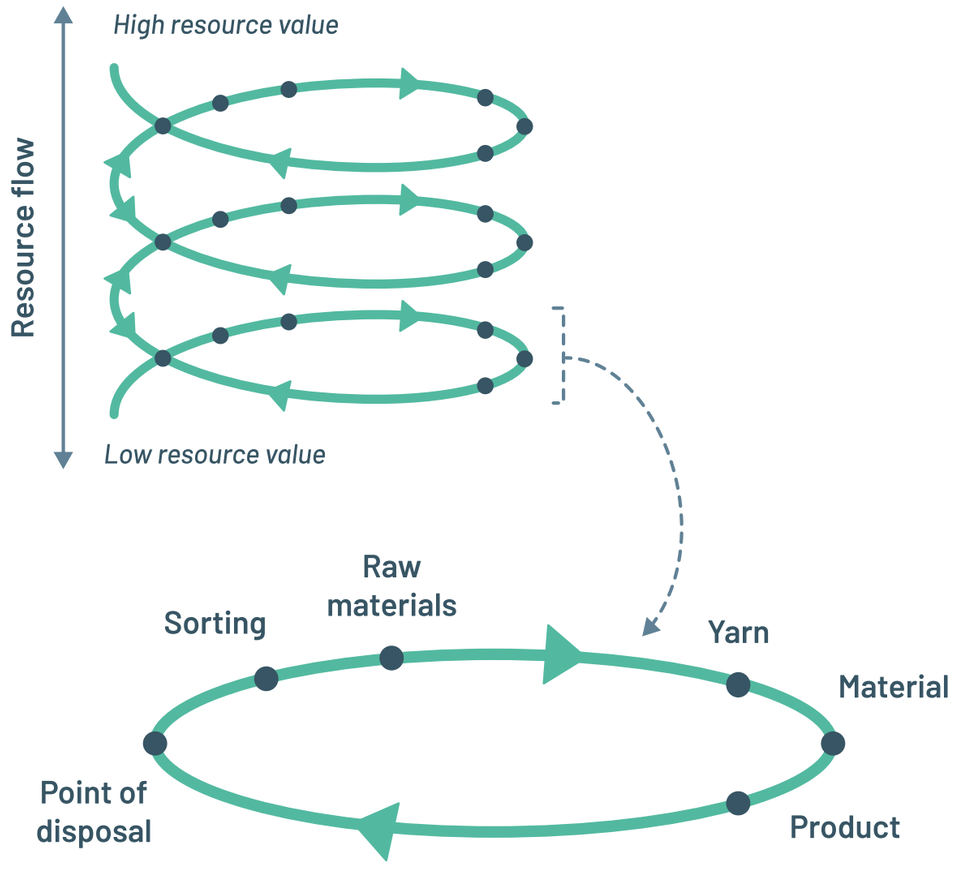


Figure 6. The resource spiral (adapted from Hall, 2021)

3.3 Implementing circular economy in the textile industry

The implementation of a closed loop value chain becomes the backbone for CE to be implemented (Jia et al., 2020). It creates a system that maximises value creation and minimises pollution, which allows resources to continuously flow in a closed loop (Jia et al., 2020). Through a systematic literature review, Jia et al. (2020) highlighted four essential practices in implementing a closed-loop value chain in the textile industry:

Product design

Product design informs the degree to which circularity is embraced by subsequent practices in the product life cycle. Relating to waste, product design affects waste generation during the manufacturing process, the potential lifespan of the product, the extent to which its material value can be captured at its end of life, and the potential hazard when it reaches the point of disposal.

Product stewardship

Product stewardship, also known as extended producer responsibility (EPR), demands all value chain stakeholders (i.e., producers, distributors, and consumers) share accountability for preserving resources in the product life cycle. It highlights the necessity of engagement between suppliers, consumers, and society.

Pollution prevention

Pollution prevention proactively tackles pollution before it is produced. It places responsibility on value chain stakeholders to maximise their utilisation of resources to ensure that pollution – whether in air, water or solid form – is generated minimally and maintained with environmental considerations.

Closing the loop

Closing the loop targets the reduction of the amount of virgin-based materials that pass through the value chain, by routing discarded materials into resources in another value chain activity. A reverse logistics system becomes necessary in order to allow (discarded) materials to undergo waste value creation processes (e.g., recycling, reuse) and be looped back into the value chain.

The above practices become necessary to effectively enable CE, and the lack of adoption of any one of the above practices contributes to the present circularity gaps in the value chain, including issues surrounding waste (Jia et al., 2020). The project will put its focus on *closing the loop*, by looking into possible value creation activities that may allow materials to be channelled back into the value chain.

3.4 Chapter takeaways

The lack of a shared and defined understanding of CE may hamper its implementation

This literature study brought to light that a systemic transition towards CE is dependent on how the actors in the system define and understand it. As Kirchherr (2017) suggested, a lack of clarity risks CE being plucked from its low-hanging fruit rather than overhauling the value chain. Without a shared understanding from both research and practice, CE stays as a utopian dream instead of being translated into on-target breakthroughs.

To some extent, frameworks help provide a starting point for implementing CE, by categorising theoretically viable and desirable actions that can be taken. However, as Reike et al. (2018) have pointed out with the R frameworks, these actions cannot be separated as neatly in practice. This, again, highlighted the concern of ambiguity, which may raise the risk of these actions being falsely valued or confusingly labelled, resulting in both intentional and unintentional practices (e.g., greenwashing) that deviate away from the goal of CE.

Making CE work necessitates viewing it across systems and time

It is critical to take both system and temporal perspectives when implementing CE. This means evaluating the externalities of a (circular) action, the value of its output, and how its output may be looped back into the ecosystem. Additionally, to recognise the activities along the system that may enable or hinder its implementation.

The idea of value cascading illustrates this perspective by placing a material in a resource spiral. It does not reduce circularity as an action at one point in time, but rather as a series of actions to carry resources for as long as possible, throughout their multiple journeys through the system.

Effectively tackling waste calls for both preventive and mitigative measures

To effectively tackle waste, it becomes imperative for circular actions to be adopted as preventive and mitigative measures. As highlighted by Jia et al.'s (2020), waste is just one part of the larger goal of circularity, and addressing the problem of textile waste should be preventively thought of before it is created. Therefore, the responsibility of "dealing" with waste should not fall just on stakeholders at the end of a product's life cycle (i.e., mitigation activities), but becomes a responsibility of all stakeholders along its life cycle.

The impact of a waste solution should be evaluated holistically

While the project puts an emphasis on waste, it should be necessary to assess textile waste solutions not just by how they address the issue of solid waste, but also by how it contributes both positively and negatively to the four areas of environmental impact: energy use, water and chemical use, and CO2 emissions. Moreover, its economic and social implications must not be overlooked. It should be ensured that a waste solution does not produce externalities that outweigh its benefits.

Chapter 4

Framing the system of interest

This chapter describes the system framing activity, which encompasses the identification of context variations and the delineation of boundaries to define a system of interest.

4.1 Identifying contextual variations

Complex problems are characterised by their multiformity, where they may simultaneously manifest in different contexts and ways (Kersten et al., 2018). Acknowledging this characteristic, preliminary research was carried out to investigate the different contextual variations in which the textile waste problem in India takes shape.

Both primary and secondary research were used to gather this information:

- Primary research was done through interviews with experts in the field of textile (value creation) systems and the context of India. Appendix A provides key summaries of the expert interviews.
- Secondary research was done by reviewing literature sources, including journals, books, news articles, and industry reports.

Figure 7 on the right provides a perceptual map of the identified contextual variations. They were found at two different levels:

1. **The artefact level**: the type and form of the waste itself
2. **The system level**: the stakeholders and activities that are connected to the problem context

In light of the identified variations, the project's focus was eventually placed on a particular context, where it became the system of interest. This activity also resulted in the formulation of the research question and subquestions mentioned in Chapter 1.3.2.

The following chapters will elaborate on the identified context variations and the chosen boundaries for the system of interest.

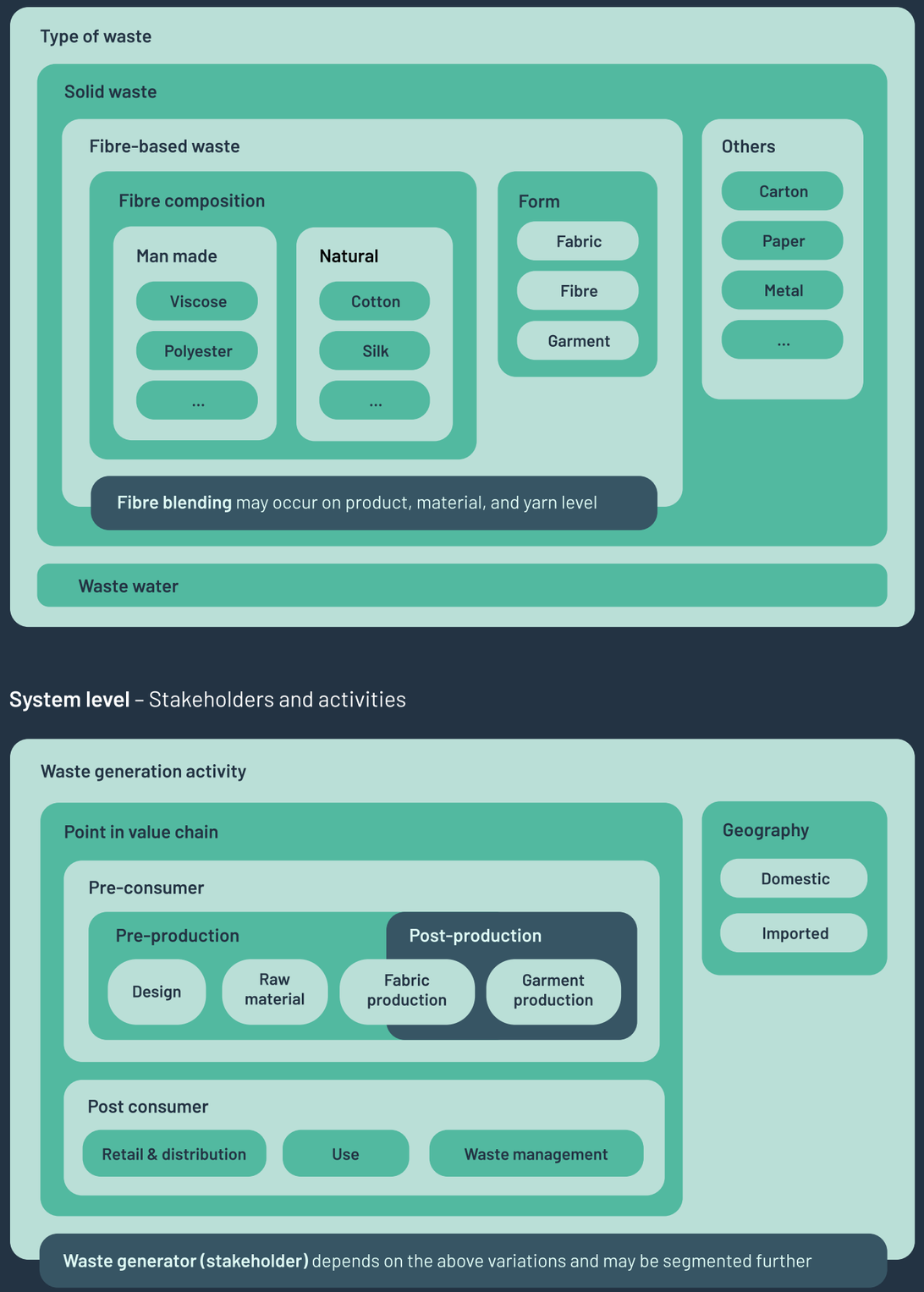


Figure 7. Identified contextual variations

4.2 Contextual variations

4.2.1 Geography

Textile waste that is currently present in India may be split according to its geographic origin: imported and domestic waste. These two waste streams, however, could not be strictly delineated. For example, some imported used garments – considered "waste" by the originating country – are channelled into the domestic market, where they are used and then disposed of by domestic consumers (Arisa & Sympany, 2020).

Regardless, both domestic and imported waste place a strain on India's local waste infrastructure. Both imported and domestic waste may come from two different value chain activities: manufacturing and consumption (Arisa & Sympany, 2020).

4.2.2 Value chain activity

Waste created within the value chain may be divided into two categories: pre-consumer and post-consumer waste (Runnel et al., 2017).

Pre-consumer waste refers to any waste created before the garment reaches the consumer, resulting from design to retail activities. It can be generated before or during the manufacturing process (pre-production) or after (post-production). Post-consumer waste, on the other hand, refers to waste that is generated after being used by consumers.

Figure 8 depicts an overview of the textile value chain, together with the waste generated at each stage.

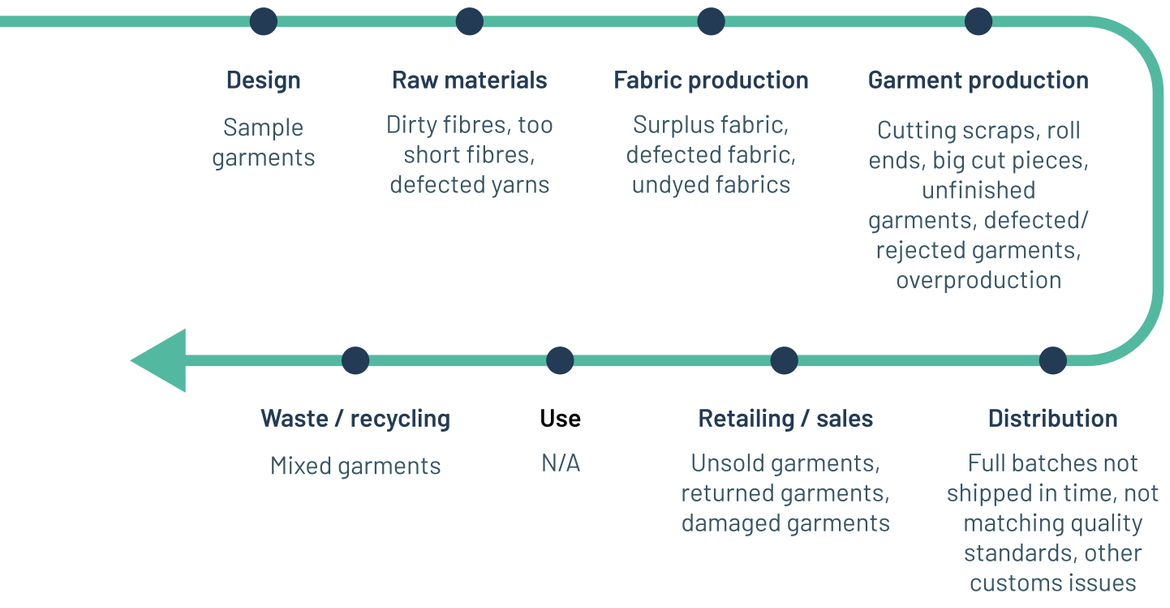


Figure 8. Waste generation in the textile value chain (adapted from Runnel et al., 2017)

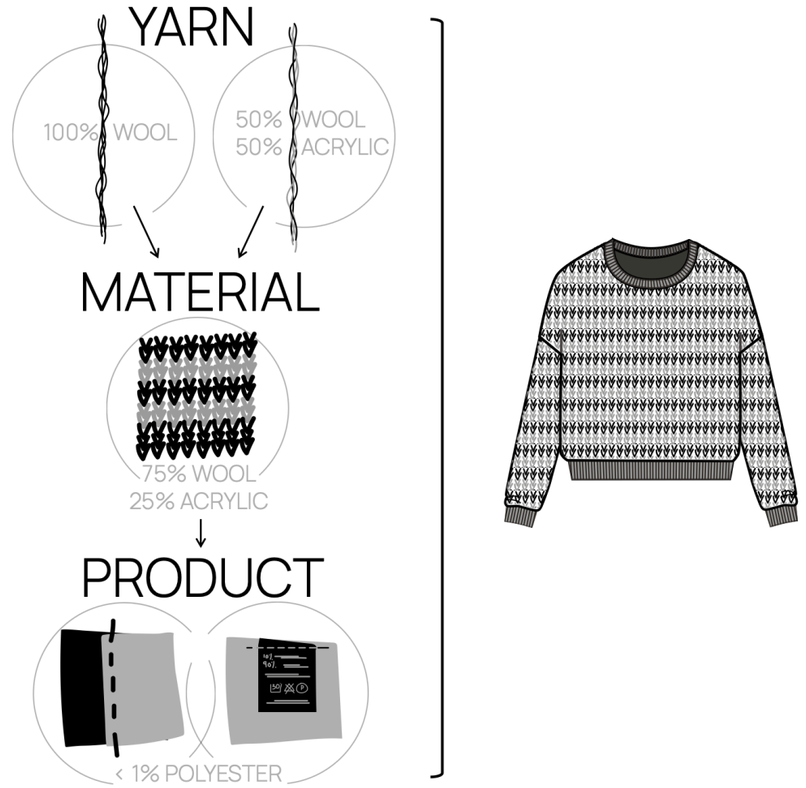


Figure 9. Illustration of fibre blending across different levels (Hall, 2021)

4.2.3 Form of waste

In general, waste that is produced in the textile industry falls into two forms: wastewater and solid waste (Stanescu, 2021). Solid waste may come in the form of fibres (or fibre-based), carton, plastic, metal, paper, wood, or other forms of general waste (Fokeer et al., 2016). Subcategories under fibre-based waste are fibres, yarns, fabrics, and garments with various forms, conditions, and sizes. Fibre-based waste makes up the majority of waste produced from pre-consumer activities (Fashion for Good et al., 2022).

4.2.4 Fibre composition

Textile fibres can be categorised into two primary groups: natural fibres and man-made fibres. They do not only differ in source, but also in characteristics and applications (Pinheiro & Francisco, 2016). The complexity of textile materials is heightened in practice as different types of fibres can be blended to create desirable characteristics for the output (Peterson, 2015). Fibre composition also affects the method of value capture that can be applied at the end of life (Hall, 2021). Figure 9 shows an illustration of fibre blending at different levels of granularity: yarn, material, and product.

4.3 System of interest

For each identified category of context variation, a variation was chosen as a system boundary. The boundaries were selected in consideration of perceived significance, the client's strategic interests, as well as project constraints. Collectively, these boundaries create the frame for the system of interest.

In brief, the system of interest was placed on the value creation chain of cotton-based textile waste generated by first-tier garment manufacturers in India.

Figure 10 provides an overview of the resulting system of interest. It is worth highlighting that the system boundaries did not necessitate the elimination of findings that fall outside of it. While the study mainly stayed within the intended boundaries, it did extend and contract in several aspects.

The selected boundaries for each context variation are as follows:

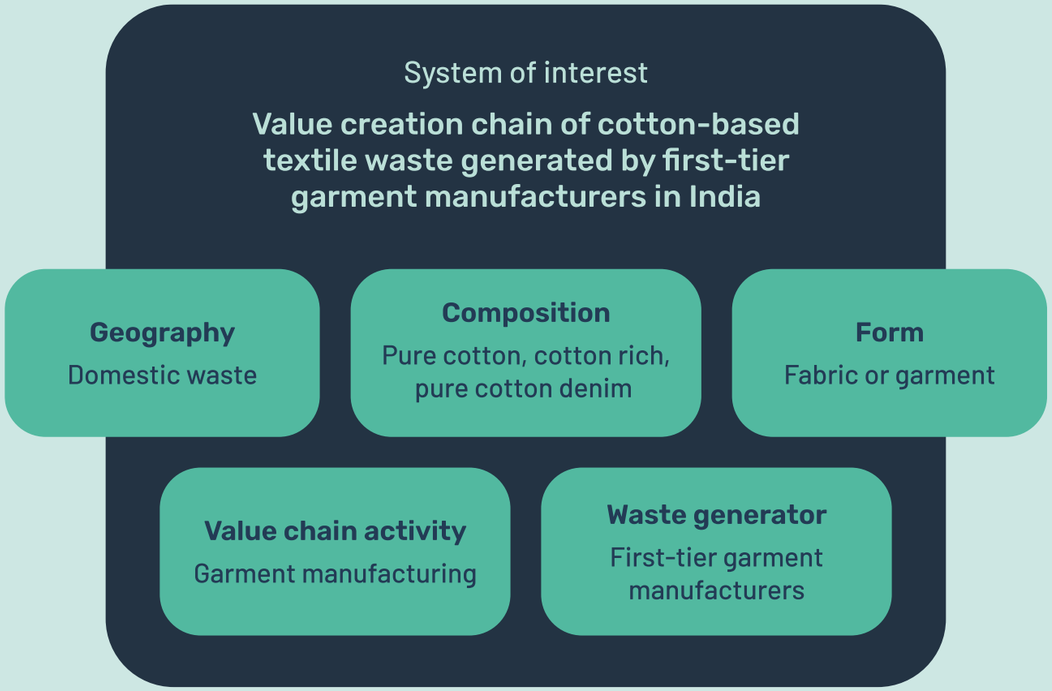


Figure 10. System of interest

Geography: Domestic waste

The system of interest focuses on domestically generated waste and the solutions to address it, due to its perceived criticality. It was identified that existing value creation solutions in India skew towards imported waste, creating a general disregard for creating value from domestically produced waste (Fashion for Good & Circular Apparel Innovation Factory, 2020). This rationale was also in line with the PWtW project that aims to build a local infrastructure for textile waste.

Value chain activity: Garment manufacturing

The focus on waste generated during the garment manufacturing process (pre-production waste) was informed by the current and future direction of the PWtW project. Additionally, as it is relatively organised and regulated, garment manufacturing activities present higher information accessibility for the research.

It should be noted that some manufacturers vertically integrate their fabric and garment manufacturing supply chains, meaning that the two processes are linked within their facility. However, for the purposes of this project, the research will focus on activities related to garment manufacturing.

Waste generator: First-tier garment manufacturer

A deeper dive into garment manufacturing revealed the layers of outsourcing within its process (Phillips et al., 2011). First-tier manufacturers were selected as a boundary due to their higher production volumes and closer proximity to brands, resulting in a greater sphere of influence that may trickle to lower-tier manufacturers (Fashion Revolution, 2020).

Form of waste: Fabric or garment

Waste in fabric and garment form was selected as a boundary, as the PWtW project focuses on creating value from these types of waste. Waste in these forms may include surplus fabric, defected fabrics, cutting scraps, roll ends, big cut pieces, unfinished garments, or defected garments.

Fibre composition: Pure cotton, cotton rich (80% cotton), pure cotton denim

Given its high production and consumption volume in India (Ministry of Textiles, 2019), focusing on cotton yields an opportunity to address a significant proportion of textile waste in India. This rationale was also strengthened by the current objectives of the PWtW project to focus on pure cotton, cotton rich (80% cotton), and pure cotton denim.

Chapter 5

Understanding the system of interest

This chapter describes the insights found in the system of interest. The system mapping process is first discussed. Next, the results of the analysis are elaborated, broken down into stakeholders and activities, material flow, and barriers and drivers towards circularity.

5.1 System mapping process

5.1.1 Information collection

Information about the system of interest was collected via two means of research:

Primary research involving interviews with organisations that are engaged in waste management and value creation. Fieldwork in India later in the project helped to enhance insights from primary sources.

Secondary research through literature review and analysis of past interviews conducted by Enviu, involving brands, manufacturers, waste management, and value creators. These interviews were deemed relevant given the similarity in research objectives as well as their exploratory nature. Details on all interviews are provided in Appendix B.

Despite the efforts to focus on the system of interest, completely isolating activities that relate to it was found to be challenging. As a result, some of the collected data overlap with aspects that fall outside of it (i.e., post-consumer waste, imported waste, non-cotton waste). Therefore, this chapter will give an overview of insights that may not be limited to cotton waste from the garment manufacturing process.

5.1.2 Analysis and synthesis

A complex problem domain necessitates a multi-faceted way of understanding as it sits on a system with multiple socio-technical aspects (Norman & Stappers, 2015). This was mirrored in the information collected from the research, which was extensive and varied in characteristics (i.e., qualitative and quantitative; system and artefact level). As a result, three methods of analysis were applied:

Stakeholder mapping was conducted to identify stakeholders and their activities in the system of interest, as well as to understand the dynamics and interdependencies between them.

Flow mapping was applied to examine the flow of materials along the value chain as well as the volume of movement. The materials that were examined are waste generation outputs and value creation outputs across the value chain.

Affinity mapping was used to qualitatively enrich the insights of stakeholder mapping and flow mapping as well as to identify barriers and drivers of waste value creation in the system.

A similar approach was employed for all these methods of analysis. The collected data were first analysed at face value according to the approach that the method took. Insights from individual information sources were then compared and contrasted with each other, in order to build the strength of the conclusions. Opposing insights or counter-arguments were noted and taken forward to be validated.

While the three methods were applied separately, insights gathered from one method built on the insights taken from another. Therefore, the outputs of these activities were then brought together into a system map. Besides being used as a sensemaking tool, the system map also served as a tool to communicate research findings to stakeholders as well as a sensitising tool for the creative brainstorming sessions that followed.

5.1.3 Expert and field validation

While much knowledge may be learned about the system of interest, it was simply not feasible to capture in its entirety due to limitations in data collection (see Chapter 8.2). As a result, the research had to proceed with a limited set of information in order to understand and draw conclusions about the system of interest.

To reduce blind spots and false conclusions, the preliminary system map was validated by experts with practical knowledge of the Indian textile industry. The feedback gathered from the expert sessions was used to reflect on its consistency. Information on the sessions is provided in Appendix C. In addition to the expert session, field research in India also provided an opportunity to validate the insights. The iterated system map is illustrated in Figure 12.

To provide structure to the elaboration of research findings, the following chapters will divide the findings based on the three methods of analysis.

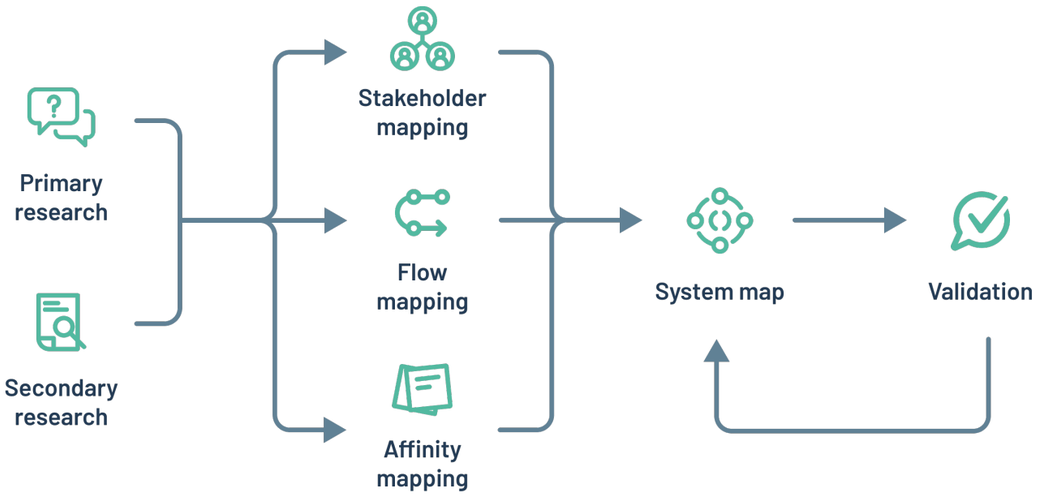


Figure 11. Diagram of the system mapping process

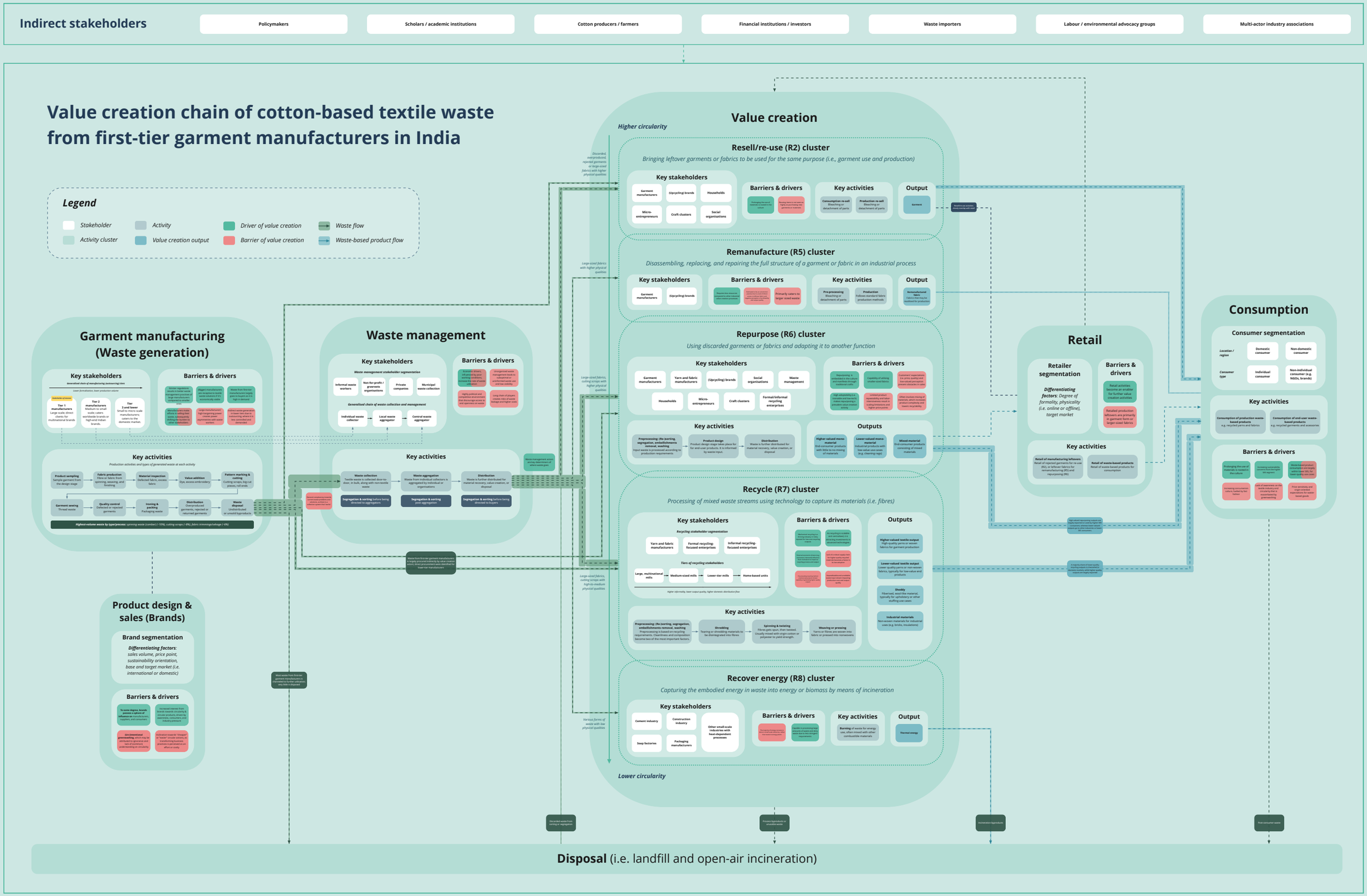


Figure 12. System map

5.2 Stakeholders and activities

This subchapter describes the stakeholders and activities identified within the system of interest, and the dynamics and interdependencies between them. Figure 13 below provides a simplified diagram of the stakeholders, activities, and their interconnections. Elaboration of the findings will be divided based on categories of activities.

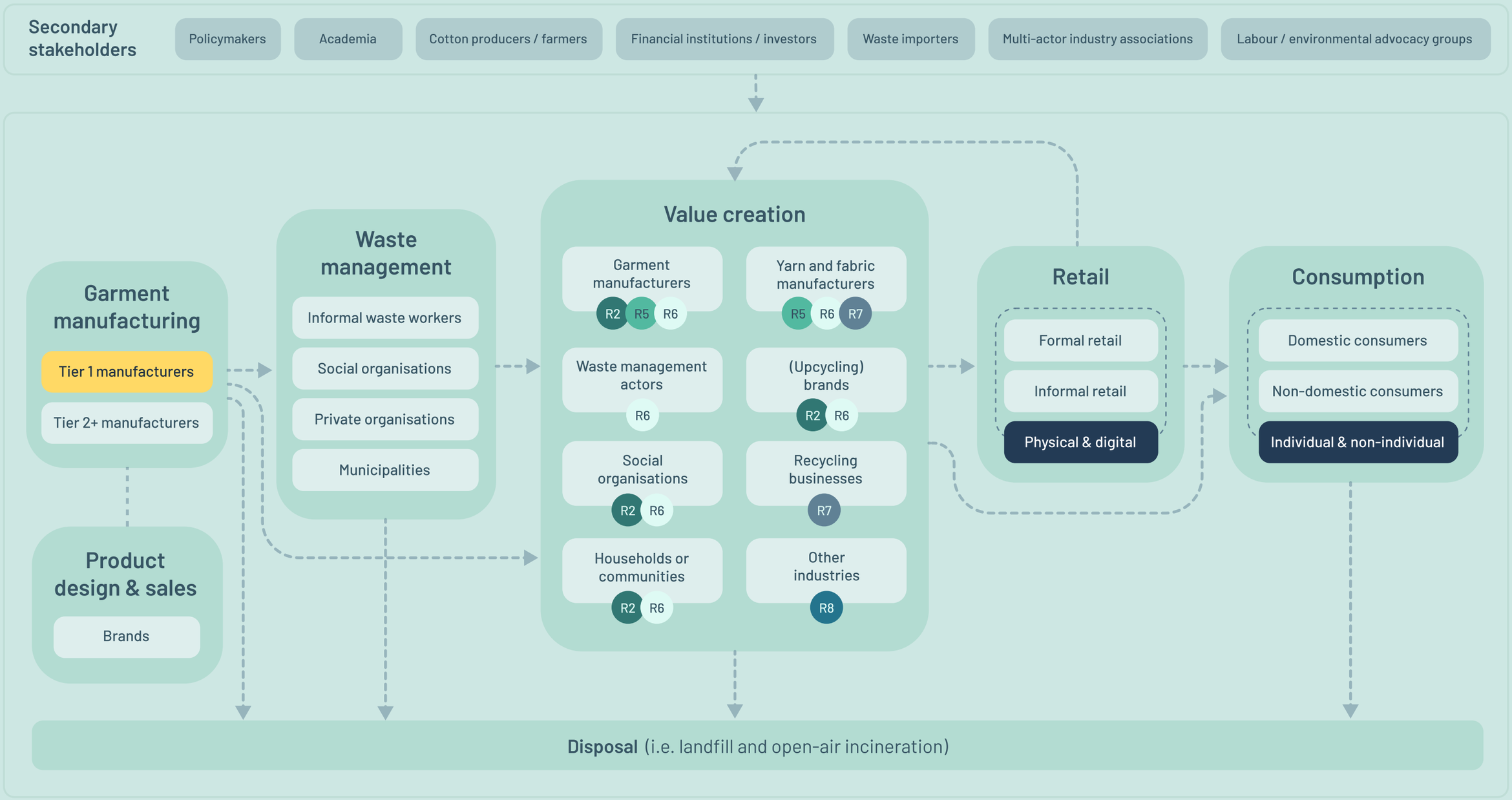


Figure 13. Simplified diagram of stakeholders, activities, and interconnections in the system of interest

5.2.1 Waste generation

Garment manufacturers are positioned as the primary waste generators within the system of interest. While the research focused on first-tier manufacturers, it was revealed that outsourcing activities from higher to lower-tier manufacturers result in indirect waste generation. While the production output is returned to the outsourcer, the responsibility of managing and disposing of the generated waste remains with these lower-tier manufacturers. Additionally, clients (e.g., brands) also indirectly influence garment manufacturers' waste generation.

The garment manufacturing process was examined in more detail to identify points of waste generation and the types of waste that are produced. A number of literature sources were cross-referenced to create a generalised description of the manufacturing process, as seen in Figure 14 (Sizwe & Charles, 2017; Rahim et al., 2017; Akter et al., 2022), while the expert sessions verified how it applies to the Indian context.

According to Fashion for Good et al. (2022), fibre waste from yarn spinning accounts for the majority of pre-consumer waste; however, this form of waste falls outside of the defined context boundary. For waste in fabric or garment form, cutting waste emerged as the second highest amount of waste generated in the textile manufacturing process (Fashion for Good et al., 2022).

Interviewees from both the waste supply side (i.e., manufacturers) and the waste demand side (i.e., waste management and value creators) recognise cotton as the highest valued waste in terms of composition, especially when it is white, larger in size, and in clean condition. Its illustriousness, in combination with the high volumes of waste that first-tier manufacturers generate, results in high demand for cotton waste from first-tier manufacturers. The bulk of this waste is sold to waste management actors with the largest purchasing power.

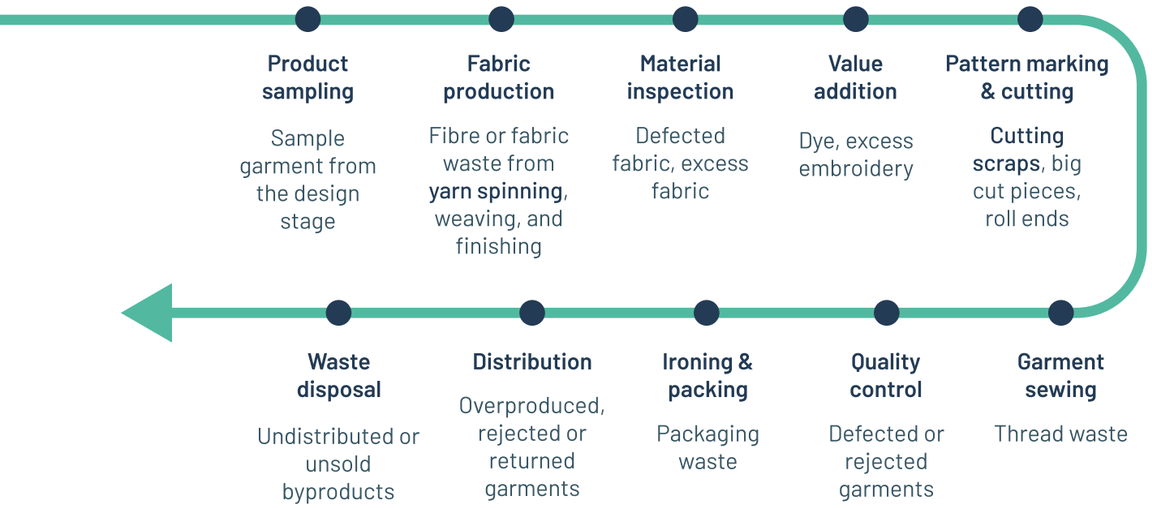


Figure 14. Waste generation in the garment manufacturing process

"What do [waste aggregators] do [with waste]? I think they sell it right? Or some of them converted into garments? Sell it to garment manufacturers in smaller towns?"

– Garment manufacturer

Figure 15. Municipal waste collection vehicle in Bangalore. Photo by author.

5.2.2 Waste management

Waste management activities are largely regarded as opaque, where disclosure of information is hampered by the sector's informality and competitive environment (Kumar, 2017). Interviewed manufacturers expressed that they have a limited view of what happens to their waste once it has been channelled to their buyers.

The research found several instances of outsourcing in the waste management sector: the highest-tier waste aggregators are small to medium enterprises (SMEs) that collect waste from lower-tier individual waste workers, either through commercial activities or direct employment. In other circumstances, some higher-tier aggregators also directly collect waste from factories. Municipal garbage collection also exists, but is limited to general post-consumer waste.

Evidence of interactions between garment manufacturers and waste management actors suggests that the chain of waste management actors may be tied to the garment manufacturing tiers. First-tier manufacturers may have contracts with higher-tier aggregators, while waste from smaller manufacturers is collected by lower-tier waste management actors or value creators (e.g., upcycling brands, recyclers)

The research concluded that waste management actors play a central role in deciding where waste is channelled, as their activities connect waste from garment manufacturers to other stakeholders in the value chain who may utilise them. The drive of waste management actors to monetise waste emerged as a salient factor that informs this activity, and helps prevent waste from going to landfills or open-air incineration.

From the perspective of value creators, the quality of waste collection, segregation, and sorting processes largely inform the potential waste value creation options that can be taken for waste. For instance, the likelihood of fabric waste being repurposed into clothes may be reduced if it is handled in an unsanitary manner. In this regard, it was found that the majority of waste collection, segregation, and sorting activities are currently done with little systematic operational guidelines and rely heavily on the experiential knowledge of waste management actors (Priya & Gupta, 2020).

"Waste, as well as accountability for it gets outsourced [by larger brands and manufacturers]. Smaller players [in the textile and waste management industry] don't have much to say."

- Waste management organisation

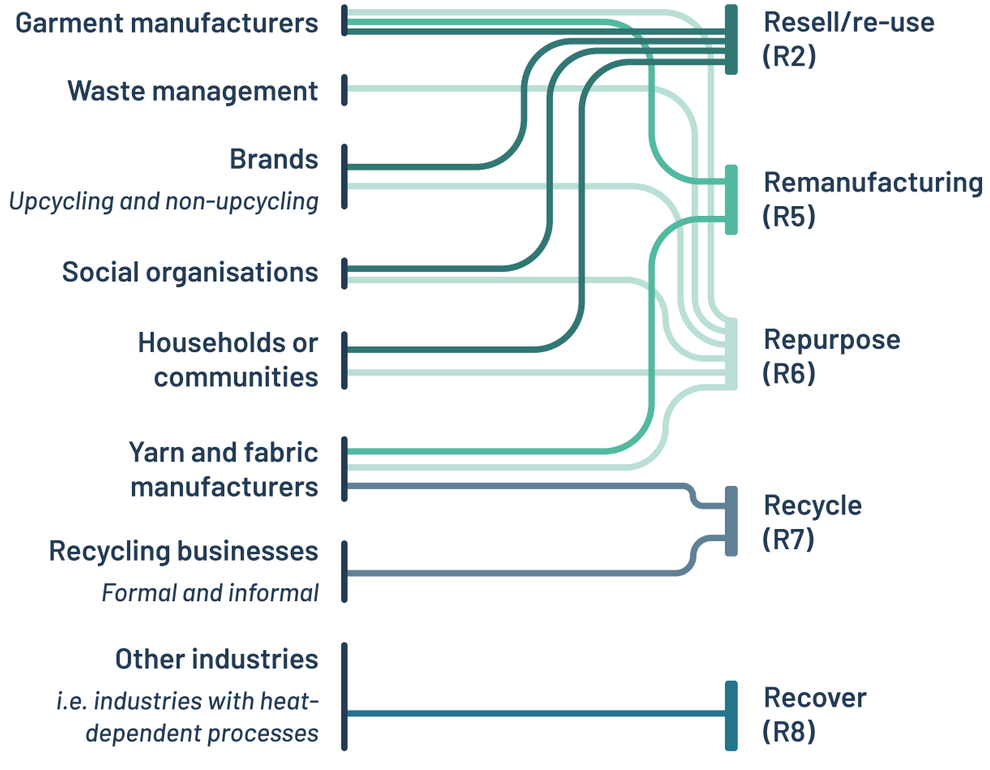


Figure 16. Mapping of stakeholder groups to value creation activities

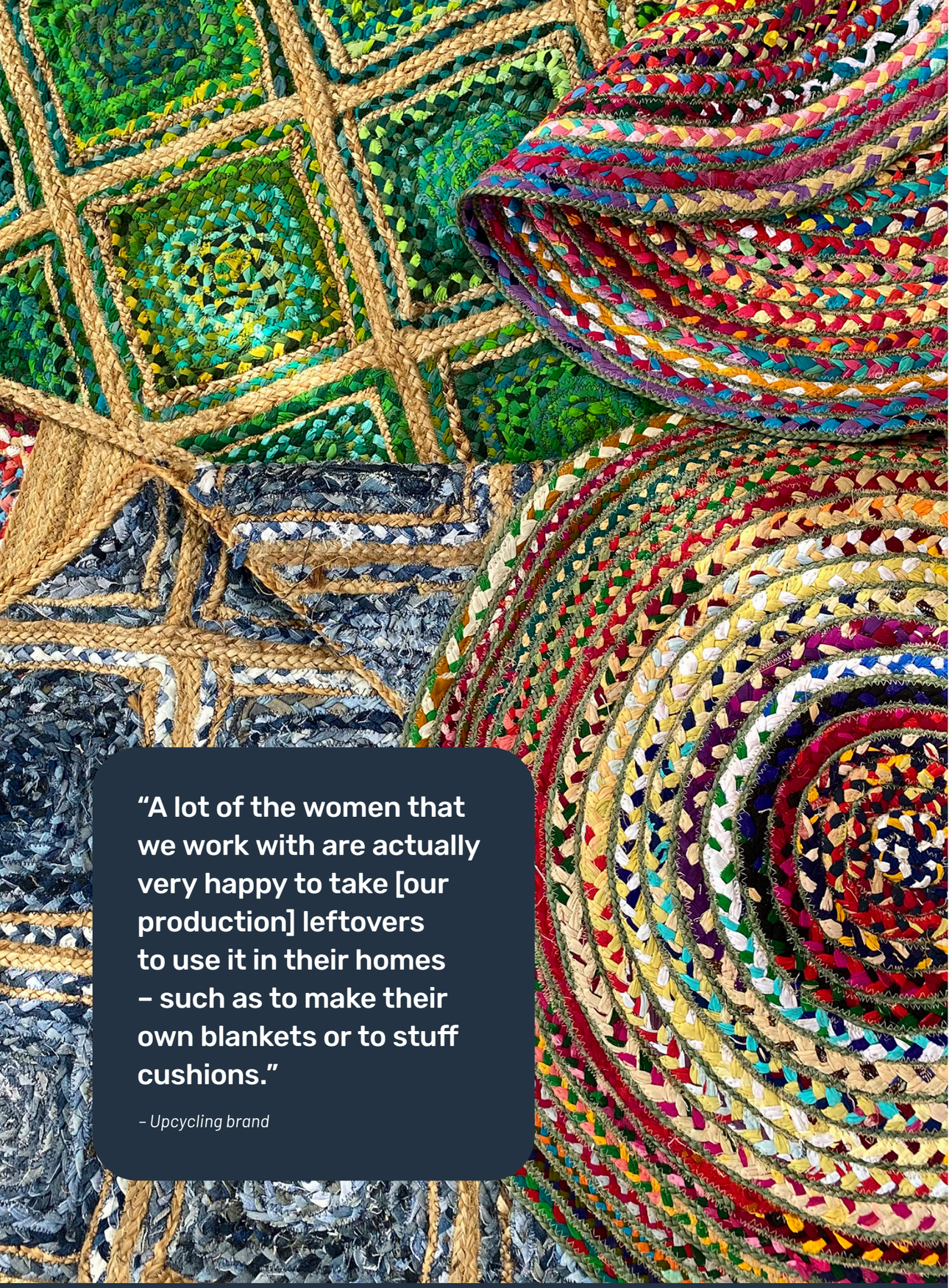
5.2.3 Value creation

It is to be noted that elaboration on value creation activities will be presented based on activities identified in the research and will not be an exhaustive list of all value creation activities in the system of interest.

The research indicated that value creation activities are not limited to those who engage in value creation as their primary line of activity. Many stakeholders also engage in value creation activities as a sideline besides their core operations. Figure 16 shows the relations between stakeholders and the value creation activities that they engage in.

When mapped to the R framework, identified value creation activities within the system of interest are associated with resell/re-use (R2), remanufacturing (R5), repurpose (R6), recycle materials (R7), and recover (R8). The following subsections will further break down these categories and the output that they produce.

While two activities may fall into the same value creation category, their outputs might differ in terms of value and lifespan. In this context, value refers to material value (fibre quality) and monetary value (price), where both were found to be correlated. Lifespan, on the other hand, refers to the potential span of time between the creation of the product and the end of its use. In this aspect, the resource spiral (Hall, 2021) provided to be a useful tool to illustrate the differences in value and lifespan between value creation outputs.



> **"A lot of the women that we work with are actually very happy to take [our production] leftovers to use it in their homes – such as to make their own blankets or to stuff cushions."**
>
> *– Upcycling brand*

Figure 17. Upcycled rugs made of discarded fabric. Photo by author.

5.2.3.1 Resell/re-use (R2)

Resell/re-use activities in the system of interest in the direct utilisation of leftover garments or fabrics for the same purpose. Depending on the type, "waste" may be re-used for two purposes: garment manufacturing and garment consumption.

Manufacturing re-use occurs when a garment manufacturer utilises discarded fabric from their production or other manufacturers. Instances found in the research revealed that in cases of cross-manufacturer re-use, the fabrics may be obtained indirectly via second-hand markets or waste management actors.

Other actors engaging in manufacturing re-use are small to medium-sized (upcycling) brands or grassroots small-scale producers (e.g., micro-entrepreneurs, craft clusters, households, social organisations). They often engage with both re-use and repurpose (R6), therefore these activities largely overlap. Fabric size was identified as a key differentiator; larger-sized fabrics are more likely to be directly re-used for garment production. Craft-based instances of re-use and repurpose are colloquially known as "upcycling", while the output is commonly referred to as "upcycled" products.

Meanwhile, rejected, unsold, or overproduced garments are resold and re-used for consumption. These activities are sold to end consumers via retail activities.

5.2.3.2 Remanufacturing (R5)

In the system of interest, activities that involve the disassembly and reprocessing of leftover garments or fabrics to be reutilised as garments or fabrics fall into the category of remanufacturing. One remanufacturing activity identified during the research is carried out by fabric and garment manufacturers, where larger-sized fabric leftovers are reprocessed for fabric production. The fabrics may be bleached to be redyed or reprinted, and then re-used by garment manufacturers.

An identified limitation of this activity is that only larger-sized fabrics are currently utilised. Insights from this identified instance pointed out that the fabrics are obtained indirectly through waste management actors or second-hand markets.

5.2.3.3 Repurpose (R6)

Activities categorised as repurpose are those that utilise discarded garments or fabrics to be adapted into products of other functions. Unlike manufacturing re-use (R2), repurposing activities result in non-garment outputs. Repurposing is perceived as highly adoptable since it is low-cost, low-technology, and trainable – demonstrated by the variety of stakeholders who engage in it.

One cohort of stakeholders that was identified to engage in repurposing as their main activity is upcycling brands. Repurposing is also performed as a secondary activity by waste management organisations, non-upcycling brands, social organisations, craft clusters, home tailors, fabric manufacturers, yarn manufacturers, and recycling-focused businesses.

Either as a primary or secondary activity, organisations or individuals may take up repurposing for various reasons, such as to make use of the waste that they receive, to utilise the waste from their own processes, or to upskill or provide livelihoods to others.

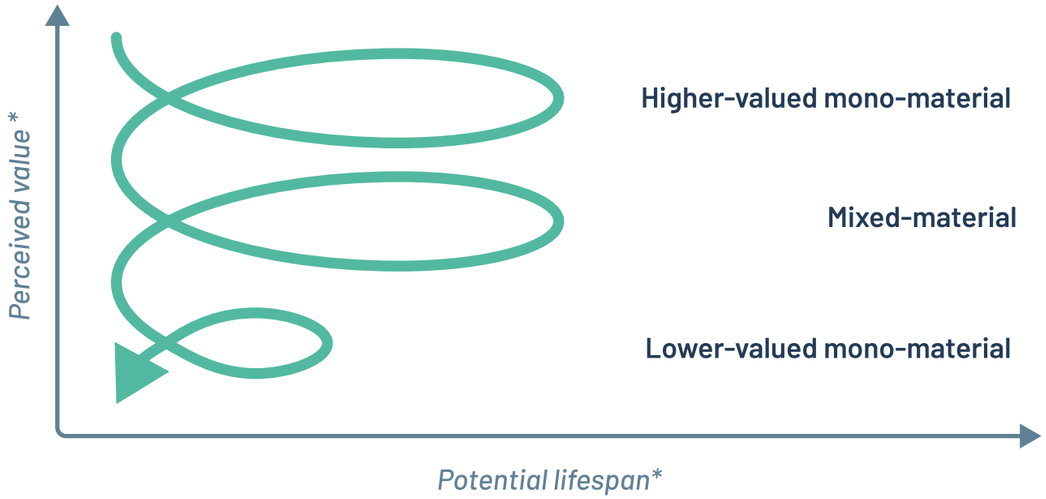


Figure 18. Perceived value and potential lifespan of repurposing (R6) output

Many traditional Indian crafts have a long history of repurposing discarded textiles, which help foster this practice both for profit and personal purposes (Singh & Rani, 2021). The resulting products are visually distinctive of the crafting method used and are generally produced in smaller quantities due to the labour-intensive nature.

Based on monetary value and potential lifespan, repurposing outputs can be grouped into three types: higher-valued mono-material, lower-valued mono-material, and mixed-material. Figure 18 illustrates the three categories on the resource spiral.

Higher-valued mono-material

Mono-material repurposing is the direct utilisation of a single type of discarded material with little or no combination with other types of (discarded) materials, resulting in outputs with comparable qualities to "new" products. (Upcycling) brands, and grassroots small-scale producers may engage in this activity for non-garment end-consumer products.

Lower-valued mono-material

Interviewees who engage in recycling stated that waste materials that do not meet their recycling requirements may be used for lower-valued repurposing. These materials are cut into cleaning rags or shredded into fillers for other industries, where they can be produced in large volumes due to the less stringent requirements.

This activity may significantly devalue materials into lower-valued applications or short-term uses, which may shorten their journey to landfills or open-air incineration. The fact that this activity may also be called "recycling" and "downcycling" in the research demonstrated varied ideas of its value and may risk misconceptions of its merits.

Mixed-material

Mixed-material repurposing is done by joining different fabric types into one product, resulting in outputs with distinctly "patchy" features. These activities are engaged by (upcycling) brands, waste management organisations, and grassroots small-scale actors to produce a range of end-consumer products, from accessories (e.g., bags, pouches) to household items (e.g., coasters, blankets).

This type of repurposing presents capabilities in utilising smaller fabrics, but the process is harder to replicate in larger quantities. Additionally, the combination of different fabrics may create further complexities when separating the product's components at its end of life, which may present difficulties in its reutilisation.

5.2.3.4 Recycle (R7)

Identified technology-based activities that extract constituent materials of textile waste (i.e., fibres) to be processed into products of textile or non-textile applications are categorised as recycling. Its output can span from (nearly) virgin quality to lower-grade quality material.

As briefly mentioned in the preceding subsection, there exists a cohort of stakeholders that engage in recycling. Closer examination revealed that while some recyclers exclusively produce outputs from waste, a number of these "recyclers" are in fact yarn or fabric manufacturers that do recycling in addition to virgin-based production.

While most of the textile recycling in India is mechanical (Fashion for Good & Circular Apparel Innovation Factory, 2020), the research identified several instances of smaller-scale recycling that make use of traditional weaving techniques. Meanwhile, chemical recycling has yet to be done at scale (Fashion for Good & Circular Apparel Innovation Factory, 2020).

Besides technological capabilities, value creators also listed qualities of the waste input, such as material quality, design, and blending, as elements that affect the quality of recycling outputs.

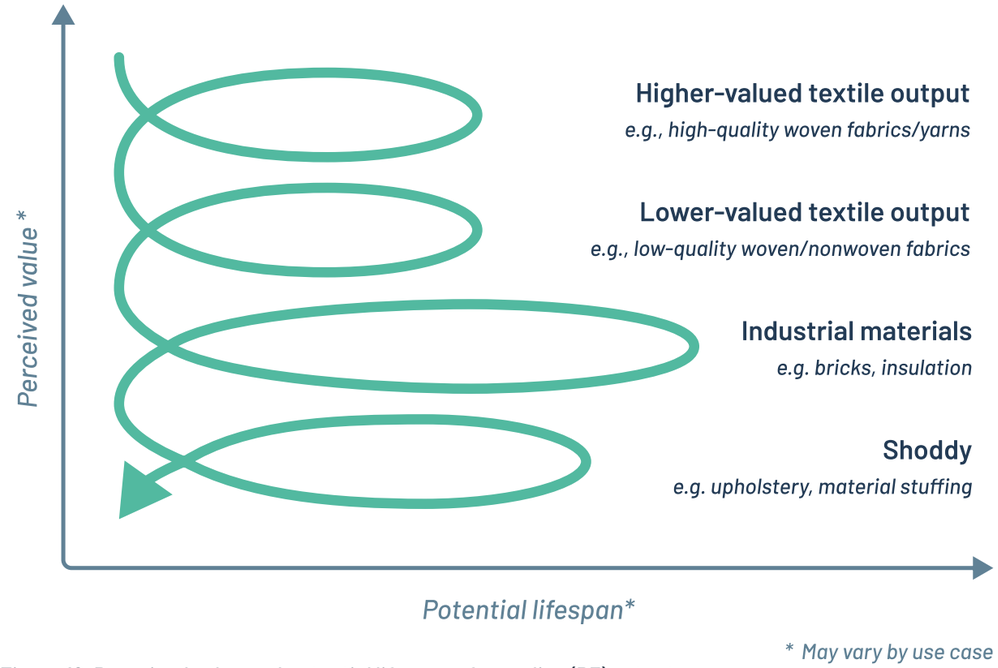


Figure 19. Perceived value and potential lifespan of recycling (R7) outputs

Based on perceived value and lifespan, recycling outputs can be generalised into four categories. Figure 19 illustrates the categories on the resource spiral.

Higher-valued textile output

Recycling outputs that are perceived to be higher in value are those closest to virgin quality or a higher thread count, resulting in outputs that are stronger and easier to spin into textiles (Harmsen et al., 2021). Since most recycling methods are mechanical, it is indicated that blended recycled outputs are more widely in circulation due to the limited abilities of current mechanical recycling technologies to separate blends. Additionally, recycled fibres are frequently blended with longer virgin fibres to produce desired strength and qualities (Harmsen et al., 2021).

Lower-valued textile output

Lower-quality products make up the majority of recycling outputs (Fashion for Good et al., 2022). These lower-quality recycling outputs come in the form of nonwovens, which are made by bonding fibres together using mechanical, chemical, or physical methods. Compared to higher-quality recycling, this process was identified to be cheaper and have less stringent requirements. These outputs are likely to be put into end-user applications such as charity relief blankets, carpets, cushion covers, or table mats (Sikka & Brar, 2018).

Shoddy

A step lower in terms of perceived value, shoddy is a recycling output that is generated by shredding and grinding textile waste. It is a fiberised substance with a wool-like quality. Several identified use cases for shoddy are upholstery (e.g., mattress stuffing) or other soft material filling. While this process is classified as recycling, the research found that it is commonly termed "downcycling" due to its output value being perceived as low.

Industrial materials

Besides shoddy, activities termed "downcycling" are also used for use cases outside of the textile industry, where cotton waste is converted into bricks, insulation, acoustics, or cement composites. They may utilise similar processes to nonwovens or shoddy, but in some instances, non-textile materials are mixed in. Due to the less strict requirements, these methods bring an advantage in taking vast volumes of waste. These outputs are expected to be longer in terms of lifespan as they are intended for long-term use.

5.2.3.5 Recover energy (R8)

Activities of incinerating waste materials for energy use are categorised into recover energy (R8). The difference between this activity and open-air incineration is that the waste is utilised as a source of energy for other processes, largely in other industries, thus capturing its value to some extent. This way of utilising waste is also often mentioned as "downcycling".

This activity is frequently selected as a means to monetise less desirable waste, particularly for those with unknown higher-valued applications or deemed unsanitary. Several cases where waste is burned for heat-dependent processes were found in the cement industry, construction industry, soap factories, and packaging manufacturing. A large risk from this activity is the improper management of its byproduct, such as landfilling.

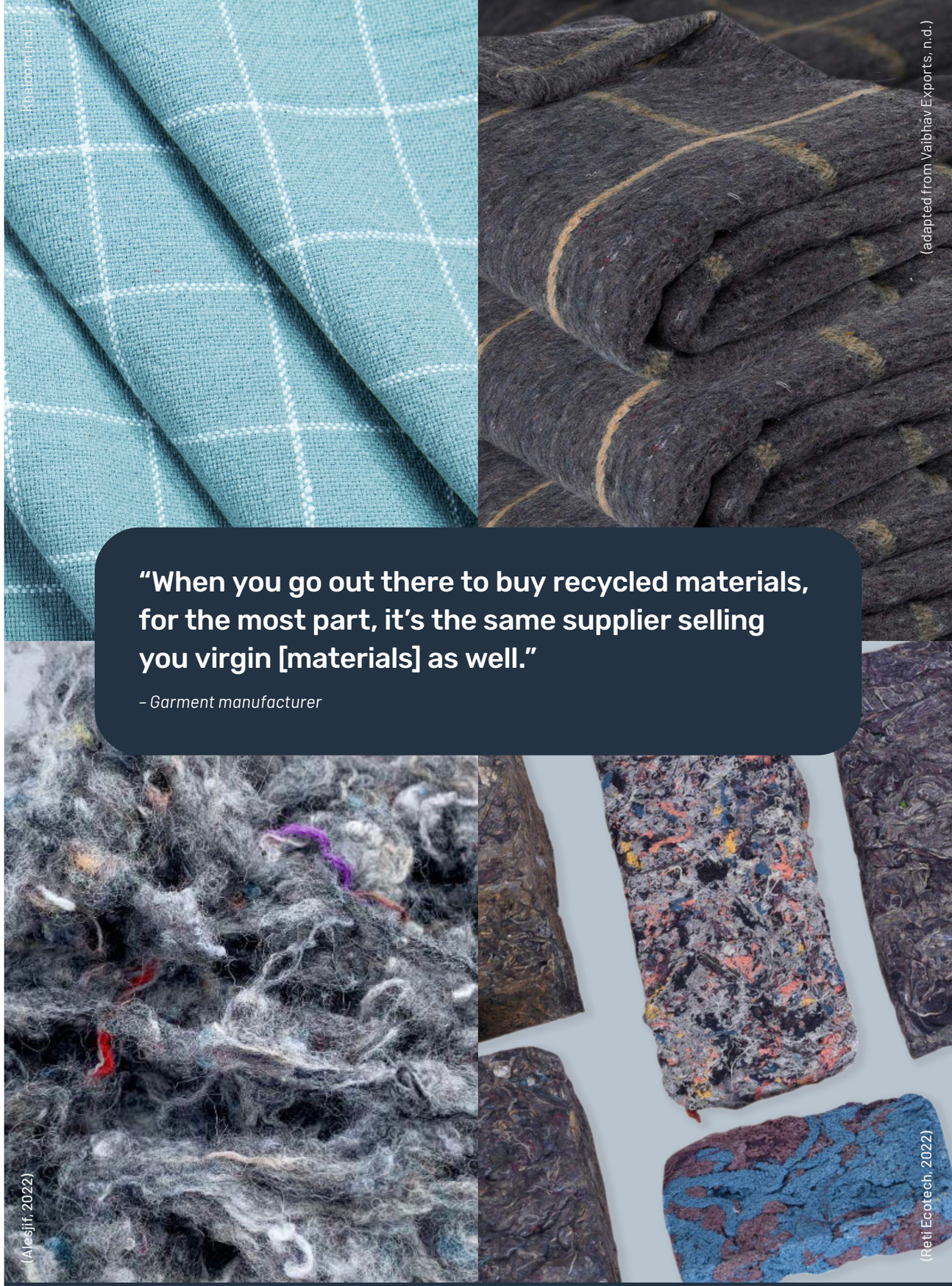


Figure 20. Examples of recycled outputs. From top left to bottom right: woven fabric, nonwoven fabric, shoddy, industrial bricks.

5.2.4 Retail

Two types of retail activities were identified: retail of discarded garment manufacturing waste and retail of waste-based products. Both forms of retail vary in their level of formality (i.e., formal or informal) and physicality (i.e., online or offline), as well as market segmentation. In India, small-scale physical retail has become the dominant form of retail (Bansal & Kumar, 2014).

Retail of garment manufacturing waste

Retail of garment manufacturing waste manifests in various forms of second-hand markets. These markets become hubs for value creation activities to further take place, namely re-use (R2), remanufacture (R6), and repurpose (R6). Insights mostly point to waste management actors as their suppliers. For garments, manufacturers may also become direct suppliers.

Types of "waste" that were identified in retail are large-sized fabrics and leftover garments. Leftover garments are re-used by end consumers. Meanwhile, discarded fabrics either become remanufactured or repurposed. Fabrics of larger sizes and volumes may go to smaller fabric manufacturers to be remanufactured. Individuals and entreprises may also take up smaller volumes of fabric to be re-used or repurposed.

Retail of waste-based products

Waste-based products, which are outputs of value creation activities, are also subject to retail activities. Waste-based products that go into retail are those that may be utilised by end consumers, such as garments, accessories, or home goods. The retail channel of a waste-based product may vary depending on the target market, price point, and (perceived) product quality.

Figure 21. A market street in Bangalore. Photo by author.

5.2.5 Use

Waste-based products are marketed to and subsequently used by domestic and non-domestic customers. Customers can be further categorised into individual and non-individual customers.

Non-individual customers may purchase waste-based products to be put into textile production (e.g., making recycled fabrics into clothes), non-textile activities (e.g., industrial cleaning rags), or to be sold to their customers. These non-individual customers can be fabric manufacturers, garment manufacturers, brands, or other organisations outside of the textile industry.

Non-domestic consumers

Products that are perceived to be higher in monetary value, such as craft-based upcycled products or higher-quality recycling outputs, are found to be exported to overseas markets with higher purchasing power (e.g., United States, Europe). Meanwhile, recycling outputs of lower quality, such as charity blankets, are exported to overseas markets with lower purchasing power (Arisa & Sympany, 2020).

Several interviewed value creators stated that they consider overseas markets valuable since their products are priced competitively. In addition, they perceive consumers in markets with higher purchasing power to be more inclined to value sustainability or circular products.

Domestic consumers

Domestically, the most widely consumed value creation outputs are found to be recycled and upcycled products with lower price points (Sikka & Brar, 2018). Commonly identified use cases for waste-based products are recycled or repurposed end-consumer products (e.g., garments, accessories, household items), as well as leftover garments. Besides end consumer use, lower-valued value creation outputs are also largely utilised for domestic textile-to-textile production or in other industries (Fashion for Good et al., 2022.

Value creators expressed that price sensitivity becomes the main influencing factor of their domestic sales. However, it was revealed that emerging middle-class consumers in India are progressively displaying favourable attitudes towards sustainable business practices (Amritha & Suresh, 2020). They increasingly become part of a currently niche market segment that consumes waste-based products at higher price points.

5.2.6 Secondary stakeholders

In addition to stakeholders directly involved in the garment manufacturing waste value chain, the research also identified stakeholders that (indirectly) influence activities in the system. Since they do not fall under the system of interest, these stakeholders are classified as secondary and were not further elaborated on.

The following are the secondary stakeholders who have been brought forward in the interviews and expert validation session:

- Policymakers
- Cotton producers / farmers
- Waste importers
- Multi-actor industry associations
- Scholars / academic institutions
- Financial institutions / investors
- Labour / environmental advocacy groups

5.3 Material flow

The research was able to map out two distinct types of material flows within the system of interest: waste flow and waste-based product flow. A simplified illustration of the waste flow and waste-based product flow that resulted from activities in the system of interest is depicted in Figure 22.

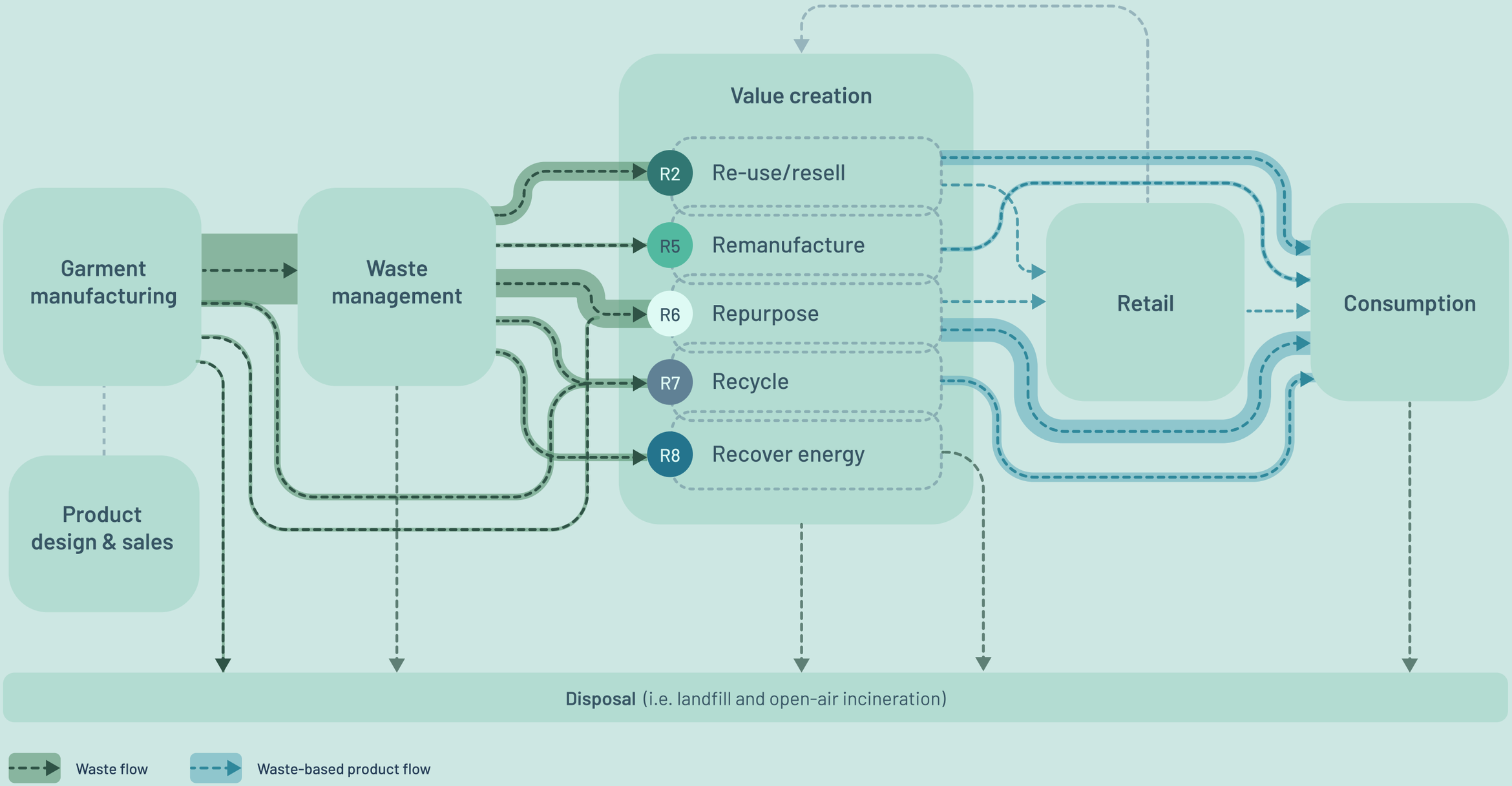


Figure 22. Simplified diagram of material flow in the system of interest

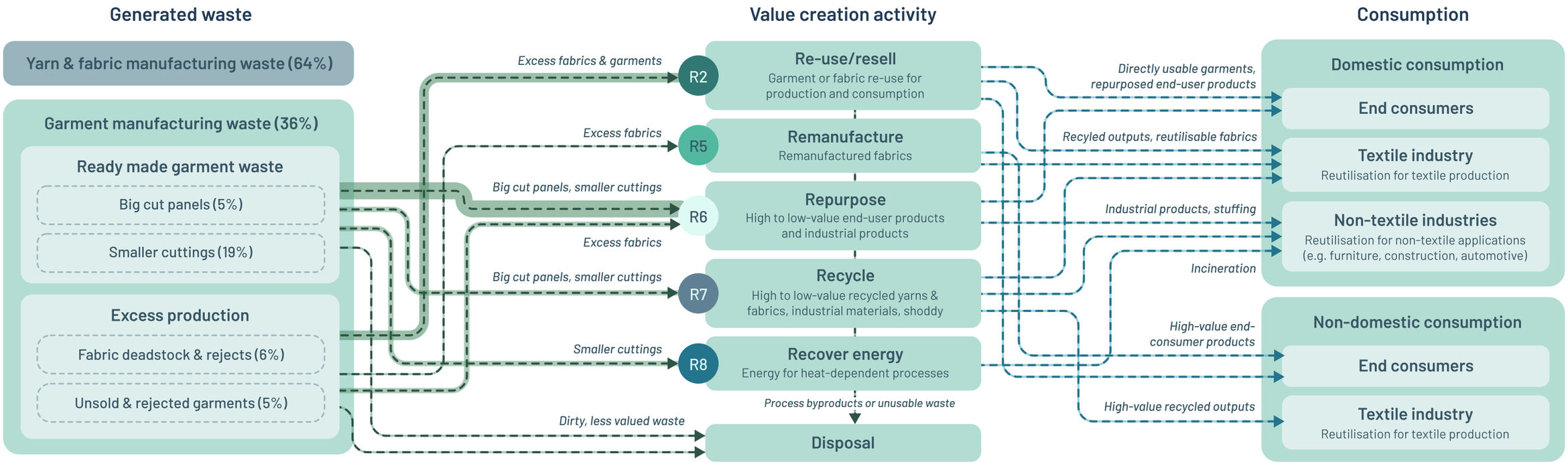


Figure 23. Estimated volumes and material flow for waste and waste-based products. Information on waste volume is adapted from Fashion for Good et al. (2022)

The research cross-referenced secondary and primary findings to draw estimations on relative flow volume and general material type that is flowing in the system. Due to limitations in obtaining data for specifically the system of interest, certain information, such as detailed volumes on waste-based flow, may be lacking.

Waste flow

Fashion for Good et al. (2022) estimated that a total of 3265 kilotonnes of pre-consumer waste is generated annually in India, where garment manufacturing activities mainly contribute to the generation of ready-made garment (RMG) waste or cutting waste (~24%) and excess fabrics or garments (~11%). Remarkably, it is estimated that only 1% of pre-consumer waste is directed to landfills or open-air incineration (Fashion for Good et al., 2022), which can largely be attributed to economic incentives. Information on first-tier manufacturers overwhelmingly points to waste management actors as primary takers of the waste. Meanwhile, direct waste procurement by non-waste management value creators was only observed in lower-tier manufacturers, most prominently for repurposing (R6) or re-use or resell (R2) activities.

The waste is then directed by waste management actors to various use cases. In India, it is estimated the largest use case for pre-consumer waste is recycling (~46%) (Fashion for Good et al., 2022). However, upon closer examination, 86% of it consists of fibre waste. This indicated that garment and fabric waste are directed to non-recyling use cases. Other prevalent use cases for pre-consumer waste are lower-value repurpose (i.e., downcycling) (~37%) and re-use (~16%) (Fashion for Good et al., 2022). It may be inferred that the utilisation of waste in fabric or garment form is significantly higher for these cases, due to the low recycling volumes. Additionally, the research also revealed that waste may travel between value creation activities.

Several identified inherent qualities of waste that determine its flow and use case are composition, size, cleanliness, and aesthetics. Meanwhile, identified extrinsic factors are waste management and value creation activities of stakeholders in the value chain, and the underlying infrastructure of these activities.

Waste-based product flow

Waste-based product flows, on the other hand, start from value creation actors. As elaborated in the retail and use sections, higher-valued waste-based products are more likely to be exported overseas, or in smaller volumes, to domestic customers with high purchasing power. The bulk of domestic waste-based products consists of outputs with relatively lower price points (i.e., industrial products, low-value end-consumer products), which are generally lower in material quality and use case.

It is estimated that 60-90% of recycled yarns, largely low-valued, are utilised for domestic textile production (Fashion for Good et al., 2022). Meanwhile, higher-valued textile-to-textile recycling was found to be limited. Waste-based products are also utilised for applications in other industries, mainly for low-valued applications such as upholstery or industrial wipes.

5.4 Barriers and drivers of value creation

Identifying barriers and drivers in the system of interest provided a better understanding of the factors that enable value creation activities as well as the constraints that impede them from flourishing.

Themes of barriers and drivers were distilled after categorising affinity mapping results into de Jesus & Mendonca's (2018) classification of drivers and barriers in the circular economy.

Table 1 provides a description of the categories, while the results of the categorisation process can be found in Appendix D.

Table 1. Classification of drivers and barriers in the circular economy (de Jesus & Mendonca, 2018)

Hard factors	**Technical**	Technology, technical knowledge and skills, and processes
	Economic / financial / market	Supply & demand trends, market dynamics, capital
Soft factors	**Institutional / regulatory**	Legislation system, infrastructure
	Social / cultural	Consumer behaviour and preferences, business practices, social awareness, environmental literacy

5.4.1 Barriers of value creation

Value or perception, knowledge, infrastructure, and **the economic climate** were the common themes that connect the categories of value creation barriers

How these themes coalesce can be first viewed from the institutional lens. Informal waste collection and lower-valued recycling are commonly taken up by low-income groups as a source of income, a decision largely pushed by economic factors (Medina, 2008). The lack of regulations and government support for waste-related activities also add to infrastructural impediments. This informal structure and ways of doing that the system is built upon, coupled with poor infrastructure, contribute to low information transparency and mishandling of waste (Priya & Gupta, 2019).

Although technical barriers can be unique for each waste value creation method, one identified common gap is that mismatches occur between the waste that value creators require and the waste that they receive or have access to. This may be backtracked to a lack of knowledge and infrastructure that supports proper waste collection, segregation, distribution, and utilisation.

In addition, the great cost of high-technology value creation methods such as chemical recycling presents obstacles to their adoption, which becomes amplified in a developing nation (Harmsen et al., 2021; Fashion for Good & Circular Apparel Innovation Factory, 2020).

On the market side, value creators expressed that barriers mostly stem from dependency on waste supply and virgin-oriented demands. Activities of waste value creation place high dependency on the supply input, which may create operational instability and barriers to scaling. These issues relate to both infrastructure and economic climate (i.e., supply-demand dynamics).

The low demand for waste-based products, especially for higher-valued ones, results from the fact that they are compared to virgin-based products in terms of quality and price, which tie back to the perspective and values that industry stakeholders hold. Additionally, the economic climate results in price sensitivity in the domestic market.

For sociocultural factors, values and perception are reflected in consumption patterns and business practices that do not see waste as a critical concern. Lack of knowledge on sustainability and circularity also contributes to inaction and poorly informed practices of industry stakeholders, which might negatively impact consumers' perception of sustainable products and practices, even those that are well-intentioned (Brouwer, 2016).

5.4.2 Drivers of value creation

Cultural values, economic motivations, and **growth of awareness** were found to be the key themes that drive value creation activities for textile waste in India

A salient driver of value creation that is specifically contextual to India is the cultural value that embeds the prolongation of the use of materials, which translates into both motivation and technical expertise in craft-based means of repurposing waste (Dev, 2016). This, in part, helped propel both value creation activities and the consumption of their outputs.

Moreover, albeit not in the most optimal ways, the research identified that economic and entrepreneurial drive have already pushed various ways of utilising and capturing the value of waste, discouraging landfilling and open-air incineration. This may provide evidence that India's innate capacity for frugal innovation (jugaad), that is the creation of context-specific solutions using scarce resources (Kumar, 2011), has become one of the key enablers of value creation.

Furthermore, the strain that the textile industry creates on the environment, both from material extraction and waste generation activities, has also taken more global awareness (Business of Fashion and McKinsey & Company, 2019). This translates into the growth of demand, investments, and economic activities that are in favour of sustainable practices, both in global and Indian markets (Sarangi, 2021).

Lastly, regulations imposed on international brands that outsource their production to India inadvertently create a push on garment manufacturers, which drives the utilisation of waste-based products and value creation activities. Domestically, extended product responsibility measures have taken place for plastic and e-waste (Paudyal, 2022), paving the way for strengthened waste management infrastructures that may benefit textile waste solutions.

Figure 24. Yarn spinner constructed from bike parts. Photo by author.

5.5 Chapter takeaways

5.5.1 Key insights

Value creation activities are largely in motion, but can be further optimised

Research findings indicate that present value creation activities skew towards outputs that are lower-valued or shorter in lifespan, in large part due to economic and technological factors. While it is good to have most pre-consumer waste being put to use, they may risk being briefly looped back in the value chain. This presents a gap in amplifying solutions that may allow materials to circulate for longer.

On one side of the system, cotton waste from first-tier garment manufacturers is already in high demand. On the other side, a range of stakeholders in and outside of the textile industry are already engaging in various means to create value from waste. While (informal) links already exist between the two, it is hampered by activities (i.e., production, consumption, waste management, value creation) that are not yet aligned with circularity goals, as well as suboptimal infrastructure.

For every value creation solution, there is a problem that fits it; the gap is in connecting the two in a circularity-informed manner

Given that each value creation activity presents its own advantages and disadvantages in terms of process and output, it may be argued that there may not be a catch-all solution for textile waste. What is more necessary is to connect solutions that fit best with the problem, both from the standpoint of circularity as well as the context that they sit in.

It was revealed that an activity with a lower R hierarchy may create an output with a longer lifespan than a higher hierarchy activity, For example, recycled insulation sits in a lower R hierarchy than a mixed-material repurposed product, yet may remain in use for far longer. This shows that a singular view at the action may provide limitations in measuring what is "more circular", and a holistic examination (e.g., lifecycle analysis) is required.

The chasm between contextual and scientific knowledge hinders value creation, but offers opportunities when bridged

Contextual factors shape the textile waste problem and its solutions in a way that is particular to India. Circularity can be found in customs that have persisted for centuries but are slowly eroding, such as crafts and consumption practices that aim to extend the life of materials. In parallel, frugal innovations become a driver for value creation activities to flourish.

Scientific knowledge also has a fundamental role in achieving circularity, yet there is a gap in making it accessible and practical to the Indian context. This may be shown in how a single activity can be perceived as "upcycling", "recycling", or "downcycling" by different parties, which risks it being falsely valued. Harnessing both scientific and local knowledge may not only provide a better understanding of the problem, but also uncover contextually relevant solutions.

5.5.2 Factors influencing waste-related activities

By combining insights from the different methods of analysis, the research identified several intangible factors that impact where waste goes and how it is utilised. These factors may influence the likelihood of waste being utilised for value creation activities, or the less desirable routes of landfill or open-air incineration. Following are the four identified factors:

Stakeholder capacity

In this context, capacity is defined as the set of abilities, skills, knowledge, as well as resources that allow stakeholders to (properly) manage, distribute, and make use of waste. For example, unsanitary textile waste is largely used as fuel in the cement industry as more preferable use cases are presently unknown.

Market forces

Market forces were recognised to significantly impact waste-related activities due to economic incentives being commonly identified as the main driver for system stakeholders. Changes in consumption patterns, competitive climate, regulations, weather, and the COVID-19 pandemic are a few identified factors that influence supply and demand in the waste market.

Value and perception

The flow and utilisation of waste are also determined by the values that a particular stakeholder holds most dear. Among many, they might be driven by social, economic, or environmental ideals. Additionally, one's perception of a material's worth also informs how they utilise or direct materials to. For example, materials that are reutilised for activities that are higher on the R framework are less referred to as "waste."

Stakeholder dynamics

Stakeholder dynamics influence the links that connect the value chain together, creating shifts in waste flow and activities in the value chain. Power dynamics (e.g., regulations), similarities in values, and shared commitments (e.g., contracts, partnerships) between stakeholders are a few influencing factors found during the research.

Chapter 6

Identifying leverage points

This chapter describes the process of identifying leverage points in the system that led to the formulation of the design direction and future vision.

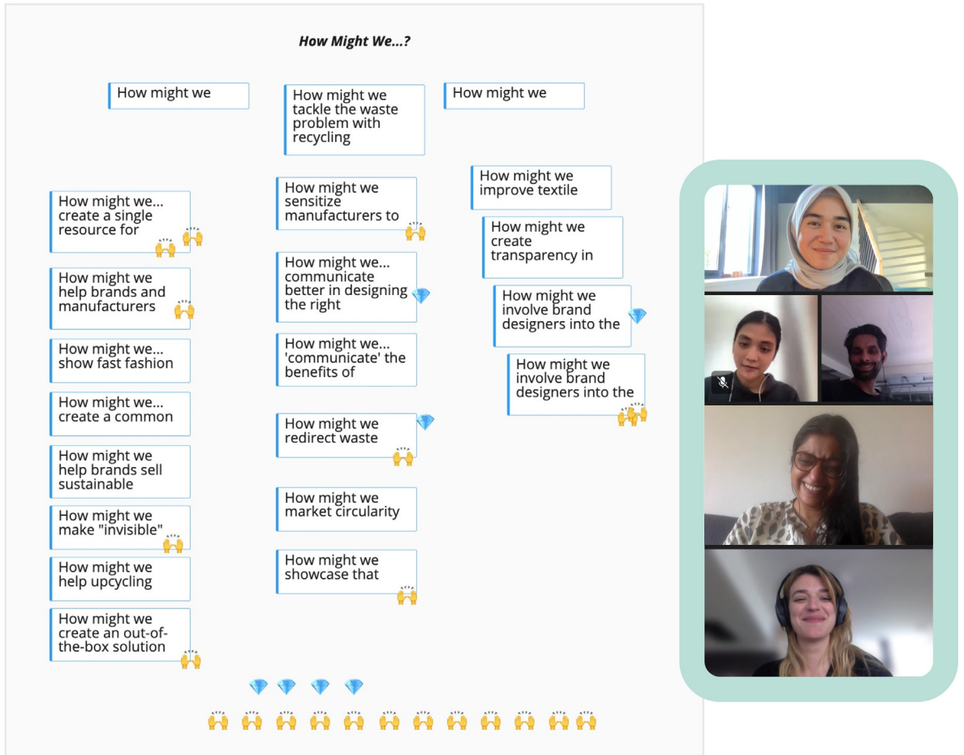


Figure 25. Creative brainstorming session with Enviu employees

6.1 Co-identifying leverage points

Leverage points are places where interventions may be applied to bring changes in a system (Meadows, 2015). While multiple leverage points may exist in a system (Meadows, 2015), the objectives established at the outset of the project have inevitably narrowed down its options.

Given the overarching objectives of the Putting Waste to Work project, this phase focused on finding leverage points where a communication means (i.e., guide, toolkit) may act as an intervention tool in enabling value creation from textile waste. However, ideas outside of this requirement were still explored to encourage a broader exploration of solutions.

Creative brainstorming sessions were held to gather ideas on where interventions could be placed in the system, and eventually informed how the design direction was formulated. The sessions were organised online with internal Enviu employees and external experts from the system map validation sessions. Details of the agenda and results of the creative brainstorming sessions are provided in Appendix E.

The following questions served to guide the sessions:

- **Problem**: What problem or gap in the system should we address?
- **Goal**: What is the desired outcome and what changes are needed?
- **Place within the system**: Where in the value chain should we act to have the most leverage?
- **Stakeholder**: Who can we target to have the most impact?
- **Accessibility**: Where do we have the most opportunity to intervene?

6.2 Mapping and clustering ideas

The brainstorming sessions resulted in two distinct outputs, Problem-as-Given (PaG) and Problem-as-Perceived (PaP) (Heijne & van der Meer, 2019). PaG ideas were generated after problem immersion using the system map, where participants were asked to share issues they perceived necessary to be tackled in the system of interest. Meanwhile, PaP ideas resulted from the activity that followed, where participants were invited to ideate opportunities for solutions using How Might We statements (IDEO, 2015).

Both the PaG and PaP were then plotted on the iceberg model (Ellis & Black, 2018), where they were placed on the level of abstraction on which the idea aims to tackle, and then clustered to form themes. While the PaG provided problem themes, the PaP formed solution themes. Figure 26 illustrates the themes on the iceberg model.

The model helped to inform the scale of impact and degree of transformation needed to enact the idea. The lower the idea sits on the iceberg model, the harder the transformation will be, but its potential impact can be greater. While not applied directly, other frameworks of systems change such as Meadows' (1999) leverage points and Williamson's (2000) institutional analysis were also considered in assessing the magnitude and complexity of change.

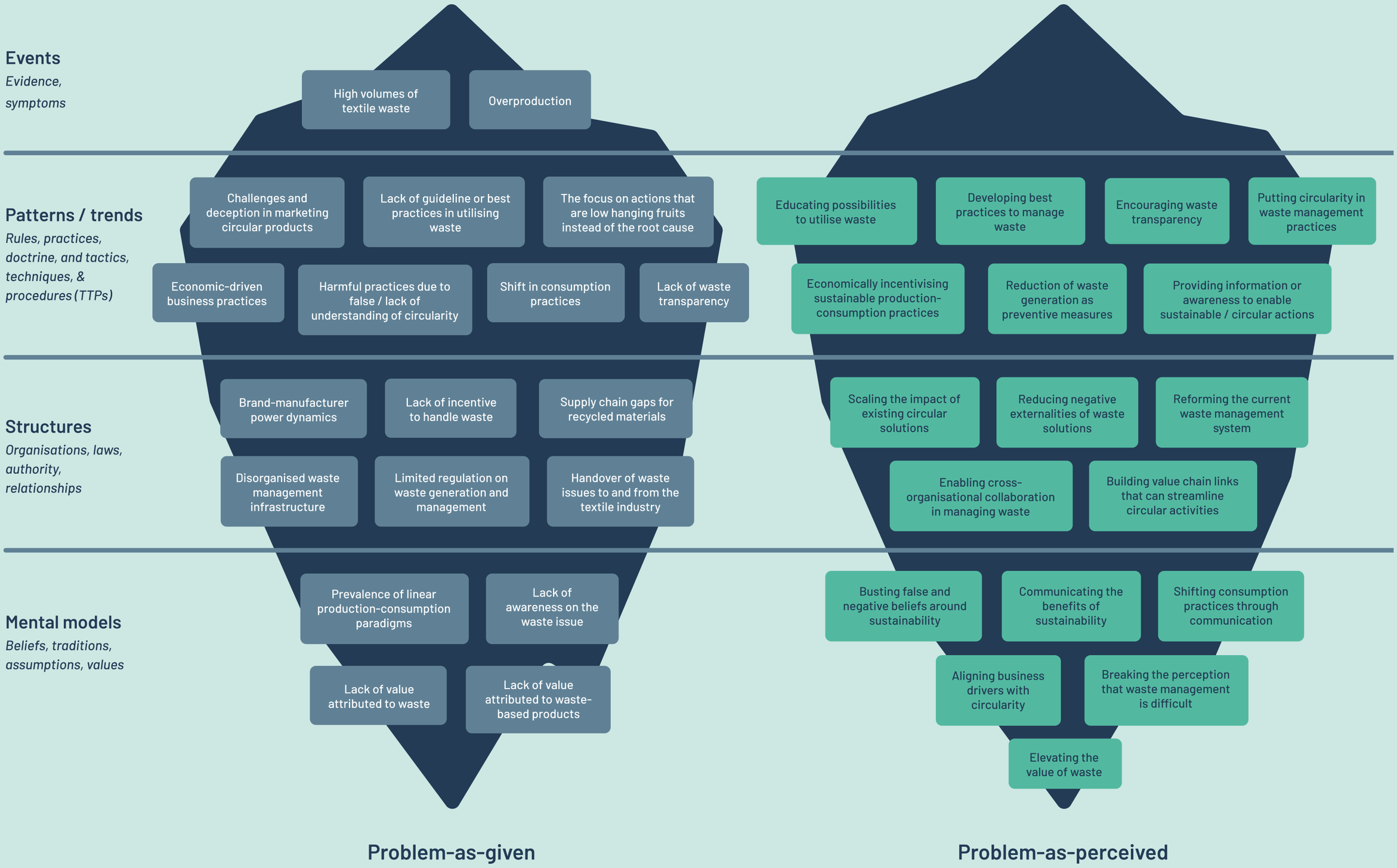


Figure 26. Themes of ideas on the iceberg model

6.3 Formulating a direction

The resulting themes, along with research insights, provided ideas for several potential leverage points. These leverage points informed the formulation of a design direction.

The following considerations were taken into account in mapping opportunities for leverage points and in formulating the eventual design direction:

1. Outcomes of the dot voting activity during the brainstorming sessions
2. Alignment and contribution to the overall aims of the Putting Waste to Work project
3. Scale of impact within the system and degree of required transformation
4. The time and resource constraints that the project functions under
5. Compatibility with the learning objectives of the study programme

6.3.1 Potential leverage points

The following are potential leverage points that resulted from the opportunity mapping activities:

The growing motivation toward enacting circular practices and value creation

The previous chapter identified that a broad range of value chain stakeholders is already engaged in circularity and value creation, and the rise of awareness results in more players being eager to jump on board. These motivated stakeholders span from manufacturers, brands, waste management organisations, to grassroots organisations.

This presents an opportunity to scale value creation activities by targeting both stakeholders who are already engaged in it as well as those who are inclined to do so. In addition, targeting those who are already motivated to create value from waste presents a lower barrier to enacting action.

The lack of knowledge and information on the textile value chain and circularity implementation

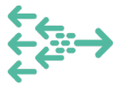
The fragmented and opaque nature of the textile industry in India creates a lack of awareness of what is happening in the value chain, who is doing what, and what can possibly be done. In addition, inadequate information on the industry also challenges for emerging enterprises when starting up textile waste solutions.

This issue is exacerbated by the circulation of vague and misleading interpretations of circularity, which lack details on how to implement it, especially in the Indian context. This lack of understanding of both the problem and solutions to textile waste has resulted in instances of intentional or unintentional harmful practices such as greenwashing.

The lack of (strategic) system-level actions from value creators

Beyond maximising internal operations (i.e., maximising waste input, production, and output), enabling value creation activities can also be done through actions at the value chain level.

System-level actions could imply creating strategic links between value creators and other value chain stakeholders, utilising their capacity to the best problem-solution fit (e.g., channelling and using waste in the most circular way possible), and building alliances and exchanges between existing value creation solutions. While these activities are not confined to value creators, few instances were identified from value creators, presenting possibilities to facilitate them.



The need to shift the current structure in order to optimise value creation activities

Research findings suggest that critical barriers in enabling value creation activities are largely structural in nature; therefore, the impact of value creators could not be maximised without the engagement of upstream stakeholders (i.e., suppliers and waste providers) as well as downstream (i.e., customers). This highlights the need to change the way the system operates.

As early adopters of circularity, value creators collectively possess the potential to disrupt the industry's archaic way of working. They do not only provide solutions to the issue of waste, but also provide value to both supply-side and demand-side stakeholders that they work with. This presents opportunities for them to create changes that may ripple in the value chain.

6.3.2 Design direction

The chosen design direction is positioned on the pattern level of the iceberg model, with the goal of establishing a trajectory towards deeper level shifts at the value chain level.

Its formulation adopted a teleological approach, in which the desired endpoint is first established, and the means to reach it is determined in response (Fiescher & Riechers, 2018).

Design direction

How might (potential) value creators with existing motivations become trailblazers towards a future where circular waste value chains become the status quo?

6.3.3 Future vision

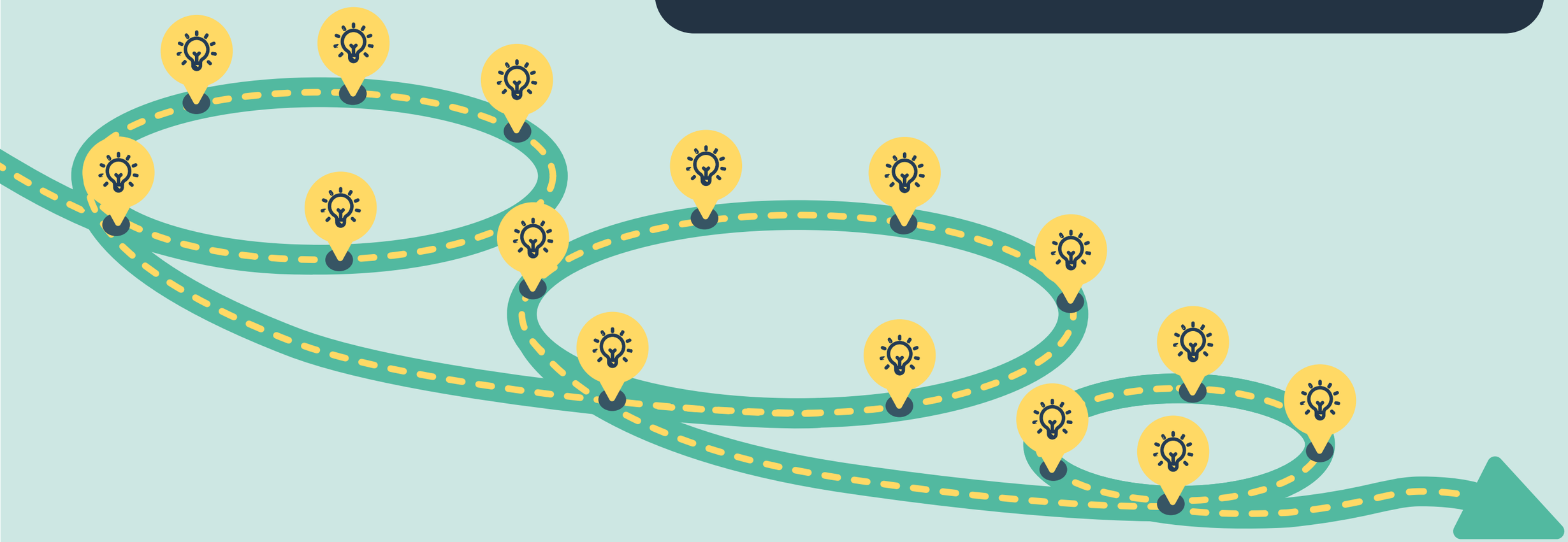
A future vision was created to set the context for desired change that the design direction is aimed to head towards.

The research insights and ideas generated during the brainstorming sessions both served as anchor points to the present state and inspirations in envisioning a desired future.

In an ideal value chain, textile waste is a shared responsibility that extends to every stage of a materials' journey

Every player in the textile value chain, be it brands, manufacturers, or recyclers, collectively play a part in providing solutions to and creating value from textile waste. Circularity becomes a relay race that runs across the value chain, where a resource is utilised to its maximum value at each stage, and flows to the desired means of utilisation within the value chain. Value creation is set as one of the mechanisms that uphold the value of materials over the long run, rather than being a one-time mitigation effort in shifting mountains of waste at the expense of others.

The notion of "waste" evolves from something that is dispensable into a resource of value. Waste reduction and value creation are no longer afterthoughts; they are woven into the fabric of how the value chain functions. Eventually, any value creation activity – or acts of creating value as a whole – does not take the centre stage as the ultimate answer to the issue of waste; rather to raise the question of: *How can we ensure that waste is not generated in the first place?*



Chapter 7

Designing an intervention

This chapter describes the process of designing an intervention to be placed in the system. The intent behind the intervention is first described. Then, the process of developing it is further elaborated. Lastly, how it was evaluated and how the outcomes were incorporated into the design iteration are explained.

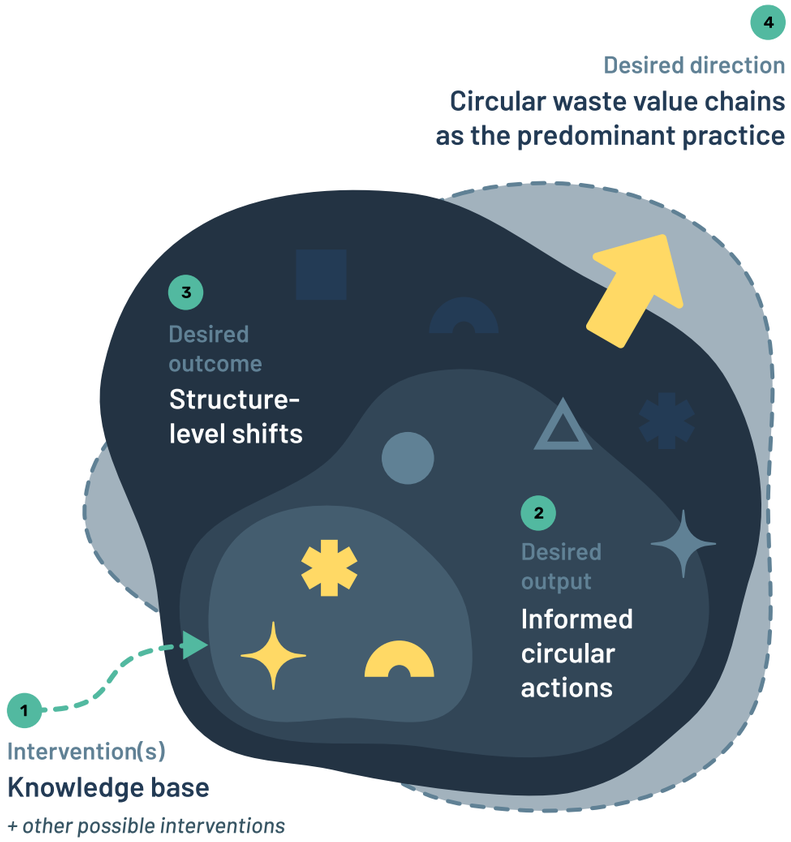


Figure 27. Desired change as a result of the proposed intervention

7.1 Designing systemic interventions

Systems thinking puts into perspective that there is not one single cause and one simple solution to complex problems, due to their dynamic and interrelated nature (Design Council, 2021). Addressing complex problems may be done by applying interventions at multiple leverage points, which may ripple to desired changes in the wider system (Meadows, 2015).

The goal of this phase was to design an intervention concept to address one leverage point in the system, as an initial step in achieving the desired direction proposed in the previous chapter: creating circular waste value chains as the predominant practice (status quo). A knowledge-related leverage point was selected since it has the potential to bring a more fundamental cascading effect to effectively carry out interventions at other leverage points. As knowledge and information, as well as their exchange, are one of the main determinants in accelerating sustainability (van Engelen & van Bommel, 2019).

The following subchapters will elaborate on the proposed intervention as well as the process of conceptualising it.

7.2 Proposed intervention

Proposed intervention

An online knowledge base intended to provide information on the textile value chain in a way that enables (potential) value creators to develop informed circular actions from a systems lens

Where

Where in the system is the intervention intended to be placed?

Besides its potential impact, the intervention focused on a leverage point that relates to knowledge since it has the potential to be addressed by a communication tool.

As discussed in the preceding chapter, knowledge emerged as one of the factors that hinder value creation activities. One fundamental gap is the lack of transparent information on the state of the textile value chain . Additionally, there exists a gap in translating knowledge on circularity into the practical Indian context. This lack of knowledge creates tunnel vision, absence of synergy between players, challenges for new circular businesses, and ill-informed practices, all of which highlight a necessity to bridge this gap.

Who

Whom is the intervention targeted towards?

The intervention will address existing and potential value creators who are already motivated to create solutions for textile waste. Since the intervention addresses the knowledge gap of the audience, they can be further divided based on the level of knowledge.

As illustrated in Figure 28, the intervention concentrates on an audience that belongs in the first quadrant, comprising individuals with limited knowledge of the textile industry or circularity in the context of India. The goal is to produce a diagonal shift where both the level of motivation and knowledge are increased.

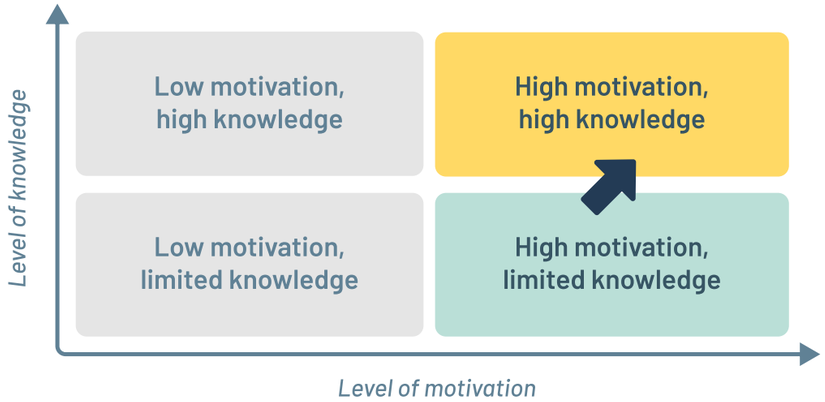


Figure 28. Audience segmentation

How

How is it intended to achieve change?

The motivation behind the intervention is to direct changes of practice to create structural shifts. In achieving this, the intervention is intended to provide information on the textile value chain in a way that enables the audience to develop informed actions using a systems lens. Building an understanding of how they fit into the ecosystem may create a broader view of barriers that they may face and opportunities on how to solve them from a systems lens.

In the proposed intervention, the Three Horizons framework (Sharpe et al., 2016) provides the structure for communicating information to the audience and facilitating them in identifying ideas for future actions. It is a framework that may be used as a tool for dialogue in navigating complexity and identifying future-oriented actions towards change. How the information is presented will be put in more detail in the information architecture section.

What

In what form will the intervention take shape?

The intervention takes shape as an online knowledge base that allows it to be widely distributed to industry stakeholders. As informational interventions have the capacity to change attitudes and motivation to a certain extent (Klaniecki et al., 2018), the knowledge base is positioned as a tool to prompt preexisting motivation into action. How this is incorporated will be elaborated in the user journey section.

The decision to adopt an online format was made because digital interactions, augmented by visualisations, may provide advantages in showing multiple layers of information in a manner that is engaging and digestible. Furthermore, as there are possibilities for knowledge to evolve and expand, adopting this format gives the flexibility to modify or add layers of information once the knowledge base is put into implementation.

7.3 Design principles

Triangulation of identified client needs, audience needs, and design intention resulted in the formulation of design principles for the intervention. These principles guided the conceptualisation process and served as metrics in evaluating the intervention. The design principles are as follows:

1. Understandability

The information provided is understandable and digestible by the audience

2. Relevancy

The information provided is relevant and useful according to the audience's needs

3. Actionability

The intervention aids the audience in devising actionable ideas for textile waste solutions

4. Modularity

The intervention allows for knowledge to be added or modified

7.4 Conceptualisation

7.4.1 Information architecture

The content for the knowledge base is derived from information gathered in the research phase.

While the system map had been a way to collate and communicate these insights, it was created for research purposes and communicated through facilitated occasions. As a result, it was still necessary to design a way of presenting information that takes into account the audience's mental model when building knowledge and solving problems.

Questions that needed to be answered were:

1. How do people approach knowledge building and problem solving?
2. What information would they find most relevant?
3. What depth of information do they require?

The card sorting approach (Spencer, 2009) was used in an effort to find answers to the above questions. It was carried out with participants who fit the archetype of strong motivation in problem-solving and limited knowledge of textile waste in India. Appendix F contains details of the card sorting exercise. The design decisions that resulted from this activity are:

Design decision #1

The intervention should give the audience the agency to find information that they deem necessary

The card sorting results inferred that the participants have different mental models when approaching problem-solving. Two identified factors that influence the participant's way of approaching a problem are their individual characteristics and problem-solving intent. Individual characteristics may relate to traits, expertise, or educational background.

Meanwhile, problem-solving intent influences the type of information and the level of complexity that an individual would need. With a goal of finding solutions to utilise waste, for example, an individual might put focus on the material level; while the goal of changing the textile waste ecosystem might start from an understanding of the value chain.

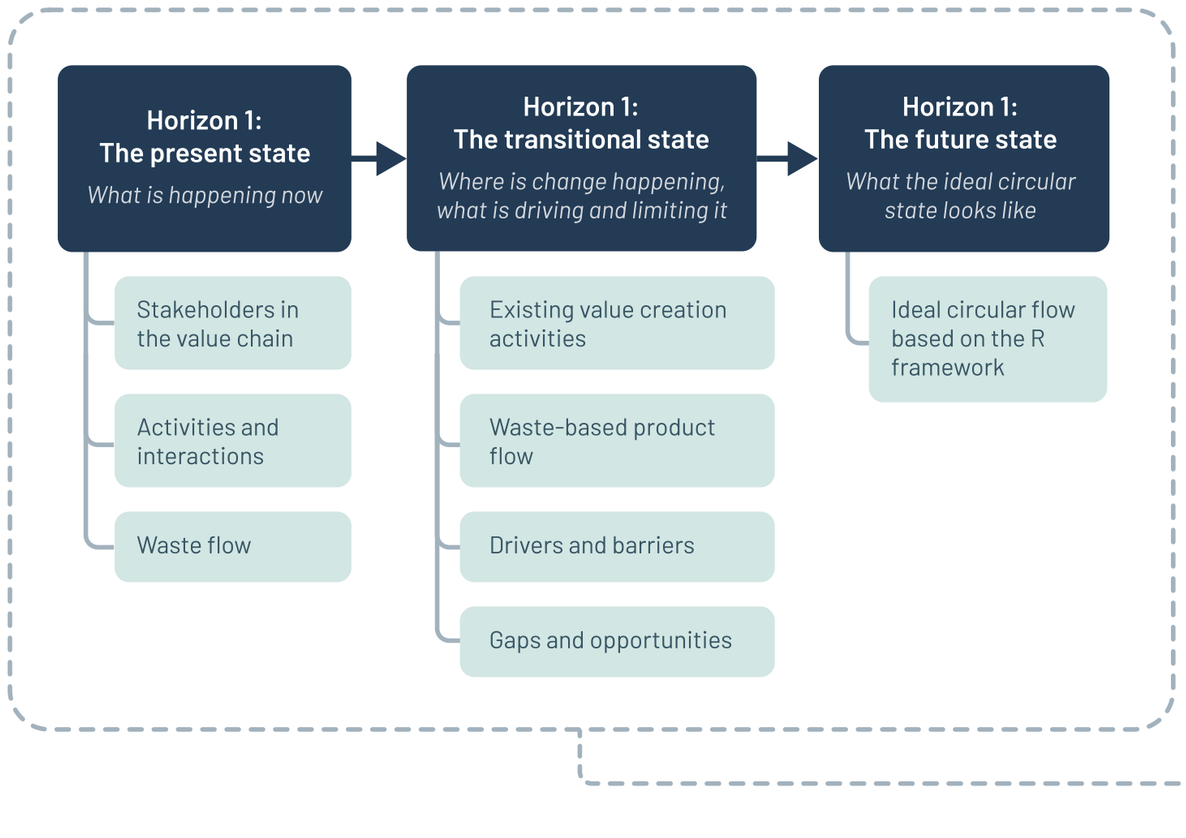
Design decision #2

The Three Horizons as a frame to deliver information, where information on the present state serves as initial anchor

Common patterns were identified in terms of the order of presenting information: what is necessary to be known first and what can be built later on. Information that emerged as anchors to other information to be built on top were about the present state of the value chain. These are information on the stakeholders and their activities in the value chain. Waste flow information and type of waste tie on top of this information and emerged as high in necessity.

Eventually, this exercise did not result in a reduction of information as it was inconclusive on which information is most necessary for the audience. Therefore, it was decided that all information would be taken forward in the prototyping and the evaluation phases. These insights, however, reinforced the idea to incorporate the Three Horizons, as its first horizon looks at the present state of a situation.

Below is the resulting information architecture which incorporated the information collected from the research, the results of the card sorting activity, and the Three Horizons framework:



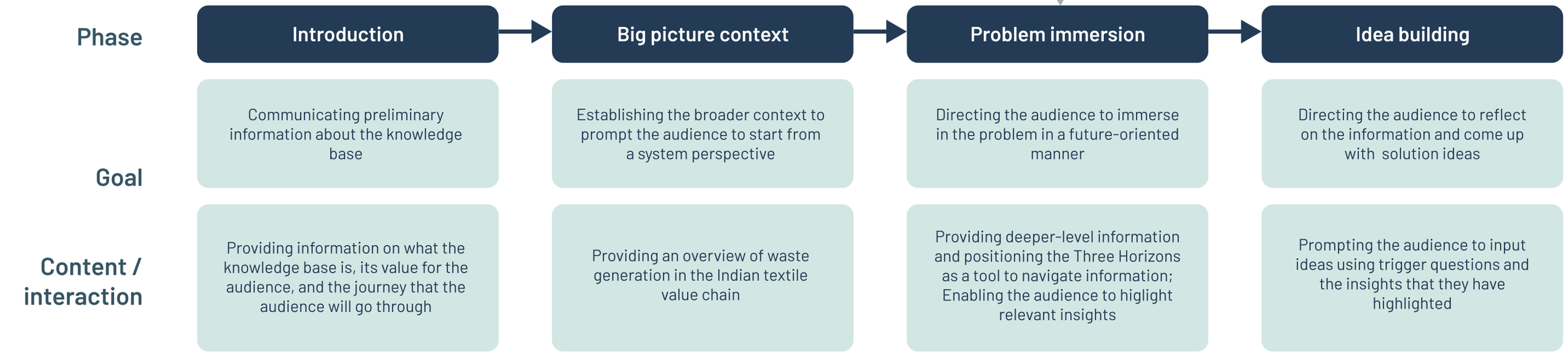


Figure 29. Information architecture & flow map of the knowledge base

7.4.2 Flow map

A flow map was mapped to lay down the journey of the audience when interacting with the knowledge base. It provided to be useful in determining the stages of knowledge building and outlining the objective of each stage. In addition, it became a starting point in detailing the information, visualisations, and interactions that were required. Figure 29 depicts the stages in the flow map, as well as the goal and the content or interaction at each stage.

7.4.3 Prototyping

The solution was further conceptualised into an interactive prototype. Figure 30 illustrates how the key touchpoints in the user flow translate into the visualisations and interactions in the prototype.

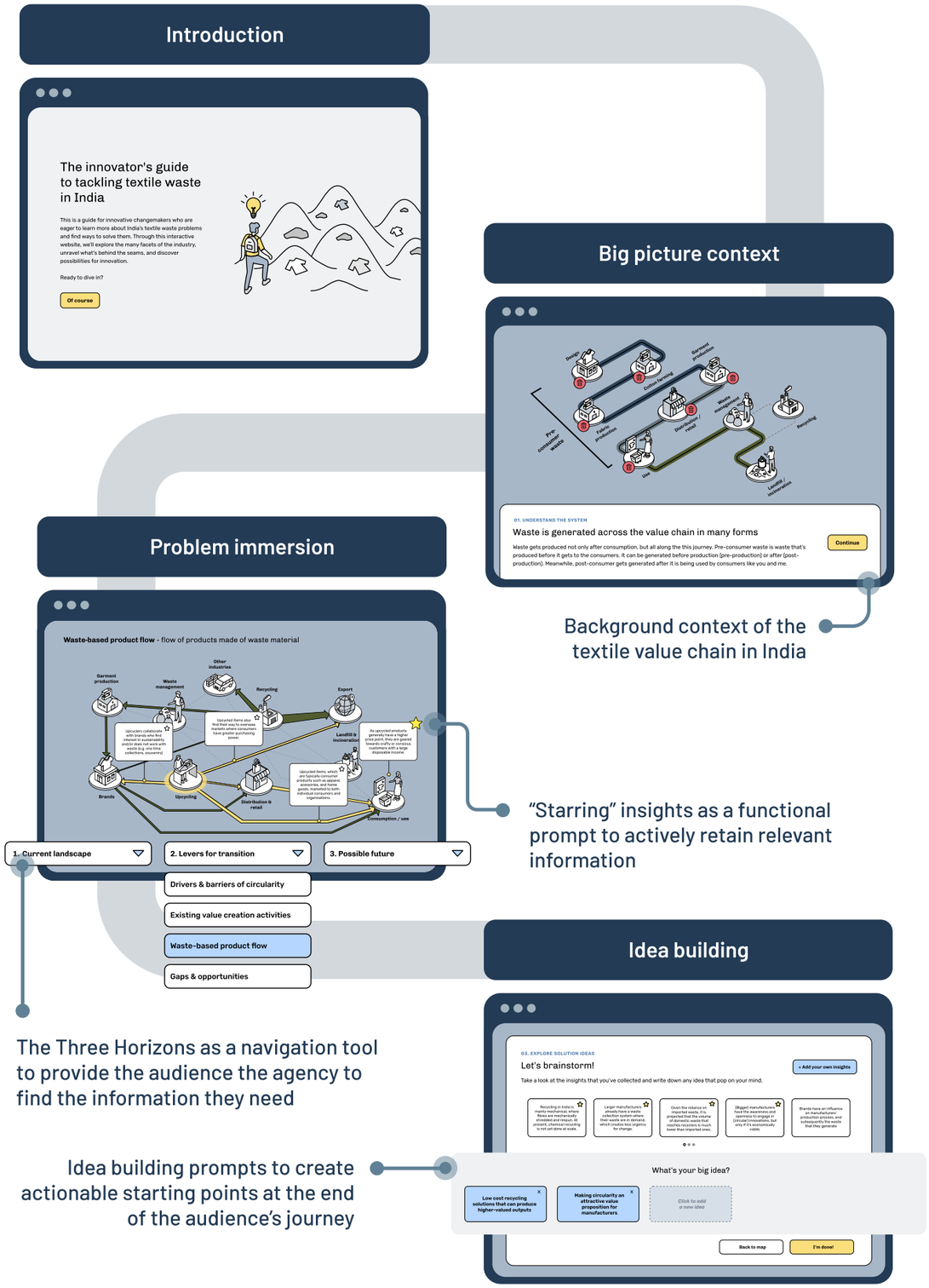


Figure 30. Interactions and visualisations at key touchpoints of the knowledge base

7.5 Evaluation

7.5.1 Goal

The intervention concept was evaluated with individuals who are working with waste management or value creation organisations in India. While there were no rigorous measures taken on the level of knowledge or motivation, the participants provided a variety of profiles in terms of core activities, the value creation activities that they are engaged in, length of tenure, and scale of operations.

The sessions put an emphasis on evaluating the value and problem-concept fit, while evaluation of content and user interactions was put as a secondary goal. The design principles served to measure the extent that the concept fulfils its intended aims.

Evaluation of the value of the concept was also done by gathering ideas on possible use cases that it may servel. Appendix G provides details on the evaluation sessions

7.5.2 Key insights

The evaluation sessions resulted in qualitative and quantitative assessment on the first three design principles as well as feedback points on conceptual, informational, and visual interaction levels. Several key insights inferred from the evaluation sessions are:

Nice to know vs. valuable to know information

While all information was perceived to be useful in gaining a better understanding of the system, action-oriented information (i.e., information that can directly be put into action) was considered to be the most important. It may be inferred that the participants have a grounded perspective and approach when it comes to creating textile waste solutions. While some preferred more in-depth knowledge, the perception that the prototype served information that was "in the middle" of in-depth and simplistic was perceived to be sufficient as a starting point in building solutions.

Too much agency creates a lack of direction, too much direction creates restrictions – a sweet spot needs to be found

It was initially assumed that giving the audience agency would provide freedom in building knowledge. However, the minimal guidance and steps created a lack of clarity for several participants on what they need to and can do at each step. A positive outcome from the evaluation sessions was that the minimal direction allowed the audience to deduce various use cases for the intervention according to their needs. Additionally, the navigation tool appeared to be valuable in reducing overwhelm as it allowed the audience to focus on a particular piece of information.

"Theory" should be explained in relation to how things are perceived and done in practice

There was a disconnect between the "ideal" circular flow presented on the prototype and what the participants saw and experienced on the ground. The disparity in terminology between what is used in academic literature and what is typically used in practice (e.g., upcycling versus repurposing) created questions in their attempt to align it with their current understanding. Furthermore, portraying frameworks as the "ideal" future state did not only cause cognitive dissonance but also presented a constrained vision of the future, as participants have different ideas of what it could be.

Interactivity and visuals can be engaging, but they must help deliver the message

When compared, for instance, to reading a report, the visuals and interactions were regarded as valuable in making the information more engaging and digestible. The map visualisation offered a consistent anchor for the knowledge to be built upon and helped to convey how all actions are interrelated. However, the sessions revealed that this manner of visualisation might not be necessary for all information types. Spreading information throughout a map made the central information less prominent, and doing hover interactions to view them may become a burden if done repeatedly.

7.5.3 Perceived use cases

The sessions uncovered several perceived use cases for the intervention, which can be seen in Figure 31. The use cases largely resembled the intent of providing information to the audience that enables informed actions, while the "systems lens" were stated more implicitly. That being said, the variety of perceived use cases also served as a reflection on whether the intent or communication should have been defined more explicitly.

Existing value creators perceived system-level knowledge as nice to know, but noted that it would be valuable to have if they were just starting. It may be inferred that potential value creators who are still in the idea-finding stage would benefit most from this concept. Meanwhile, existing ones found it valuable in addressing knowledge gaps or finding new opportunities.

In addition, several participants noted that the intervention might not provide enough aid to create action. Existing value creators suggested that information to aid their operational needs would also possibly be necessary (e.g., where to find a constant waste supply, how to market their product). Participants also suggested needs on other levels of the iceberg model, such as support from the governments (structure level) or the need to shift customer perception on waste-based products (mental model level).

From these learnings, it can be concluded that the intervention concept provided a promising starting point in enabling informed action from a systems lens, especially for potential value creators. However, more interventions will indeed be needed to effectively enable it.

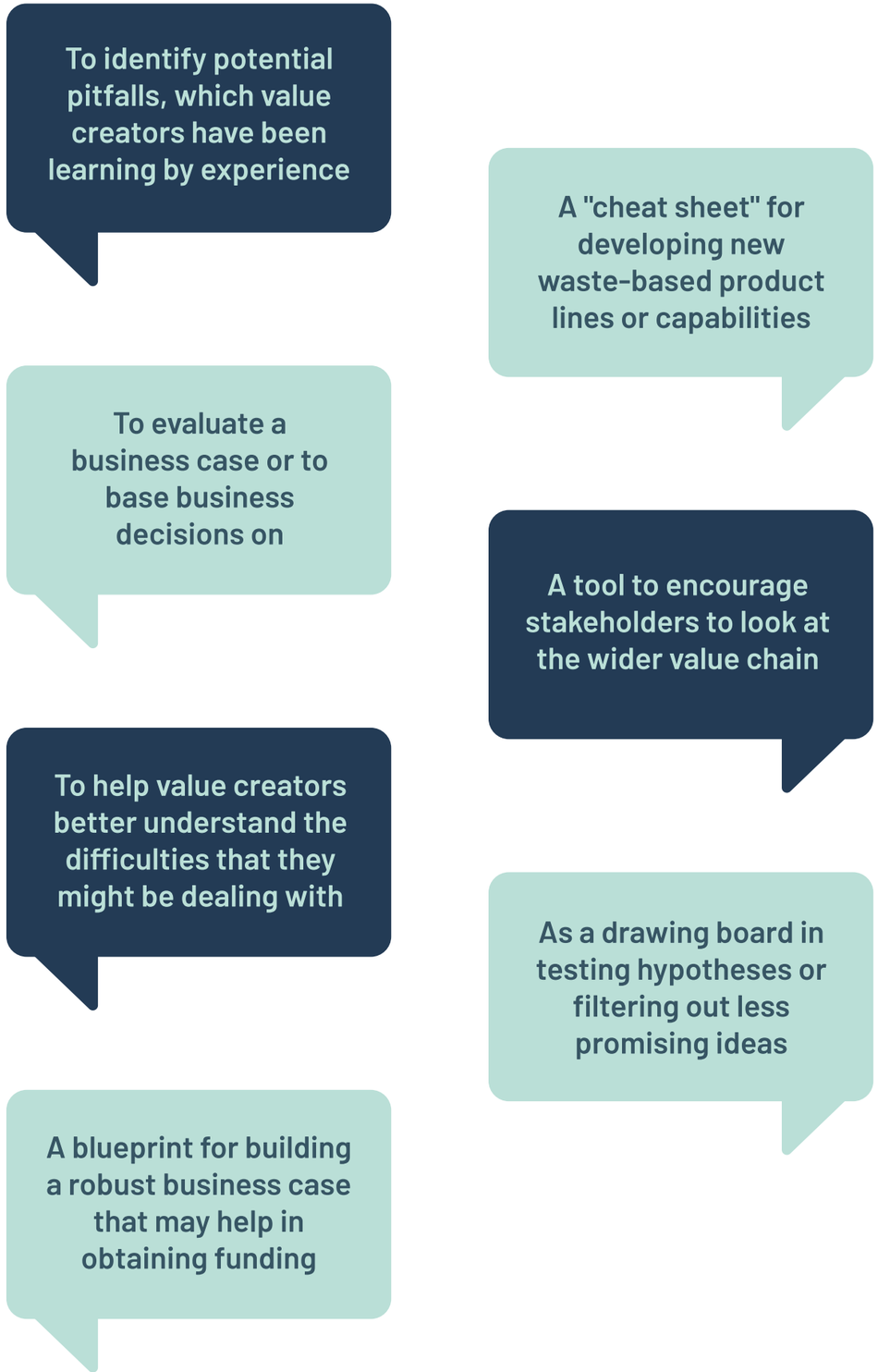


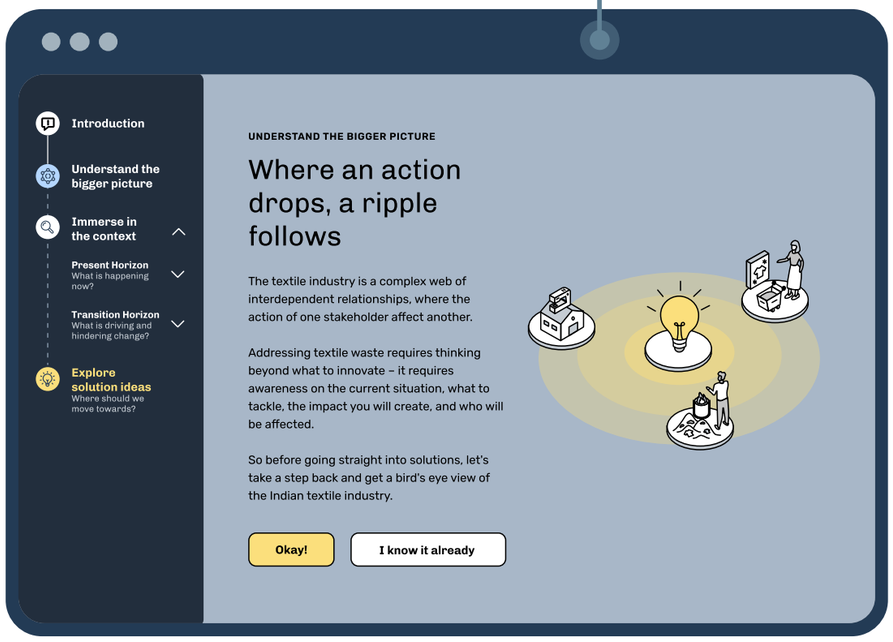
Figure 31. Identified perceived use cases from the evaluation sessions

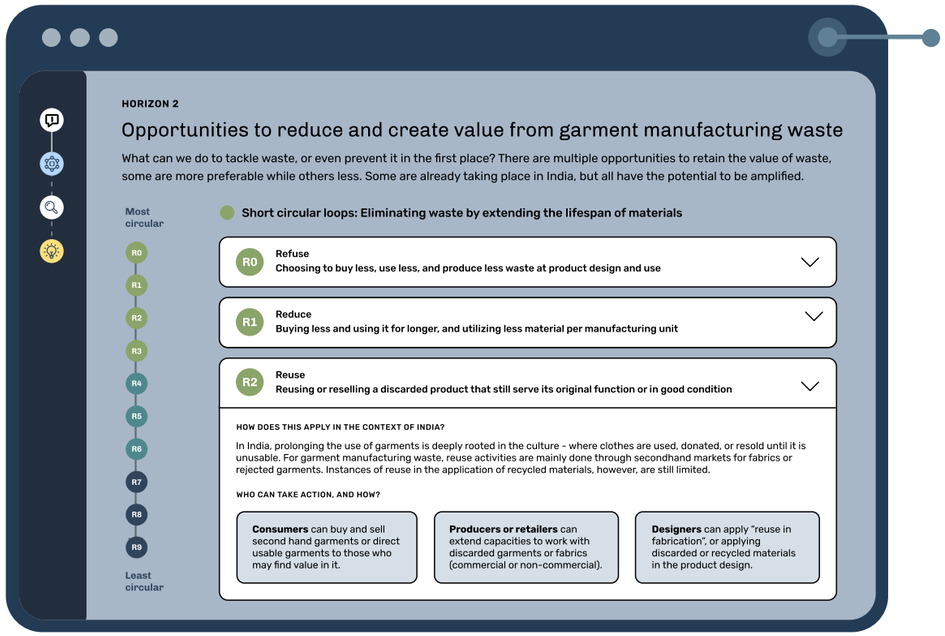
7.6 Iteration

The key insights from the evaluation sessions were formulated into points of improvement for the intervention concept. The following are the improvement points and how they were translated into the design:

1. Providing directional and situational awareness

This point of improvement resulted from the reflection that the initial concept lacked directedness. The idea is to provide a sense of directional and situational awareness for the audience – that is the section they are at, what they can do, and what is next – while still giving them the flexibility to move from one section to the other. Visually, this manifests as a fixed navigation tool that resembles a table of contents or a progress bar. Whereas content-wise, section introductions were added to provide context to what is shown and what the audience needs to do.

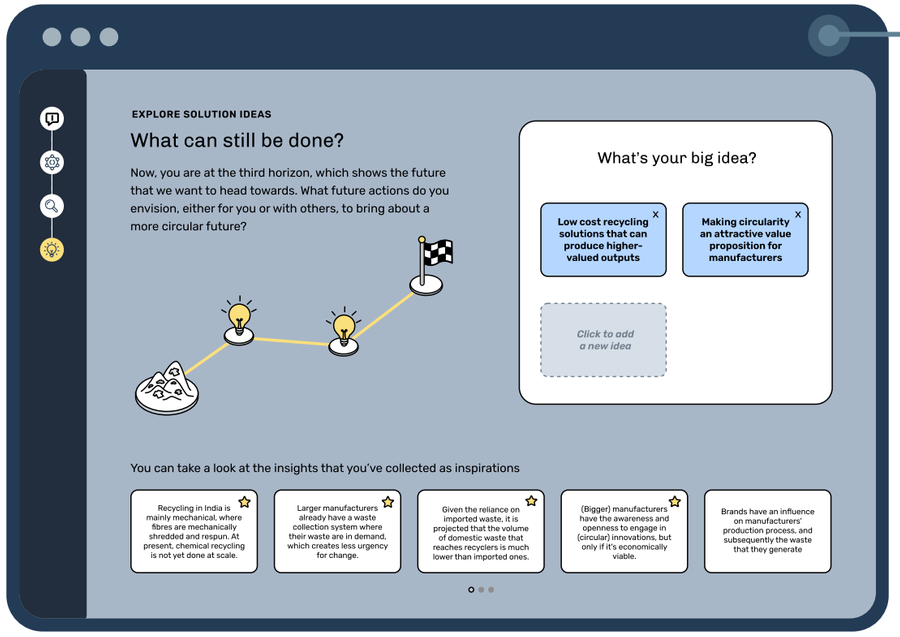




2. Presenting practical information, in a practical manner

The second improvement point relates to tailoring information and the manner in which it is communicated to what is perceived to be valued most by the audience: practicality and groundedness. Figure on the left depicts how this was incorporated while iterating the R framework information to make it more actionable.

The previous map visualisation made it difficult to process the R framework because a value creation action might be carried out by and directed to multiple stakeholders. Therefore, the visualisation was adjusted in the second iteration, putting an emphasis on how it manifests in practice and what can be done by the audience, rather than ideal flows and definitions.



3. Reframing the third horizon as the solution prompt

The evaluation sessions uncovered different visions for the future of the textile waste value chain. Therefore, instead of presenting the third horizon in a concrete, theory-oriented way, it was reframed as a prompt for the audience to fill in the ideas on what they can do to achieve their envisioned future. The previous R framework information was moved to the second horizon as informational content.

Chapter 8

Conclusion

The conclusion of the project is presented in this chapter. The answer to the previously defined research question is discussed, along with the limitations that were faced. In addition, future recommendations are put forward based on the project's learnings. The chapter is concluded with personal reflections from the author.

8.1 Conclusion

The project started with the aim of exploring circular solutions to generate value from textile waste in India and identifying potential industry stakeholders with value creation capabilities. Initial context understanding through literature review and expert interviews identified layers of context variations beneath the problem area. This resulted in the focus being narrowed down into a system of interest, resulting in a more concrete formulation of research question and sub-questions.

Research question:

Explore how landfilled and open-air incinerated textile waste in India could be reduced through a communication means that enables value creation activities for cotton-based garment manufacturing waste

Three subquestions were formulated to help break down the research question. To answer these questions, information on the context was gathered through primary interviews, secondary interviews, and literature reviews. Stakeholder mapping, flow mapping, and affinity mapping were then applied to the collected information, where the resulting insights were combined into a system map and validated by experts. A follow-up field study in India later in the research helped enhance the findings.

Subquestion 1:

What value creation opportunities are possible for cotton-based textile waste generated by garment manufacturing activities in India?

Research on the Indian context provided an understanding of the current state of value creation, while literature review of circularity principles provided a reference to the ideal state and the range of possibilities from an academic perspective. Based on the categorisation of Reike et al. (2018), it was identified that existing activities in the system encompass re-use/resell (R2), remanufacturing (R5), repurpose (R6), recycle materials (R7), and recover (R8). An insight that emerged is that the majority of existing value creation activities skew towards activities that produce lower-valued outputs with shorter lifespans, which presents a gap to increase value creation activities that may allow materials to stay longer in the value chain.

Subquestion 2:

What opportunities and barriers are present in the production of cotton-based garment manufacturing waste and its utilisation?

Affinity mapping uncovered several drivers and barriers of value creation across categories of technical, economic, institutional, and social factors (de Jesus & Mendonca, 2017). Barriers to value creation can be distilled into several themes: value or perception, knowledge, infrastructure, and economic climate. Meanwhile, cultural values, economic motivations, and growth of awareness were found to be salient drivers that encourage value creation activities. Triangulation of the three analysis results produced four factors that influence the flow and utilisation of waste: capacity, value and perception, stakeholder dynamics, and market forces.

Subquestion 3:

What stakeholders possess the capacity to enable value creation from cotton-based garment manufacturing waste?

To answer this question, present stakeholders within the system of interest were first identified. This allowed the research to further identify stakeholders that engage in value creation activities. Value creation was found to be done by garment manufacturers, waste management actors, brands, grassroots organisations, households, fabric manufacturers, yarn manufacturers, recycling-focused enterprises, and other industries. These stakeholders do a variety of value creation activities listed in the answer to the first subquestion.

Developing a communication means to enable value creation

Creative brainstorming sessions were organised to identify possible leverage points, or areas of intervention in the system. The resulting ideas were then plotted on the iceberg model (Ellis & Black, 2018) according to their degree of impact and change. A design direction was eventually formulated by combining these ideas, research insights, and project aims. Furthermore, a future vision was depicted to illustrate the future that the design direction intends to head towards.

The formulated design direction is as follows:

"How might (potential) value creators with existing motivations become trailblazers towards a future where circular waste value chains become the status quo?"

The design direction served as a basis for conceptualising a communication-level intervention. It is aimed to address an identified gap relating to knowledge on the textile waste value creation ecosystem, which is creating tunnel vision and an absence of synergy between existing players, challenges for new circular businesses, and ill-informed "circularity" practices.

The proposed intervention is an online knowledge base intended to provide information on the textile value chain in a way that enables (potential) value creators to develop informed circular actions from a systems lens.

The intervention is designed with the goal of increasing the level of motivation and knowledge of (potential) value creators who are already motivated in developing textile waste solutions to propel them towards action. The information presented on the knowledge base is structured based on insights on the problem-solving mental model of the target audience, combined with the Three Horizons framework (Sharpe et al., 2016). Four design principles were formulated to guide the conceptualisation and evaluation process.

A prototype of the intervention was used as a tool to evaluate the value of the concept and problem-concept fit with the potential target audience. It can be concluded that the perceived value of the intervention concept largely resemble its intended goal. While the intervention concept provided a starting point to enable value creation, it was revealed that more interventions would be necessary to translate motivation into action. Learnings from the evaluation sessions were then put into points of improvement for the concept iteration.

8.2 Limitations

The project was carried out under several limitations:

Information collection

The project faced limitations regarding information collection, particularly in relations to the project timeframe, physical and informational accessibility, as well as language and cultural barriers.

The research and concept development phases took place remotely from the problem context, therefore these activities resorted to digital communication and information means. Information collection as well as interactions with research participants were also done digitally. Moreover, language and cultural barriers placed a constraint on the process of discovering and understanding information.

In addition, the lack of available and reliable (online) data on the research topic presented limitations for desk research. To an extent, the two-week field study conducted later in the project helped to validate both the concept and the understanding that was previously gathered.

Sample size and selection

Participant sampling was limited to a certain sample size and archetype, which unavoidably will not have been fully representative of all stakeholders within the system of interest. This limitation applied to the sampling of participants for the interviews, creative brainstorming sessions, as well as validation sessions. While the research attempted to sample a variety of stakeholders, for feasibility reasons it concentrated on organisations that formally engage in value creation activities. The project was able to gain little direct information on stakeholders who operate in the informal sector, and insights on these stakeholders were mostly gathered through secondary accounts.

In an effort to strengthen the validity and reliability of the research, its findings were connected to academic literature and validated by subject matter experts. It is important to point out that the experts were mostly oriented toward the perspective of industry rather than academia.

Scope of research and analysis

Due to the complexity and scope of the problem area, the focus of the project was narrowed down to a system of interest, namely cotton-based waste from first-tier garment manufacturers in India. This resulted in the exclusion of aspects that may contribute to the problem yet fall outside of the system interest, which might have influenced the subsequent analysis and design phases. Moreover, the project viewed the textile waste problem from an environmental-focused lens.

Multiple elements within the system of interest were investigated, encompassing stakeholder activities, material flow, as well as various lenses of drivers and barriers. Broadly approaching these different elements provided value in building a holistic picture of the situation, but also brought the disadvantage of having each element examined less in depth. In addition, this investigation was conducted on a set of information that was collected under the limitations discussed in the first point.

8.3 Recommendations

8.3.1 Recommendations for research enhancements

To address limitations of information collection, the validity of the information and insights drawn from the research would need to be investigated. Moreover, further research into as well as engagement with actors who work informally becomes critical, since textile waste management and value creation activities were found to be largely done in an informal manner.

Scope limitations also left gaps for the system elements to be examined in depth through the lenses of their respective fields of studies, especially in regard to the textile (waste) material and the technical perspective of value creation. In addition, it would be valuable to investigate the extent to which the project results can be generalised to other contexts beyond the system of interest. Furthermore, as the problem domain was broadly viewed from the lens of India as a nation, a look into local and regional contexts that exist within the country may still be necessary.

8.3.2. Recommendations for intervention enhancements

The first point of recommendation is to further validate and iterate the intervention concept. Since it is still in conceptual form, the intervention may also be elaborated upon, along with the assessment of resources needed to feasibly and viably realise it.

The previous chapter concluded that additional interventions may be necessary for the target audience to enact value creation activities. Therefore, a portfolio of interventions to enable value creation activities would be necessary to accompany the intervention concept.

While interventions may sit on different levels and may be applied through many lenses (e.g., political, economic, social), the following recommendations are directed towards Enviu for the continuation of the PWtW project. They were built upon the research insights and devised with considerations of Enviu's organisational capabilities and the overarching goal of the PWtW project. Figure 32 provides a summary of the intervention recommendations.

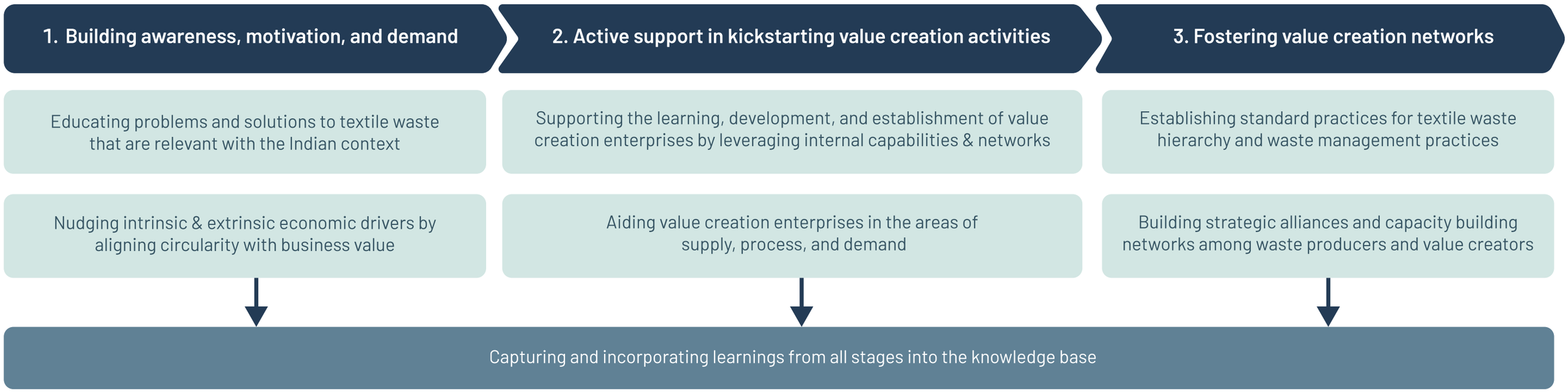


Figure 32. Summary of recommendations for future interventions

1. Building awareness, motivation, and demand

Targeting motivated (potential) value creators hangs upon their motivation to exist in the first place. Therefore, it is necessary to have interventions targeted at intrinsic and extrinsic motivation building, through awareness and demand generation. One of many ways this can be done is by communicating both the problem of textile waste and its potential solutions in a contextually relevant manner. While the proposed intervention has partly addressed this, it still presents gaps for further enhancements and the development of alternative interventions.

The research identified that among many, economic drivers have a significant influence on the presence (and absence) of value creation activities. This provides an opportunity to utilise this driver to nudge motivations. Showcasing the business value of circularity and circular goods to stakeholders across the board may be one potential means to drive motivation as well as demand across the value chain.

2. Active support in kickstarting value creation activities

Alongside the proposed intervention, several interventions may potentially be employed to drive motivation towards informed action. Enviu's expertise in venture building as well as its extensive network may provide support for value creators as they learn to develop and establish value creation enterprises.

The research identified three areas where value creators may require support: supply (e.g., waste procurement), process (e.g., capacity and knowledge), and demand (e.g., marketing, sales).

Procurement can be directly supported by linking value creators with the textile waste collection and sorting centre of the PWtW project, which may symbiotically benefit value creators in receiving a reliable waste input stream as well as the PWtW project in extending circular value chains from the textile waste centre.

Furthermore, Enviu may leverage its network in both public and private sectors to aid value creators in the aforementioned areas, especially in capacity building, capital support, and market linkages.

3. Fostering value creation networks

Circular value chains need to be developed to create a mechanism for resources to flow for the longest time at the highest value. This may be enabled by creating strategic links between stakeholders that produce waste or textile byproducts (e.g., brands, manufacturers, other value creators) and value creators that may provide a fitting solution, in consideration of the (perceived) resource value, type of waste, and contextual needs. Developing standards for textile waste hierarchy and waste management practices become a foundational step in achieving this.

Networked innovations may also be amplified by linking collaboration and learning networks among value creators and waste producers, as industry players may benefit from each other's capabilities and experiences.

Eventually, learnings from all stages can be captured and further incorporated into the knowledge base.

8.4 Personal reflections

This project allowed me the chance to connect the dots between different facets of knowledge and ways of thinking, something I've since discovered I very much enjoy doing. In this aspect, I found the research phase to be particularly fascinating. Especially as someone who may be considered an outsider when it comes to the project's context, I learned how to be cautious of presumptions and biases in my attempt to understand it.

But for me, this wonderful fascination also became a threat. When looking into something so broad, it is very easy to get lost and overwhelmed. Having the project goal as a north star and keeping boundaries in check became very important, and I appreciate my supervisors for making sure that I try to do so. Being at ease with complexity and having the confidence to go forward without fully knowing everything was a significant lesson that I did, and still need to, learn.

Working on this project also prompted me to ponder on the role that design(ers) can play in addressing societal challenges. As a designer, it might somewhat be second nature to envision ideal scenarios, but being in touch with the complex reality made me confront my limitations. Then again, it is simply not possible to solve the textile waste problem in India with just one project. Through this, I have come to understand the value of thinking big and (strategically) starting small.

Taking on complex challenges can seem daunting, discouraging even, but perhaps not to the optimist and hopeful. And as a practice that constantly seeks to create better futures, optimism is a quality that design and designers embody.

However, design by itself, is not a panacea. So along with the realisation that much work still remains, comes the hope that many more will take on this challenge and create bridges between people and disciplines.

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Appendices

Appendix A. Expert interviews

A1. Interview questions

Expert Interview - Question List

Note: Questions are adjusted based on the expertise of the interviewees

The textile (waste) industry (general and India context)

1. Can you give me an overview of what the textile (waste) industry looks like (in India)?
   - What is now being done with textile waste?
2. What barriers and opportunities are there in terms of waste getting recycled or utilised in any way?
   - What do you think are the causes of the textile waste problem (in India)?
   - Which stakeholder do you think we need to focus on in reducing this waste?
   - When thinking of value creation opportunities for pre-consumer cotton waste, where do you think I should look at?
3. If you could get ideas off your head, what are the potential and/or preferable ways to utilise textile waste (that is relevant for the Indian context)?
   - What contextual factors need to be taken into account?

Technical questions on textile (waste) and value creation methods

1. Can you tell me more about textile recycling (value creation)?
   - What existing value creation methods are there?
   - What factors play into the recyclability of a material?
   - What factors come into play when determining how to utilise waste?
2. What do you need to understand first before thinking of solutions to textile waste?
   - What technical considerations do you need to keep in mind?

A2. Interview summaries

Expert #1

Expertise: Textile materials, context of India, garment manufacturing

- Textiles is one of the biggest industries in India after agriculture.
- The current textile production and consumption processes have become archaic in nature. How do we undo the damage that has been done?
- There are multiple aspects and scales of the textile industry, from a conglomerate to a microenterprise. There are social innovations on the ground, usually individual led. Tackling bottom up would take more effort, whereas top down would be easier.
- Apart from environmental sustainability, there is also a need for financial sustainability to move businesses to a sustainable way of working. It requires a tremendous amount of work on policy-driven, infrastructure-related, and mindset shifts.
- More opportunities for all stakeholders in this space must be created – not just from the point of view of somebody who creates textiles or repurposes waste. Accountability has to go beyond an individual company owner, but also governments, citizens, and the policies that govern it. Both ethical and environmental responsibility.
- The solution is not only to move to conscious consumerism, but conscious affordable consumerism, where costs are reduced and waste products are more accessible.
- The habit of mending textiles was very common and part of the Indian lifestyle. It was generational knowledge that has been passed on. There was an ecosystem of occupations, repair shops, specialised to mend goods.
- A lot of South, Southeast Asian countries import a lot of waste, and they see it as a resource, but the waste that is generated within these countries are neglected.
- Behavioural change happens when people find value in the changed behaviour. What value will they derive out of it? How much is the cost implication?
- When talking about value creation, there are problems that keep creating more problems. There is no one solution, or a hard and fast way to decide a best solution. When one switches to a solution, one must realise the implications of it.

Expert #2

Expertise: Material driven design, base of pyramid innovations in the context of India

- A product can be examined through technical and emotional parameters. When making products especially with waste, it might be worthwhile to understand their experiential qualities. Waste can influence perception - are there any products, essential and non-essential, that people are less concerned about when it comes from waste? After that, use cases can be identified when figuring out what to do with waste-based materials.
- Experiential quality would be an influence for apparel because it is wearable. If the experiential quality of the recycling output is not suitable for wearables, non-wearable applications can be considered (e.g. pets-related items, cushions, toys)
- Size constraints can play a factor when utilising waste. Smaller waste may result in smaller outputs. Another aspect of figuring out what can be made of waste is the material quality.
- Applications of waste can also be explored in other industries (e.g., agricultural)
- In summary, aspects to think about when thinking about what can be done is the waste are: volume (high volume means possibility about repeated sales, essential products), scale, type of material, target market (market demands, volume, higher price points), and the mentioned experiential properties (sensational, emotional effective, etc.)

Expert #3

Expertise: Textile recycling systems, material value

- Creating solutions to textile waste depends on the waste source, fibre, sorting, and the system you're designing for. Pre- and post-consumer come from separate systems.
- There are several kinds of recycling systems, focused on mono-materiality: cotton, polyester, nylon. Mono-materiality is much easier than blends because with blends you have two different materials and that's complicated and different from a scientific point of view (makeups, molecules).
- Blending is a spectrum, current sorting practices have broad categories and room for mistakes (e.g., 80% often gets bundled with 100%). 100% material is very high quality and desirable—but often it is blended with other fibres, meaning it gets downvalued.
- Synthetics and natural fibres get recycled in slightly different ways. Chemical recycling makes more sense for synthetics, where it can be taken to polymer or monomer level.
- There is a myth that the consumer thinks 100% recycled is the best, but if it is not going to perform to their expectations, it might be better to have less than 100% recycled.
- There is a negative connotation around downcycling. Donating a t-shirt is technically downcycling because the monetary value goes lower. However, it is termed "reuse" and has more positive connotations around it.
- It's okay if recycled outputs go to a lower market, it's good to get them into a higher market, but what really needs to be considered are where the resources come from and the appropriate market to go to.
- Determining the degree of circularity may depend on how blended it is, the potential of what it can be turned into, and the people that sit between them.
- There are two values at play that influence recycling - the value at the sorting stage (how easy the waste is to sort) and the value for their buyers (what kind of application and to which industries can the output be sold to). It becomes a vicious cycle, where it is challenging to balance what's available and demanded in the market.
- Proactive and reactive design: not only designing for recycling but also incorporating recycling into design.
- The resource flow loop illustrates that resources can flow up and down in the value chain. There are things that you can also do to extend the loop.

Expert #4

Expertise: The Indian textile value chain, informal (waste) economy in India

- Many different informal "groups" currently collect waste. Chindiwallas collect from small manufacturing unites or small tailors. The Waghri community works on post-consumer waste, as a barter economy. The waste pickers collect every material (cartons, papers, etc.) and they sell it to bigger aggregators. The waste management sector is a black box – companies give their waste and don't know what is done with it.
- India's recycling is mostly mechanical recycling. There is this big industry on imported waste in Panipat. Chemical recycling almost does not exist. There are two cohorts of mechanical recyclers: In Panipat, it is between recycling and downcycling. The waste is turned into low quality yarn (greige yarn), which gets produced into blankets or cheap bedsheets, pillowcases, and household items for domestic and export. In Western India, there are recyclers who buy waste, recycle it into yarns, and sell it into international markets as higher quality yarns.
- The method of recycling determines the quality of fabric, the length of fiber. The longer the fibre, the softer it is. Mechanical recycling reduces the length of fibres. When doing mechanical recycling, some percentage of virgin material needs to be added.
- Most of the recycling in India relies on imported waste, not only post-consumer waste but also manufacturing waste as well.
- Second-hand markets are more geared towards certain socio-economic classes. It is unlike European vintage clothes shops that are 'hip'.
- Plastics in India are now ~90% recycled, without a formal infrastructure in place. How? Because it is easier to sort and because of the regulation pressure.
- Brands have influence over the procurement of materials and labour. Tier 1 manufacturers communicate closest to brands; tiers 2, 3, and 4 are outsourced by manufacturers. Most brands don't know who is actually making their clothes.

Expert #5

Expertise: Technical side of textile recycling

- The process of recycling waste is to 1) open the fibres, 2) card the fibres, 3) draw fibre alignment, and 4) spin them into yarn.
- The output of the recycling largely depends on the machine. It could be worthwhile to research the types of mechanical recycling machines used in India.
- There are several techniques for spinning – ring, open end, etc. They result in different applications for their output. Open end spinning is easier to handle and quicker, resulting in a lower cost. But the thickness of the yarn is higher, so it is more bulky.
- In instances that I know, an EU-based recycling company may outsource their production abroad due to lower production costs. The recycled products are sent to the EU market because the market is generally more profitable there.
- In port cities, there are free trade zones. Business regulations are more flexible there. The import or export of textile waste can happen here.

Appendix B. Stakeholder interviews

B1. Interview questions

Stakeholder Interview - Question List

Note: The Ps correspond to the questions' level of priority; the lower the number, the higher the priority for the question in respect to time limitations.

Present activities and future aims

1. **[P0] Present activities**: What's the connection between your organisation and textile waste?
   - What kind of "waste" do you work with, how do you work with it, and how do you create value from or minimise it?
2. **[P0] Challenges and drivers**: What are the challenges that you encountered in running your venture – then, and now?
   - What were the challenges that you faced when you started?
3. **[P2] Future aims**: What is your organisation aiming towards?

Starting out and growing as a value creator

1. **[P2] Internal factors**: What are the things you wish you had known when you started?
   - If I were someone who wants to start a venture around textile waste in India, what are the things that you think is necessary for me to know and take into account when building my venture?
2. **[P1] External factors**: Looking beyond the internal operations, what are the factors that you think influence how you operate your business?
3. **[P1] Scaling**: What is needed to grow and scale these organisations that are working on textile waste - such as you?
   - Imagine there are 100 value creators such as you, how would you feel about that?

Industry views

1. **[P0] Untapped opportunities**: What potential uses, or opportunities do you see with pre-consumer textile waste that are not yet, or hard to be realised? And why?
   - Is there any waste that you are not able to use?
2. **[P1] Collaboration**: What other stakeholders in the value chain do you work or interact with?
   - Are you in touch with organisations that work in the same line of business as you? Is that something you are interested in doing?
3. **[P2] Industry hotspots**: What areas should the industry be focusing its efforts on in tackling pre-consumer textile waste?
4. **[P3] Vision**: If you could envision the ideal textile waste value chain, what would it look like?

B2. Summaries of primary interviews

Interviewee #1

Circular fashion platform

- Industry actors are comfortable in doing their business and don't have the bandwidth (e.g. time, money, energy) or motivation to put effort in changing towards sustainability. Many players do not understand the urgency.
- Circularity incurs a cost to a business, both operational and marketing. Being in the textile industry is already difficult with its uncertainty. The focus is on surviving. Especially for small businesses, they are not ready to make this effort towards circularity, unless they have a strategic advantage.
- Initially, most sustainable fashion brands find it hard to communicate with and educate consumers on circularity. In addition, consumers might be sceptical about the quality of waste-based products. Circularity is not yet a differentiating factor or advantage that can shift consumer behavior.
- Many people do not have a complete understanding on both the industry and circular economy – where their place is, and the kinds of actions/interventions they can do in regards to circularity. Even sustainability-focused fashion brands might provide services that are falsely circular.
- The problem with upcycling is having stable access to quality raw material, at the right time.
- Besides circularity, the larger environmental and social footprint needs to be considered (e.g. labour, last mile delivery).
- Hierarchy of considerations when it comes to fashion: 1) aesthetic, 2) quality, 3) sustainability, 4) circularity.
- Creating clothes means you are giving birth to a new entity.
- A lot of Indian traditions already revolve around circularity. They are passed down by older generations: nothing goes to waste, reusing clothes among siblings, or donating to others. Suddenly, the culture transitioned to fast fashion.
- "There are bigger players who have good volume and good investments, so bigger industry interventions can be their responsibility."

Interviewee #2

Upcycling brand

- People dispose of clothes because the material does not fit or due to trends, not because the material has worn out.
- Works with both pre- and post-consumer waste. The type and size of fabric depends on what the manufacturer has on hand. Pre-consumer: tie ups with manufacturing units; post-consumer: secondhand markets, chindi markets.
- Challenges across different stages of production:
  1. Dependency on waste input: one of the biggest issues is not being able to figure out what kind of material you are actually working with. It becomes hard to have a lean model of manufacturing.
  2. The unpredictability of material that comes in results in a production line that is tailored to it rather than mass production. The production takes time as it handles one material at a time. Washing also adds an expense to the business. We have now figured out a patch case.
  3. Most important point, marketing: it is hard to publish the product, also the need to educate the consumer that the end product might differ from the image.
- When dealing with waste, you have to go through an alternative way of running a business.
- Increasing consumer awareness is very important. Once they are aware, they are likely to make decisions that are in favour of your business.
- There is a difference between talking about a non-sustainable product in a sustainable language vs. saying some aspects of sustainability are outside of their boundaries. When these two things intersect, that's where the problem lie.
- In the beginning, the challenge was to start the supply chain, and figure out what design could be made from the waste.
- Things to consider when building a waste-based enterprise: 1) access to supply chain, 2) whether the output brings a valuable or disruptive solution, 3) the market's readiness to accept, 4) then, figuring out the product design.

Interviewee #3

Textile manufacturer producing various recycled outputs

- The majority of the waste is sourced from imports. The waste that did not get used in production is also sold domestically to other companies who may utilise it or recycle it into other products.
- The challenge with being a waste-based business is that it is hard to grow in volume. Waste is not easily available, and as technology and awareness improve, there will be less of it.
- It is very hard to grade and sort waste. Every consignment differs, so it is hard to price or obtain.
- There is a hierarchy to what is done with the waste input: the first objective is to try and reuse the waste in its as-is condition. If it can't be reused, it may be cut into wiping waste or segregated to create yarns and make new products out of it.
- The utilisation of waste depends on: 1) the level of percentage of [cotton], 2) colour (e.g. undyed, solid, printed), 3) size, and 4) level of contamination.
- White or bright colours are always in demand because it saves the hassle and cost of redying. Multicolored fabrics are the difficult ones because the recycling output will result in dirty gray-colored yarns. Therefore, it is usually used in the lower-valued spectrum of applications.
- If there is contaminated waste, it needs to be assessed whether it is worth cleaning or not, because a lot of it is manual. Contaminated waste does not get spun into yarns but converted

into the lowest levels of fibres.

- Why is there no formal methodology for collecting pre-consumer waste? One of the factors is because of the cost it incurs. India is a big country, and the logistics costs are sometimes more than the cost of the waste. Logistics and supplies are a very high-cost component.
- I feel that still, the first thing to prioritise in any business is profit. Where people get a bit lost is the balance between profitability and circularity/sustainability. It's very important to cover the expenses of the business.
- Whatever is related to waste has to be looked at from a scale perspective. There are many stories of businesses that fail miserably when scaling.
- A lot of (waste) businesses in India work on a cash basis, which does not suit our formal way of working.
- The lower quality wastes (the more mixed) are all sold domestically because in India the price point is a big factor.
- At least in India, there is no support from the government for waste businesses. It is being looked at rather negatively than positively.

Interviewee #4

Recyling enterprise

- The prices for recycling are actually very low because of the specific requirements of the recyclers and the disconnect between where clothes are manufactured and where recyclers are located. The price varies quite a lot depending on the type of waste, segregation requirements, and hygiene.
- A lot of recycling solutions are not scalable; many can only deal with a few kilogrammes of waste here and there. If we want to kind of create a solution that can actually redirect tonnes of textile waste, the solution has to be something that can easily be scaled up.
- Textile waste is sourced from many sources: manufacturers, designers, even waste management organisations in India. The waste is then shredded, bound, and compressed. The output can be used for applications ranging from indoor facade walls, furniture, to insulation panels.
- The textile waste sector in India is extremely unorganised and informal, so not enough studies have been done on it. On-ground reality is not reflected through official reports. We spent quite some time figuring out the exact issues in the textile industry and how it works. All the information was scattered and we had to talk to like hundreds of people just to get an idea of what was happening.
- Working with pre-consumer waste is easier, mainly because it's cleaned up.
- It's hard to figure out the composition of waste material. That's why waste management organisations also sometimes struggle with material segregation. And for recyclers, it can affect the product quality. Mixed fabrics are more problematic for production. We need predictability and certainty of composition for every production.
- Some high-end designers don't want their designs to go out to markets or the traditional recycling streams, because they're afraid that their designs will get copied and sold at a cheaper price.
- Impact first is where we want to go. That influences our solution, business model, and value proposition. We are still figuring out our business model, but creating a market for the products is probably going to be one of the most challenging tasks.
- Challenges with investors and funding. Big investors want a profit first model, or in many cases, the funder wants a demonstrable model, but it requires capital to provide product samples to customers.
- Compared to plastics, the textile waste problem has not been formally acknowledged or reached wider acceptance.
- India has a different set of problems than other countries, so having local solutions to local problems make sense. Not only because the logistics are easier, but also for cultural factors.
- India has recycling embedded in our industry, and there is an opportunity to make use of that. There are local small-scale recyclers everywhere.

Interviewee #5

Upcycling brand

- Traditional Indian quilting originally came from upcycling. There are different styles of quilting across the country. People may save and collect old clothes in their home and layer them over to make quilted blankets.
- The model that is used is a partnership with NGOs focused on livelihoods. Together with the NGOs, they conduct craft training, which powers the production of upcycled crafts and, in return, creates jobs. When introducing a new product, there needs to be another cycle of training and quality control.
- A challenge that comes in is that some NGOs are not accessible, so logistics are complicated to facilitate. Moreover, space constraints may also become an issue as the individual crafters work in their homes. Quality control also becomes a challenge because the output relies on the individual crafters.
- Individuals that they work with are happy to take the remaining waste and use it in their homes. It is used to stuff cushions, make their own blankets, put in dolls, etc.
- With upcycling, it is hard to scale and repeatability is challenging due to the varying materials that are taken in. Moreover, it is a process that takes time. On the other hand, it creates a "one of a kind" quality and highlights the beauty of the craft.
- From the consumer side, challenges arise from expectations regarding pricing, design, and quality. Additionally, there is a mindset towards products made from waste that holds a lot of people back.
- There are two types of brands: those that just want to get rid of their waste and those that are attached to their fabrics or want to monetise them. Smaller scale boutiques with 5–10 kilogrammes of waste often don't have solutions to their waste because they cannot sell it to anyone. Purchasers are looking for sellers that can offer hundreds of kilogrammes at a time. We try to partner with brands that we know have a similar wavelength.
- A system of stocking up quilted sheets is put in place so it can be modularly used for different

types of products.

- There are some markets that sell off cuts from large factories. We don't work with those because they have a ready market. There is, for example, a small-scale economy of tailors that buy these fabrics and make products to sell in their community. The small waste pieces fall through the gaps.
- The lack of proper pre-sorting of waste becomes a hassle. Even after proposing requirements, the fabrics that are received are often mixed with those outside of requirements. Though we make an effort to utilise as much waste as possible, some dirty, stained, or very synthetic fabrics inevitably end up in the bin.
- Everyone who's working with waste is really open to sharing and collaborating. I think the bigger impact is to have 10 different people doing different things that support each other, rather than 10 people doing the same thing and competing.
- The affordability of an upcycled piece also needs to be considered. It's not necessarily even about liking or not liking, it's also about what you can and cannot afford.

Interviewee #6

Waste management organisation engaged in upcycling

- "We train and build the capacity of grassroots communities to develop solutions for many forms of waste, including textiles, as a way for them to generate income as well."
- Even though the industry in Panipat has been recycling products from textile waste, the output that is produced is not of fine quality.
- We do have our own networks of waste collection and distribution with textile manufacturers, local tailors, e-commerce companies, or individual donations.
- There are different channels where waste is collected. For a production order, it is preferable to source industrial textiles from companies we have built relationships with because they have larger amounts of waste and cuts of fabric. We also have a local network of grassroots recyclers, but they usually gather smaller pieces from smaller manufacturing units. Most factories are in clusters, so they go around the clusters collecting it.
- The challenges may come from the waste material supply. If there is less material than what is required, it will involve negotiations with the buyer and the collection of materials from additional sources. This is more of a challenge with bigger brands.
- The created waste-based products are mostly exported to the EU or the USA. The European market is still much more sensitive to sustainability and the social implications of the fashion value chain compared to India. India is also changing, and there is an audience, but it might take years to penetrate the masses.
- Domestically, challenges also apply for businesses to change their mindset and approach when placing orders and making payments (i.e., consignment model).
- For most new companies entering the waste space, sourcing becomes the biggest challenge. They have no idea where to source materials, let alone sorting and cleaning them. We have been handling end-to-end waste management and it is even too long for us to handle. You need companies specialising in each of the processes.
- The informality involved in this space, along with the players in it, also creates an unstable and political environment where laws are ambiguous.
- One organisation alone can only scale up to a certain point, it is only through the contributions and roles of other stakeholders that impact can be maximised. Especially with policymakers, as their role creates a basis for textile waste management in the country. As well as bigger companies who have the scale and audience to facilitate the change towards circularity,

B2. Summaries of secondary interview analysis

Interviewee #7

Recycled yarn manufacturer

- Has existing waste suppliers (imported) - relationships help increase predictability of input. Waste procurement is not done directly from the waste source, but via collectors or traders. They collect from many different waste sources and already have a network of buyers. Textile waste is mixed with many different wastes from factories (e.g. plastic wrappers, floor waste).
- In India, large part of waste transactions are cash based. If you want to set up a proper, legal, and documented system, you might face resistance from waste players, especially smaller ones.
- Waste collection from factories (i.e., pre-consumer) already has an existing system. There is no problem with it. There is a system in place to sell the waste.
- When a waste generator says that they need traceability or transparency, it might not reflect their actual interest in it (saying vs. doing).
- Small factories have lower demand because logistically it is a hassle to collect smaller quantities. Meanwhile, bigger ones that generate a lot of waste have a lot of demand and have systems to sell their waste.
- A waste generator or collector would try their best to create monetary value out of their waste before throwing it into landfills.
- There are different hierarchies of recycling waste; recyclability depends on: 1) cleanliness, 2) composition. First it is assessed whether it can be made into yarns or fabrics, otherwise it is made into shoddy. Landfill is a last resort.
- Composition plays a major part. In Europe, you might find more people wearing cotton and wool; in India, clothes made from synthetic filament yarns are prevalent, which are [currently] not recyclable.
- There is a big demand for cotton, especially pure cotton. It is a low-hanging fruit. Many do not want to work with blends because chemical recycling is not possible, while mechanical recycling has limitations – its output is always blended because the fibres cannot be separated.
- A proper waste collection, segregation, and sorting system becomes a prerequisite for effective recycling.
- "We are interested in working with waste as long as someone is willing to buy the recycled output. We have been left high and dry by brands. After processing their waste into yarns, the output is "not workable" by the brands."
- The recycling output is usually bought by brands but not directly. They would direct their manufacturers to buy The majority is sold outside of India.

Interviewee #8

Recycled fabric weaver

- Weaving techniques do not emit CO2 emissions because they are not dependent on any fuel. Weaving recycled yarns is a bit different with virgin yarns.
- There is some amout of waste that comes out of the process (100-200 grammes) and it can be collected and made into carpets.
- When using recycled yarns, dying is not required, thus water is conserved. The sourced recycled yarns are sourced from post-production post-consumer waste. After that, they are shredded and segregated by colour, then turned into yarn. Post-consumer yarns are coarser than post-production.
- [Mechanically] recyling waste into yarns requires blending in some amount of virgin materials (in this case polyester) to give it strength when spinning.
- At the start of building the business, it involved a lot of trials with yarn suppliers. Sourcing the correct yarn supplier is a challenge because not many are producing recycled yarns or can provide recycling certificates.
- Customers are mainly independent designers or small brands, domestic and international.
- Educating customers about the characteristics of recycled yarns is also a big challenge, the expectations of virgin materials cannot be applied.
- There is a database of handloom societies in Karnataka. There are looms and there are weavers, but there is no work and they don't have access to the market.
- Consumer awareness is very different in India, where price is still the deciding factor. Many people are still clueless about sustainability or sustainable products. There is only an initial segment who understands and buys them.
- The entire textile waste value chain is very fragmented. There is a disconnect between yarn producers, fabric producers, the government, etc.

Interviewee #9

Garment manufacturer

- Operates from xx factories and produces xx tonnes of waste per month. xx% of them are 100% cotton, and the rest are blended and sometimes denim. [Numbers are confidential]
- The waste is predominantly in the form of cutting waste, below 30 cm. The waste from auto cutting will be wider.
- There are a lot of collectors of waste that segregate and send it down the supply chain. However, most of it is not visible. Tier 2 waste collectors are not disclosed by Tier 1 waste collectors (the direct collectors) due to worries of competition. They say that 100% of the materials that they pick up are being utilised.
- "When people introduce "professional" and more sustainable innovations, we are open to helping, but ultimately the question is: will it give any benefits in terms of revenue?"
- "We want to bring in professionals who can make good end products from waste, so it can create a win-win situation for us."

- Those currently enaged with waste are labour-intensive and don't have much mechanisation. Waste segregation is done in a very broad way. If it is done properly, more value can be taken out of it. There are some people who can tell 100% cotton by its look and feel.
- Waste inventory turnaround is very quick, 3–4 days. Waste cannot be kept for long in the facility. Therefore, buyers for them need to be found. The bigger waste aggregators, who have more purchasing power, are buying the waste. There is negotiation on the pricing, then long-term agreements are made.
- Fluctuations in the markets create implications for the input side (suppliers) and the output side (waste collectors). Waste can be held off when its market value is down.

Interviewee #10

Garment manufacturer

- There is value in recycling, but it is made less by the amount of greenwashing that is happening (e.g., polyester from PET bottles creates microplastics). There is also manipulation in recycling certifications.
- "There is no awareness of sustainability across the board. Sustainability in itself is more of a buzzword."
- For the most part, recycling relies on supply and demand. Suppliers selling virgin also sell recycled.
- Until chemical recycling is implemented [at scale], the amount of energy that goes into recycling seems counterproductive versus using virgin.
- There are many activities of utilising (imported) waste but there is no transparency on the cost (e.g. carbon cost of shipping).
- The diversity of the production line creates a challenge for waste management; it changes every day.
- Cutting scraps is the bigger problem in terms of generating waste.
- There is a mechanism in place to reuse waste. There are formal and informal uses. An example of informal use is for mattress stuffing. Whereas an example of formal use is turning waste into upcycled products.
- The challenge with upcycled products would be consumer acceptance. It is hard to sell and produce at scale, which creates limitations. Consumers are happy to use recycled textiles, but not so much for upcycled textiles. Output quality is important from the consumer's perspective.
- "In a developing country, sustainability is more about survival than anything else."
- The waste generated in the production process is between x%, which would translate to xx metres a month. It is in various categories and grades. Similar ones are aggregatred. The waste coming out is being tracked per shipment (for profit and loss) but not on a holistic level. [Numbers are confidential]
- The generated waste is collected by individual scrap dealers who have been coming to the factories for many years. They pay for the waste, the price varies depending on the type. They come every month and take everything. So there is a system that works.
- Assumptions of what is being done with waste based on what the scrap dealers say: being sold, converted to garments, or to manufacturers in smaller towns. For smaller waste: into bags, kids' clothes, or mattress stuffing.
- The clients have no interest in products made out of production leftovers.
- The value of waste has come down considerably. The cost and labour used to be much lower. It is also because the availability of textile waste has increased.

Interviewee #11

Clothing brand

- [Post-consumer context] One of the biggest challenges for used garment collections is sorting by fibre composition. It is now done manually. Currently, only 100% cotton is utilised for recycling, but ideally it should extend to mixed fibres. There are technologies that exist to recycle them, but the sorting does not. The quality of input feedstock (cleanliness) also creates a hurdle, it affects both the recycling technology and the output quality.
- Recycling technologies exist in the market, although expensive and not at scale. Inconsistency of input volume also creates challenges in scaling.
- The challenge is that the ecosystem that enables the flow of materials from waste source to production does not exist. This requires collaboration within the industry, also with legislators.
- Ideally, the waste that is generated in India should be circulated within India.
- Making [circularity] happen requires good demand and pull from brands. The key is to send a signal to the market that there is a demand. Currently, the value [of utilising waste] is not being seen in the industry. Having just one brand pushing suppliers is not enough.
- There is no traceability of where waste actually ends up. There are several unnecessary steps in the value chain which do not add value to the waste but simply add to the cost. Some high-value waste streams also go downcycled.
- Chicken and egg situation: If the waste does not have value in the market, it does not get sorted as thoroughly, resulting in waste that cannot be utilised because it is not sorted.
- 100% cotton is high value. Many suppliers seek it but not for other types of waste.
- Downcycling reduces the value of materials, but certain materials have no other solution, so it becomes the best possible value that it can be channelled to.
- The capacity of suppliers needs to be enabled, such as by having industry guidelines in place.

Appendix C. Expert validation

C1. Approach

Participants

The expert validation sessions were conducted with five experts with practical expertise and knowledge of textile (waste) materials and its supply chain in India – from textile (waste) generation, waste management, to textile (waste) utilisation and consumption. Two sessions were organised: one with four experts, and another separate session with one expert.

Agenda

1. **Introduction** of the project and its aim
2. **Walkthrough** of the system map to facilitate and trigger discussion points on the gathered insights
3. **Wrap-up** to capture other general feedback

C2. Key discussion points

- The current system is driven by cashflow and there is no long-term perspective regarding the utilisation of waste. The orientation goes towards value equals money. The cashflow of the trader-driven market is a competitive advantage for waste collectors but also for new players to come in.
- The cashflow behind waste collection from garment manufacturers is quite official (e.g. involving invoices). Most of the large manufacturers have long-term trading agreements with the "fairly formal" waste collectors. Individual waste workers or smaller ones lose out on access to waste because of these long-standing relationships.
- Manufacturers don't just produce fabric waste; there is more waste output that they are not specialised in handling. The waste that is perceived to not have recycle value is the kind of materials that nobody comes looking for.
- There is no organisational structure, not from the government either, and no guidelines to deal with different kinds of waste. However, bigger companies are more structured and regulated in their waste management, and improper activities may be penalised. At MSME level, there are grey areas when it comes to handling waste, and it is a very big problem. Especially in industrial areas where there is no resale of waste, textile waste is often burned.
- The amount of pre-consumer waste that's turning up is mostly from the small and medium. For MSMEs, the pressure to get rid of waste is much greater because of cost, but they don't have the network for waste collection.
- The system is designed to discourage traceability. It is due to competitiveness and intentional hiding. A manufacturer may share information on their Tier 1 waste buyer, but not disclose the lower tiers and the price that they are selling for. Transactions might be half recorded and half cash-based.
- There is still a low incentive to tackle waste. Price also creates resistance to it. For example, technological innovations are an expensive investment which requires commitment, with no demonstration of its value yet.
- Waste management has different stakeholders in it: waste workers, waste management facilities, and material recovery facilities. From city to city, it is completely different.
- Material recovery facilities can not usually segregate multiple kinds of streams. The materials that they can't segregate are then put together into lower-valued applications (e.g. energy, brickets).
- Most of the waste goes back to the mill or goes back to carpets, cleaning wipes, or mattress filling. A large majority finds its way, not in the most circular way, but it does go to a solution. There is a disparity between what is seen on the ground and what should technically be the case [in regards to circularity].
- India has moved rapidly from being zero waste to having everything at its disposal, and it needs to adjust to this culture. There is a mindset that says the more you waste, the wealthier you are.
- There is a lot of demand for using recycled materials, even domestically, from both manufacturers and customers due to heightened consciousness. Manufacturers are seeking to source recycled materials, but there is not yet a supply chain that is robust and easy to access for these materials.
- The textile industry is under immense pressure trying to do something which is immediately a next-step problem rather than a solution. Everybody wants a piece of the sustainability story, and they are looking at the lowest hanging fruit. Now, problems in one industry are bleeding into another. For example, recycled polyester from rPET might result in ocean pollution. But brands continually sell a sustainable story.
- Environmental indexes may also create false justification that recycled polyester is sustainable. If you are producing for an international brand, there are a set of certifications and regulations that manufacturers have to comply with.
- Recycling blended materials is currently not done at scale. It may be extended by giving it some new lease, but not necessarily brought back into the loop.
- The sphere of influence that brands have over manufacturers may be a myth, except when they actually own control. However, over small scale manufacturers, they still have all the stake.

Appendix D. Barriers and drivers of value creation

D1. Barriers of value creation

Hard factors	**Technical**	Technical limitations in producing higher quality recycling outputs (nearer-to-virgin)
		Volume and speed limitations for labour-intensive value creation methods
		Technology-specific requirements for waste input
		Lack of technical knowledge on waste utilisation and waste management resulting in suboptimal waste utilisation
	Economic / financial / market	Waste-based products are more expensive compared to virgin-based products
		Mismatch in perceived quality and consumer expectations
		Competition and intellectual property around waste
		Dependency of value creation process and output on waste input supply
		Dependency on imported waste due to volume, quality, and accessibility
		Low domestic purchasing power for waste-based products
		High investment cost in more advanced machinery
Soft factors	**Institutional / regulatory**	Textile and waste management economy that is largely operating informally
		Low transparency of waste flow, creating low traceability
		Lack of robust domestic textile collection and aggregation system
		Limited regulation on textile waste production and management
		Lack of government support for existing value creation activities
Soft factors	**Social / cultural**	Complacency to current suboptimal solutions to waste
		Consumerism culture exacerbated by fast fashion
		Perspective that circularity is not aligned with profitability
		Negative beliefs and low perception around the value of waste
		Circularity not being put as a core concern or business driver
		Lack of contextual understanding on circularity, creating misconception and negative practices
		Short-termism in approaching textile waste problem
		Lack of (shared) responsibility for waste

D2. Drivers of value creation

Hard factors	**Technical**	Local expertise in repurposing waste through crafts
		Developments of value creation and waste management technologies
		Established mechanical recycling sector
		High adoptability of low-tech or low-resource value creation activities
		Prevalence of frugal innovation approaches
	Economic / financial / market	Inherent economic drivers that encourage value creation and discourage landfilling or open-air incineration
		Resource depletion and increasing raw material prices
		Volatility of cotton production
		Growth of sustainability-driven players
		Price competitiveness of waste-based products in international markets
		Growth of sustainable investments in India
		Growth of demands for sustainable products
Soft factors	**Institutional / regulatory**	Waste regulations for higher-tier manufacturers
		Regulatory pressure for international brands indirectly affecting their outsourced production in India
		Strengthened waste management due to extended producer responsibility policies for other materials
	Social / cultural	Prolonging the use of materials is rooted in the culture
		Increased environmental consciousness from both consumers and industry players

Appendix E. Creative brainstorming sessions

E1. Agenda

Participants

The creative brainstorming sessions were conducted with four internal participants (Enviu employees) and five external participants (experts from the insight validation sessions), in separate sessions.

Agenda

1. **Sensitisation**: An introduction deck sent via e-mail
2. **Problem immersion**: Walkthrough of the system map
3. **Problem-as-Given ideation**: Capturing ideas on salient "problem areas"
4. **Problem-as-Perceived ideation**: Capturing ideas on possible interventions using HMWs

E2. Introduction / sensitising deck

1

Excited to have you involved in the project!

This document provides an overview of the project and its findings, which should provide you with some context prior to our upcoming session.

It is also available on the Miro board that we will use for the session.

Thanks for reading and looking forward to meeting you!

2

About the project

Hi, I'm **Mutia**, a Strategic Product Design student at TU Delft. I'm currently working on my graduation project with Enviu.

My graduation project focuses on **value creation of textile waste**, where I explore opportunities to create value from textile waste to decrease the amount of waste going to landfills or incinerators.

It is part of the "Putting Waste to Work" project in collaboration with GIZ, Concordia Textiles, and PurFi Global.

Project goal: *Developing a tool/guide/communication means for..*

Research scope

- Value creation from textile waste
- Domestic, pre-consumer waste from the garment manufacturing process
- Putting more focus on pure cotton, cotton rich, pure cotton denim

3

Goal of the session

At the moment, I am wrapping up the research phase where I map out the waste value creation ecosystem.

Involving people who are familiar with the industry would be very valuable for me to:

1. **Validate my research findings** and fill in my knowledge gaps
2. **Gather ideas on areas where the solution could focus on** and the stakeholder/problem it could address

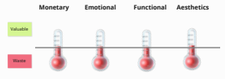
Project approach: design + systems thinking

Session agenda
(1 hour session)

1. **Introductions** Quick overview of the research findings
2. **Input session** Gathering input on the research findings
3. **Brainstorm session** Ideation on areas where the solution could focus on
4. **Wrap-up**

4

💡Things I found interesting along the way



"Waste" is in the eye of the beholder

Stakeholders ascribe different **values** and **motivations** to textile "waste". Some see a certain material as valuable, some do not see value in it.

Value mismatches and **value depletion rate** make the journey to landfill quicker.

Waste that no one has attached value to, gets landfilled. This also includes waste that is seen as valuable only in large quantities.

The textile (and recycling) industry is set up for the market it serves

Simple economics: the utilisation of waste is driven by **supply and demand**; which goes across the supply chain. Example: how waste is sorted is dependant on its market (e.g. recyclers)

This creates a chain of dependency that has not reached equilibrium. **High production of waste, low demand for waste-based products.**

Ignorance, misconception, inaction

Circularity is still at the **bottom of the agenda** for most, which is not only attributed to ignorance, but a myriad of internal & external barriers. Even those who do talk about it, are oftentimes **not on the same page**.

It is inherently human to have a limited capacity to grasp **complex concepts** such as circularity. And we're not talking about the complexity and hidden layers of the textile industry in India yet.

5

About the research process

I started the research by gathering information via desk research, as well as interviews with industry stakeholders.

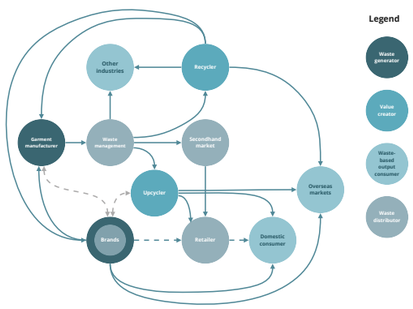
I further mapped out and analysed these information, by focusing on:

1. **Key stakeholders in the value chain**: their activities and the dynamics between them
2. **Barriers and drivers** that are present in the system in regards to circularity and waste value creation.

The following slides summarise the key findings from the research phase. For a more detailed snapshot, feel free to browse through the Miro board.

Stakeholders and waste flow (simplified)

Context: Value creation chain of garment manufacturing waste in India



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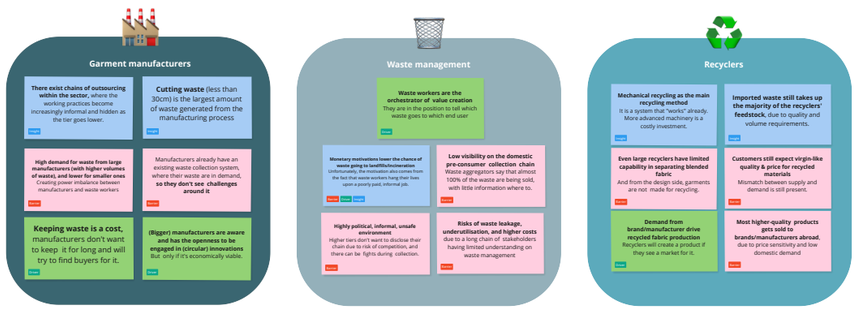
Key findings – Part 1

Insights, barriers, drivers towards circularity



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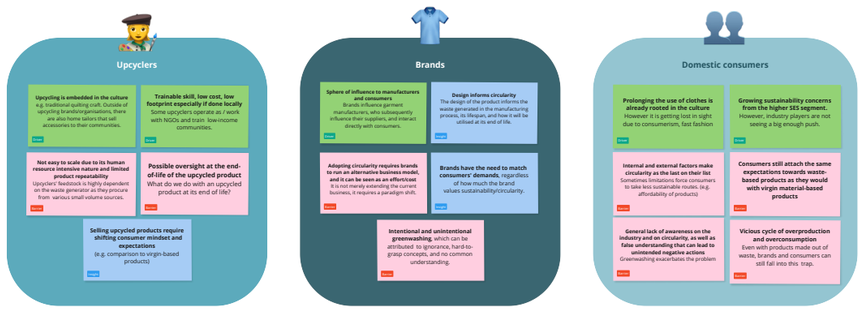
Key findings – Part 2

Insights, barriers, drivers towards circularity



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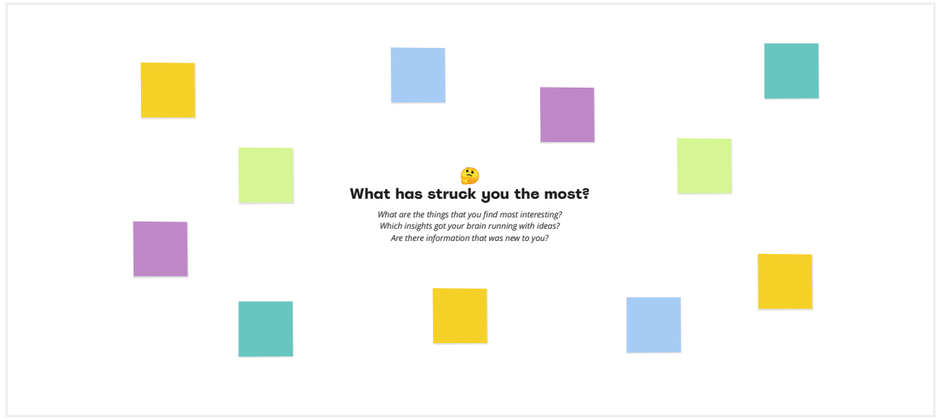
Key findings – Part 3

Insights, barriers, drivers towards circularity

E3. Idea generation

The following boards were used to facilitate idea generation activities after the problem immersion phase (presentation of the introduction deck and system map).

1



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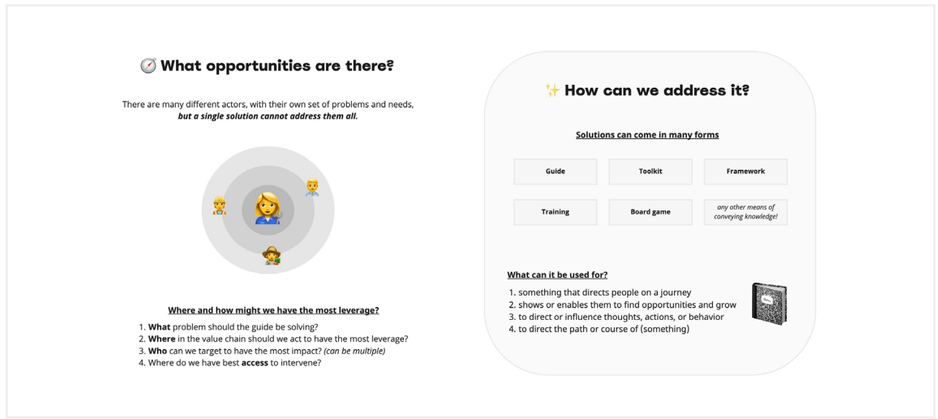

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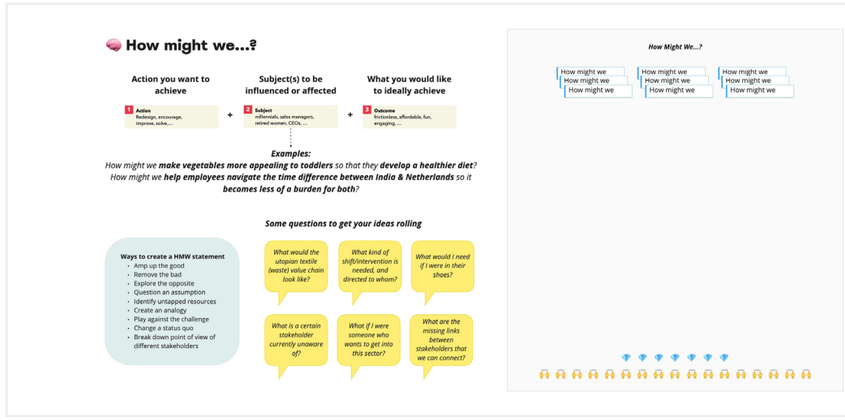


E4. Mapping of ideation outputs

Events

Evidence, symptoms

Overproduction

overproduction

High volumes of textile waste (being burnt)

Manufacturers in industrial areas without waste resale just burn waste, causing harm to its surroundings

Patterns / trends

Rules, practices, doctrine, and tactics, techniques, & procedures (TTPs)

The focus on "surface-level" problems and actions

The industry is under pressure and players are jumping on the bandwagon yet grabbing the low hanging fruit

Plastic might not be the most unsustainable material, but how we use it is unsustainable. So it's more about the action. Even in that sense, any natural fiber can also be very unsustainable.

Harmful practices due to false / lack of understanding of circularity

Brands are hopping on the bandwagon but not necessarily trying to transform their business practices, half of them are lost

Indexes / impact measurements can falsely justify that an action is sustainable (i.e. recycled polyster)

downcycling perfectly recyclable/useable waste

Factories don't just produce fabric waste, there are more things which they are not specialised in handling

Challenges and deception in marketing circular products

marketing circular products: useful to market it as circular or not?

Lack of guideline or best practices in utilising waste

Waste utilisation not yet defined: where waste goes, in what fraction, to what use

Economic-driven business practices

What would be a positive motivator for a business to change to sustainable practices? Good working capital

The waste collection system is a trade-driven market where cash flow is a huge advantage

Shift in consumption practices

The country have moved very rapidly from being effortlessly zero waste to everything at our disposal and we are not used to of this culture

Lack of waste transparency

The WM system is designed to discourage traceability and access

Structures

Organisations, laws, authority, relationships

Limited regulation on waste generation and management

MSME factories operate in grey areas because their waste is less regulated, and it's a big problem

Disorganised waste management infrastructure

There is no organised structure that informs how to deal with different kinds of waste

Handover of waste issues to and from the textile industry

The problem in the textile industry is also bleeding into another industry

[in regards to waste] the textile industry should be declared as a self-taking-care industry, like many other industries

Supply chain gaps for recycled materials

Demand for recycled materials from brands and consumers, but no supply chain that is robust and easy to access for Indian brands

Lack of incentive to handle waste

No incentive in dealing with waste (especially financially) across the value chain

Brand-manufacturer power dynamics

brands do not have power on big manufacturers anymore

Mental models

Beliefs, traditions, assumptions, values

Lack of awareness on the waste issue

lack of awareness toward this issue to the wider public

Prevalence of linear production- consumption paradigms

The love towards virgin plastics they love towards ufs, white bleached fabric, it's not helping upcycle goods to reach their maximum capacity.

Lack of value attributed to waste-based products

How do you convince buyers to still see the value in in a product which is not completely come to end of its life. And also, how do you add emotions and sentiments to these products?

Today we do not see upcycle product as high value (ie. haute couture). Need to change that that thinking perception. The most important thing is to create a culture where upcycling is not looked down.

Lack of value attributed to waste

lack of value allocated to waste

the lack of value on post manufacturing waste of <30cm

The way we have to look at waste is something that we need to change. Is waste actually waste? And what are the materials that can be recurved out of it? At each and every level. Best example is crude oil

Problem-as-given

Providing information or awareness to enable sustainable / circular actions

How might we make "invisible" workers visible to brands and consumers

How might we create a shared understanding of the problem of and solutions for textile waste for future sustainability professionals/brands

How might we... create a common pool of data about textile waste in India to enable informed action

Economically incentivising sustainable production-consumption practices

How might we economically create opportunities for each value chain stakeholders so they are more inclined to adopt circular practices (reducing / consumption) practices

How might we help brands and manufacturers keep products low-cost while being designed for circularity

How might we help brands sell sustainable products at the same scale/profit as fast fashion to customers

How might we economically incentivise consumers to change their purchasing behaviour to create a ripple effect for demand?

Encouraging waste transparency

How might we encourage waste generators to be transparent about ALL the waste they are generating

Putting circularity in waste management practices

How might we redirect waste workers to circular practices with circular solutions in mind

Developing best practices to manage waste

How might we develop a waste hierarchy that is contextual and modular so that industry can take it up easily

Reduction of waste generation as preventive measures

How might we improve textile production, in order to reduce the amount of production waste

Educating possibilities to utilise waste

How might we involve brand designers into the possibilities of post-production textile waste, leading to a branded assortment of products made from textile waste

Enabling cross-organisational collaboration in managing waste

How might we see the potential of cross collaboration

How might we enable the public sector to co-invest with the private sector in managing waste generated in industries

Building value chains that streamline circular actions

How might we create transparency in the quantity, quality and material mix of post production waste, so waste supply and demand can be streamlined and connected

How might we use technology to streamline this for us and greater a larger context

How might we create an out-of-the-box solution for brands to re-sell their post-production waste / re-use their own waste

Scaling the impact of existing circular solutions

How might we help upcycling brands achieve true scale (com / should upcycling even aspire to scale?)

Reforming the current waste management system

How might we create a resilient and just system for [waste management] workers?

Reducing negative externalities of waste solutions

How might we tackle the waste problem with recycling technologies (or other solutions), without contributing to the waste problem. Giving value to waste might create more waste!

Shifting consumption practices through communication

How might we... communicate better in designing the right 'message' to increase the actual demand for sustainable production that appealing to the current production houses

How might we change the way we educate people around sustainability so that it is easier to grasp and create certain impact on how someone consume things?

Communicating the value of sustainability

How might we... 'communicate' the benefits of sustainability in each product to consumers for longer impact

Elevating the value of waste

How might we make people understand the value of materials and not to be treated as waste

How might we support yarn/fabric/garment manufacturers in seeing waste as a value based material

How might we create value for a product so revalue it to give my consumer the satisfaction for that product?

Aligning business drivers with circularity

How might we showcase that circularity is not (always) the more expensive option

How might we sensitize manufacturers to reduce their waste and showcase the (economic) value of their waste

How might we link the intrinsic drivers of businesses (demand, capital support) with sustainability?

Busting false and negative beliefs around sustainability

How might we bust myths around greenwashing and help "sustainable" brands not unintentionally greenwash

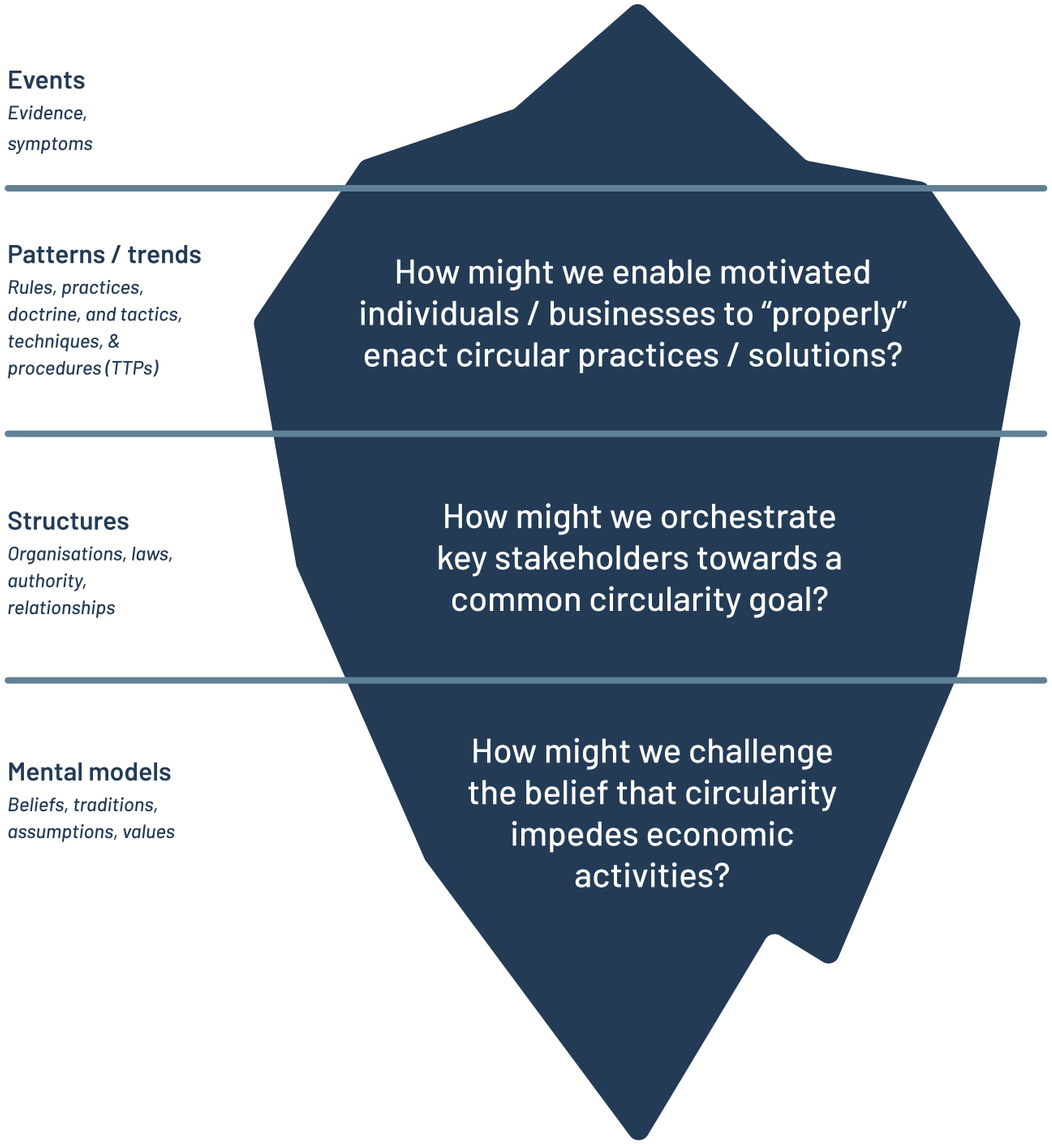
How might we market circularity as a necessity rather than a 'niche' -market

Breaking the perception that waste management is difficult

How might we (w) show that scaling waste management is possible and easy?

Problem-as-perceived

E5. Design direction options



Appendix F: Card sorting activity

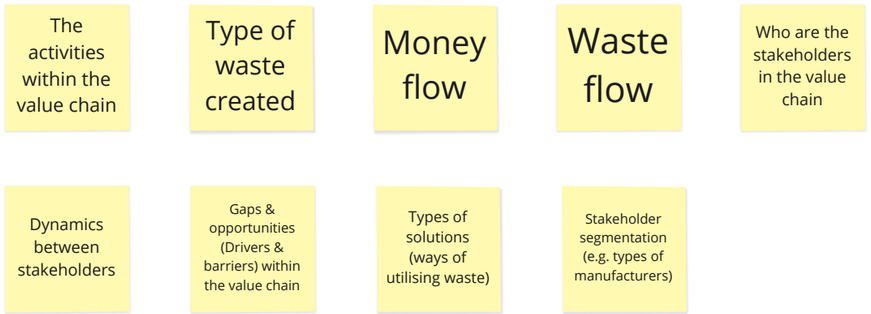
F1. Tool & approach

The card sorting activities were done in-person with four participants and online with one participant, using Miro as a facilitation tool. Participants were presented with the below post-it cards and were asked to rearrange, group, highlight, or order the cards. Additionally, participants were invited to add information that they would find relevant yet had not been provided in the default card set.

The following question was asked as a prompt: *"If you want to create a circular solution related to textile waste in India, what information would you find the most necessary?"*

Default card set

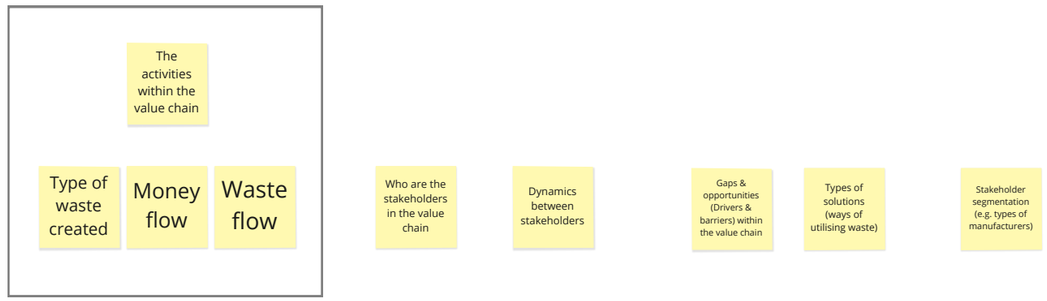
Types of information gathered in the research phase



F2. Results

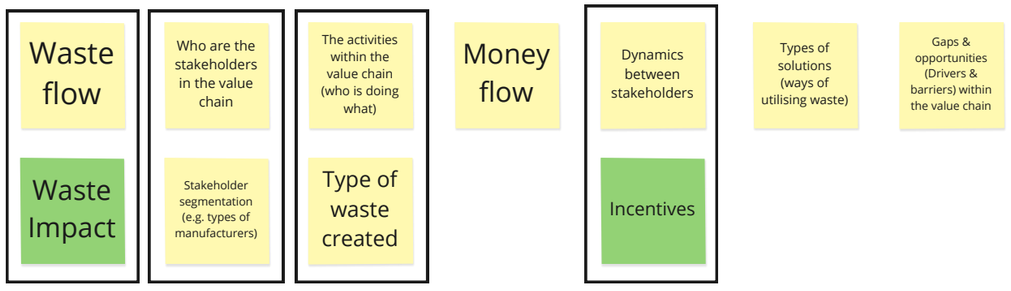
Participant #1

TU Delft student, MSc Complex Systems Engineering



Participant #2

TU Delft student, MSc Strategic Product Design

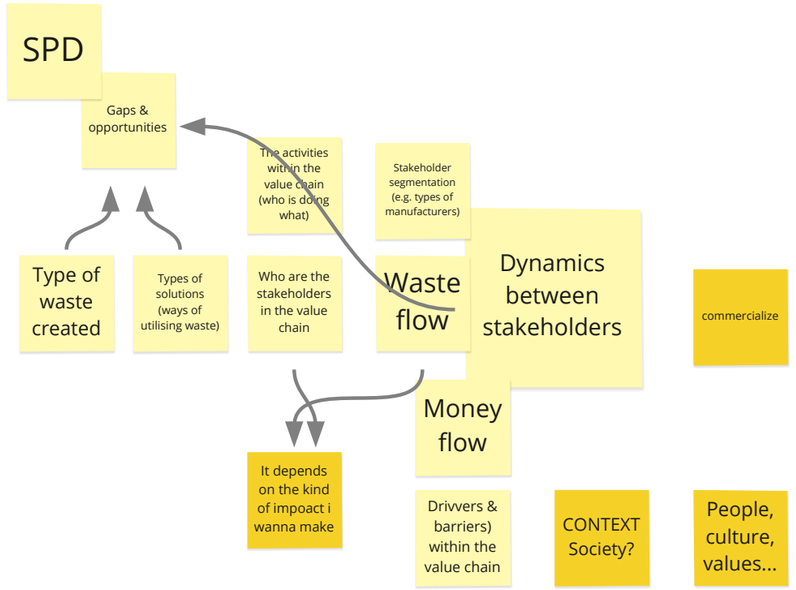


Participant #3

TU Delft student, MSc Strategic Product Design

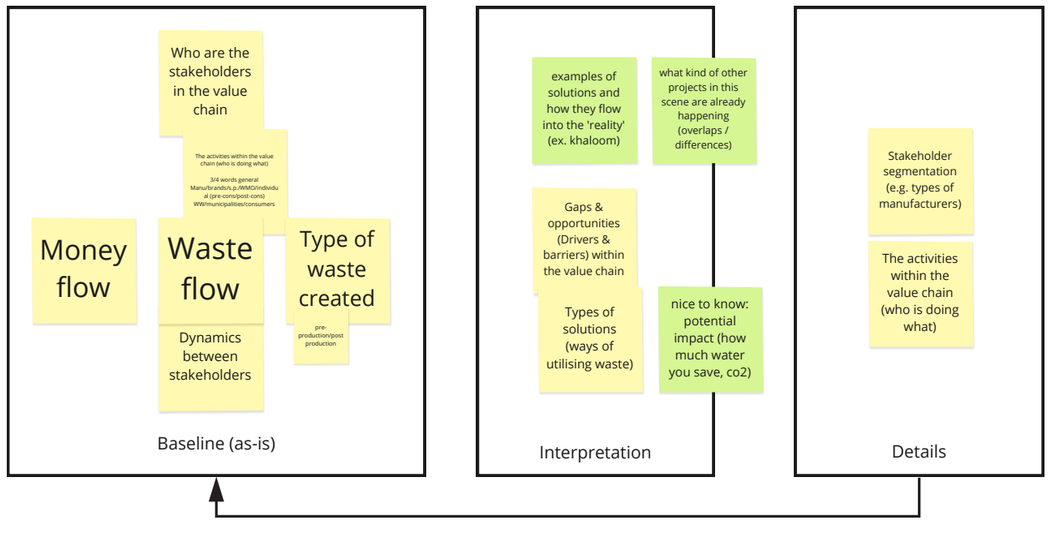
Participant #4

TU Delft student, MSc Strategic Product Design



Participant #5

Associate Venture Builder at Enviu



Appendix G. Evaluation sessions

G1. Evaluation plan

Evaluation Plan
Note: The Ps correspond to the questions' level of priority; the lower the number, the higher the priority of the question

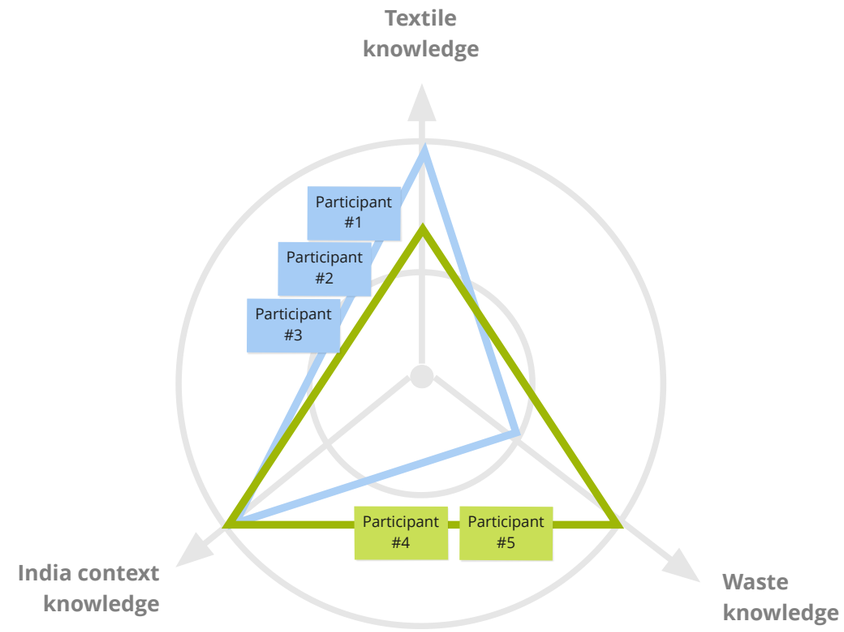
Questions to be answered
1. **[P1] Problem understanding**: Does my remote research reflect what is happening on the ground?
2. **[P0] Problem-concept fit**: Does the concept facilitate the user* in coming up with solutions for textile waste? (*User: existing & potential value creators*)
3. **[P0] Design principles**: From the perspective of the users, does the tool fulfil the design principles?
    - Scalability principle is not evaluated as it is a non-functional principle

Means of evaluation
1. **Problem understanding**: Observation and informal interview during visits to value creators' facilities
2. **Problem-concept fit and design principles**: prototype walkthrough followed by reflective questions

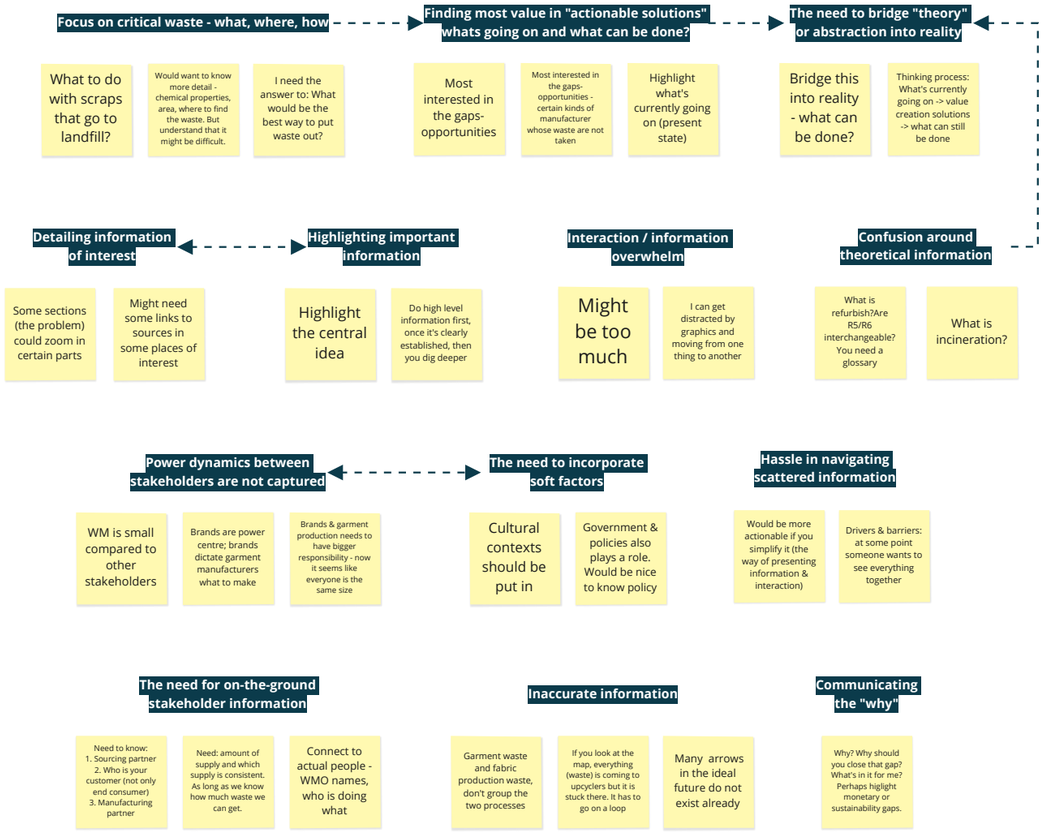
Evaluation scenario
1. **Introduction:** Introduction of the goal of the session and the developed prototype
2. **Preliminary interview**:
    - How are you involved with textile and/or waste?
    - Based on your experiences, what is your observation towards the current state of the textile waste management in India?
3. **Walkthrough**
    - Facilitated walkthrough of the flow of the prototype while inviting participants to click around and think out loud.
4. **Wrap-up**
    - First impression / general remarks: What is your impression ? Any feedback?
    - What kinds of use cases do you see this tool could being suitable for?
    - **Design principles**: On a scale of 1-10, how much do you agree with this, and why?
        - The information provided is **understandable** and easy to follow
        - The information provided is **relevant** and **useful** for my needs
        - This tool helps me to take **action** in developing textile waste solutions

Potential limitations
1. Schedule conflicts & time limitations
2. Participants' willingness and availability

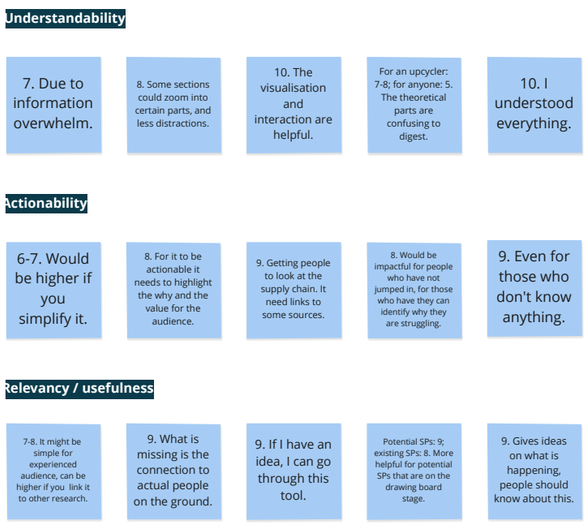
Participants
Existing value creators engaged in different means of value creation and varying degrees of knowledge.



G2. Clustered insights



Design principle scores



Appendix H. Project brief

DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Khairunnisa
initials: M. given name: Mutia
student number:
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):
IDE master(s): ( ) IPD ( ) Dfl (1) SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ( ) Honours Programme Master
specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Dr. Holly McQuillan dept. / section: SDE / MF
** mentor: Prof. dr. ir. Jo van Engelen dept. / section: SDE / DfS
2nd mentor: Jiska Coppoolse
organisation: Enviu Foundation
city: Rotterdam country: Netherlands

comments (optional): Holly has a research focus on sustainable textile materials and systems, while Jo's expertise lies in integrated sustainable solutions and business development. Both areas will become relevant in the graduation project.

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

TU Delft

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair Dr. Holly McQuillan date 09 - 02 - 2022 signature

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC
Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC
List of electives obtained before the third semester without approval of the BoE

★ YES all 1st year master courses passed
○ NO missing 1st year master courses are:

name K. Veldman date 25 - 02 - 2022 signature Kristin Veldman Digitally signed by Kristin Veldman Date: 2022.02.25 09:58:48 +01'00'

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ★ APPROVED ○ NOT APPROVED
Procedure: ★ APPROVED ○ NOT APPROVED
comments

name Monique von Morgen date 15 - 03 - 2022 signature

Personal Project Brief - IDE Master Graduation

TU Delft

Circular waste management strategy for textile waste in India project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple.
Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 21 - 02 - 2022 08 - 07 - 2022 end date

INTRODUCTION **
Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The textile industry has a significant detrimental impact on the environment due to the large amounts of waste it generates from production to post-consumption (European Parliament, 2021). As the second-largest textile producer and the largest cotton textile producer worldwide, India is one of the countries most affected by this negative impact. At the same time, the local waste infrastructure in India is highly informal and fragmented, resulting in a lack of proper waste management (Gidwani, 2015). In consequence, a considerable portion of textile waste gets landfilled, damaging soils and emitting hazardous gases. This highlights the urgency to minimise the negative impact of the textile and garment industry by challenging the current linear "take-make-waste" system.

This issue is what Enviu aims to address through one of their programmes, Reweave. Enviu is a not-for-profit organisation that accelerates systemic change by building and supporting innovations that improve livelihoods and the environment. With the Reweave programme, Enviu aims to build a scalable and inclusive textile waste value chain that can contribute to the reduction of landfilled waste while creating better labour conditions in India. The programme itself is brought up alongside several partner organisations such as the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Circular Apparel Innovation Factory (CAIF), and IKEA Foundation.

The Reweave programme has recently established a textile sorting centre in Chennai, India that collects and sorts pre-production, post-production, and post-consumer textile waste. For its next development phase, the programme intends to explore feasible means to repurpose the collected textile waste so that circular value chains can be extended downstream from the sorting centre. In parallel, the programme aims to identify industry players that can create value from the textile waste – referred to as solution providers – since these organisations possess valuable knowledge and skills of certain manufacturing processes and materials yet are currently operating in silos.

This presents a possibility for the graduation project to conduct research on approaches to generate value from textile waste and identify opportunities to further develop circular value chains within the Reweave programme. The project will primarily be conducted from the Netherlands, with plans to carry out field research in India. As a contingency plan due to the COVID-19 situation, Enviu teams in the Netherlands and India, as well as partner organisations of the Reweave programme will provide support for data and information collection.

References:
1. European Parliament. (2021). The impact of textile production and waste on the environment. https://www.europarl.europa.eu/news/en/headlines/society/20201208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographic
2. Gidwani, V. (2015). The work of waste: inside India's infra-economy. Transactions of the Institute of British Geographers, 40(4), 575–595.
3. Nakatani, J. (2014). Life Cycle Inventory Analysis of Recycling: Mathematical and Graphical Frameworks.
4. Sarkis, J. (1995). Manufacturing strategy and environmental consciousness. Technovation, 15(2), 79–97.

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Personal Project Brief - IDE Master Graduation

TU Delft

introduction (continued): space for images

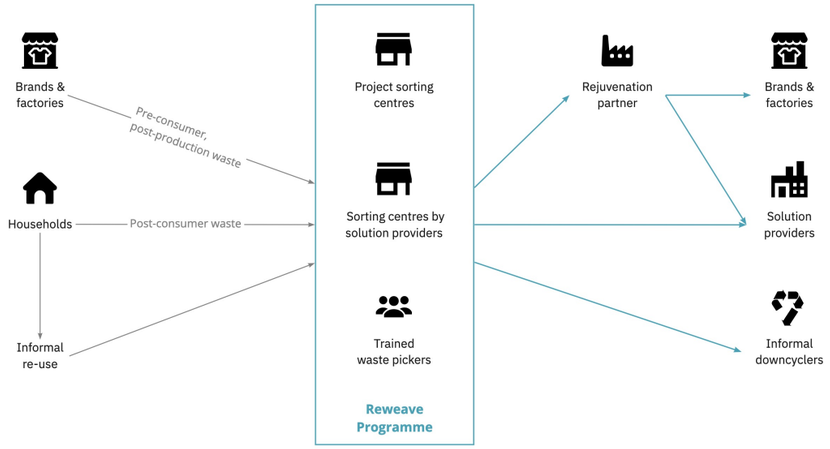


image / figure 1: Project context

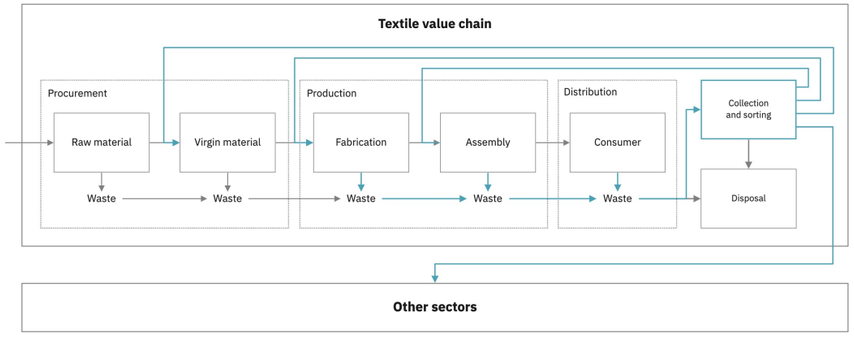


image / figure 2: Overview of project scope – adapted from Nakatani (2014) and Sarkis (1995)

Personal Project Brief - IDE Master Graduation

TU Delft

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The graduation project will explore solutions to generate value from pre-production, post-production, and post-consumer textile waste in India, which the Reweave programme could further implement into circular textile waste value chains. It will be approached by linking conceptual models on circular economy with a systems analysis of textile waste streams and materials. The project will focus on the context of textile waste in India, where the established textile sorting centre in Chennai will provide insights to develop the research further. Furthermore, it will identify approaches that can be taken to close resource loops, by taking the degree of circularity and impact into account. These findings will then be formulated into a circular textile model that provides a means to inform future strategies and evaluate potential circular options.

The project will expand on the circular model by exploring practical solutions to bring both use and economic values to textile waste. This will be achieved by integrating research findings with resources and knowledge of the system stakeholders, particularly the solution providers. The circular model and explored solutions will be conceptualised into a communication means (e.g. guide, toolkit) that describes potential circular approaches to generate value from textile waste. The communication means will provide guidance for the Reweave programme in developing new value chains as well as to serve as a capacity building tool for stakeholders within the programme. At this stage, the communication means suggested by the client is in the form of a guide. However, the project will further explore a form of communication that best suits the project goal and the needs of the audience.

In conclusion, the graduation project will address the following research question: What circular strategies and approaches are feasible for maximising and extending the value of textile waste?

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The graduation project will investigate circular solutions to generate value from textile waste and identify industry stakeholders to whom the Reweave programme can expand its circular value chain. The project expects to deliver a circular textile model and an actionable communication means (i.e. guide, toolkit) that can provide guidance for the Reweave programme in building new circular initiatives, value chains, and partnerships.

The graduation project will involve the following activities:

1. Investigating relevant frameworks and conceptual models
   - Literature review on circularity frameworks and models
   - Research on (circular) textile processes
2. Understanding the system and practical context
   - Context research on India and the textile sorting centre in Chennai
   - Analysis of system stakeholders, waste streams, and its dynamics
   - Identification and interview with potential solution providers
3. Designing a circular textile model
   - Circular flow mapping within the value chain
   - Assessment of gaps and opportunities within the ecosystem
4. Developing solutions to repurpose textile waste
   - Analysis of resources and capabilities of potential solution providers
   - Co-development of possible solutions to generate value from textile waste
5. Conceptualising communication means
6. Validating and iterating the solution concept

Initials & Name M. Khairunnisa Student number

Title of Project Circular waste management strategy for textile waste in India

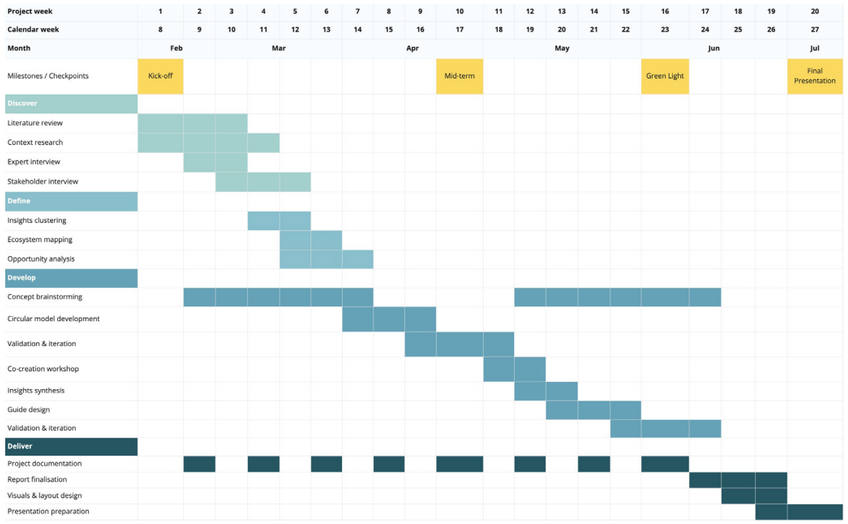
Personal Project Brief - IDE Master Graduation

TU Delft

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 21 - 2 - 2022 8 - 7 - 2022 end date



The graduation project is planned to be completed over the course of 20 full-time weeks or 100 working days. On the timeline above, the project is structured linearly into the four phases of the Double Diamond framework: Discover, Define, Develop, and Deliver. However, to accommodate the dynamic nature of design projects, activities of concept brainstorming & idea development will be integrated throughout all phases.

Context research is planned to be conducted partially remotely, and if the situation allows, in conjunction with a field study in India. Furthermore, the Develop phase will incorporate two cycles of iteration and validation. In terms of project delivery, project documentation and report writing will be done on a bi-weekly basis to ensure incremental progress and quicker feedback loop.

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

It has always been a personal aspiration of mine to create a positive impact for others, particularly when it comes to important issues in society. My studies at TU Delft have been a formative experience that broadened my understanding of complex societal challenges and the approaches we may take to address them. Through a range of sustainability-related projects at the university, I developed a better understanding of the subject. In addition, I gained a better understanding of social issues, particularly those affecting the global south. Throughout the process, I realised that within this increasingly interconnected world, these complex problems call for systemic and collaborative solutions.

Moving forward, I would like to explore approaches that I can adapt to address higher-complexity issues and apply them in practice. Moreover, I would like to strengthen my capacity as a strategic designer, especially in the areas of organisational and systems-level design. The graduation project serves a fitting opportunity for me to dive into this area and develop my desired skills.

On a more personal level, working with an impact-driven organisation such as Enviu allows me to take a step towards my intended career path and personal aspirations. By uncovering strategies to shift the textile industry towards a more circular direction, the project could hopefully serve as a starting point towards a more positive societal change.

In essence, the graduation project would be an avenue for me to hone the following competencies:
1. Developing in-depth knowledge of circularity in the context of the textile industry
2. Applying methods and practices to tackle complex problem contexts
3. Capability to link literature with practical insights to deliver implementable design outcomes
4. Independently organise a structured research project and manage stakeholders

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.