Sourcing in a Circular Economy – It's all about Relationships – How different levels of supplier integration are leveraged by apparel brands to realise circular design principles

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BSC	Buyer-supplier collaboration
CE	Circular Economy
cf.	Confer/conferatur (Latin), *compare*
CSR	Corporate Social Responsibility
DV	Dependent Variable
CDP	Circular Design Principles
EMF	Ellen MacArthur Foundation
et al.	et alii
e.g.	exempli gratia, *for example*
etc.	Et cetera (Latin), *and so forth*
GDP	Gross Domestic Product
i.e.	Id est (Latin), *that is (to say)*
IV	Independent Variable
LCA	Life Cycle Assessment
Mgmt.	Management
NRBV	Natural Resource-Based View
p.	page
pp.	pages
RBV	Resource-Based View
rRBV	Relational View
SCM	Supply Chain Management
SDG	Sustainable Development Goal
S&P	Sourcing & Procurement
UN	The United Nations

Abstract - English

While the circular economy literature widely points to the importance of collaboration within value networks, the concept provides little guidance on structuring collaboration and how collaboration, in turn, leads to circularity. Specifically, the role of buyer-supplier collaboration in achieving circular design principles in the context of product development remains underexplored by scholars, both theoretically and empirically.

This thesis examines how different levels of supplier integration are leveraged by apparel brands to realise circular design principles. Relying on a multi-case study approach with typological theorising, I evidence how greater buyer-supplier collaboration measured as the level of supplier integration (frequency of interaction, sharing of resources, joint planning and decision-making, and respective roles and responsibilities) leads to the realisation of more circular design principles compared with lower supplier integration.

Abstract - Deutsch

In der Literatur zur Kreislaufwirtschaft wird zwar häufig auf die Bedeutung der Zusammenarbeit innerhalb von Wertschöpfungsnetzwerken hingewiesen, das Konzept bietet jedoch nur wenig Anhaltspunkte für die Strukturierung der Zusammenarbeit und dafür, wie die Zusammenarbeit wiederum zum gewünschten Ergebnis der Kreislauffähigkeit führt. Insbesondere die Rolle der Zusammenarbeit zwischen Unternehmen und Lieferanten bei der Verwirklichung von Prinzipien des kreislauffähigen Designs im Kontext der Produktentwicklung ist sowohl theoretisch als auch empirisch noch nicht ausreichend erforscht.

In dieser Arbeit wird untersucht, wie verschiedene Stufen der Lieferantenintegration von Bekleidungsunternehmen zur Umsetzung von Prinzipien des Kreislaufdesigns zur Anwendung gebracht werden. Anhand eines Fallstudienansatzes mit typologischer Theoriebildung zeige ich, wie eine intensivere Zusammenarbeit zwischen Unternehmen und Lieferanten, gemessen am Grad der Lieferantenintegration (Häufigkeit der Interaktion, gemeinsame Nutzung von Ressourcen, gemeinsame Planung und Entscheidungsfindung, jeweilige Rollen und Verantwortlichkeiten), im Vergleich zu einem niedrigeren Grad der Lieferantenintegration zu der Umsetzung von mehr Kreislaufdesignprinzipien führt.

1 Introduction and Background

1.1 Background and Relevance

‘Circularity as the new normal’ is the title of a recent joint report by WWF and PWC and is one of many increasingly insistent calls for a resilient (PwC & WWF, 2021) economic system that respects planetary boundaries – the ‘safe operating space’ for human development on earth (Rockström et al., 2009). The circular economy is a promising meta-theoretical concept that has gained immense traction in academia and practice over the last five years. While inspiring, to practitioners it often appears dogmatic and hard to implement (Balkenende, 2018). The underlying idea of the circular economy is centuries old, but as an academic field, it is still quite immature. Conceptual coherence and clarity have yet to emerge, as is the case for completely circular value chains beyond very limited scopes. Several previous studies on the implementation of a circular economy have focused on waste disposal issues without fully highlighting the primary reasons for the problems (Djuric Ilic, Eriksson, Ödlund, & Åberg, 2018).

Meanwhile, product development and the choice of materials significantly influence circularity, yet few models have managed to adequately connect product development, sourcing, and supplier relationships to specific circularity outcomes (Taticchi, Garengo, Nudurupati, Tonelli, & Pasqualino, 2015). Common challenges in feeding resources back into the economic loop (e.g., efficient disassembly, remanufacturing, and reuse) at the end of the product life cycle stem from failures in the initial product design (Sabaghi, Mascle, & Baptiste, 2016). The product development stage determines around 80% of a product’s environmental impact (European Commission, 2018), and once product

specifications – and with that, the resources, materials and infrastructure – and activities are defined, changes are usually complex or not possible (Tsoulfas & Pappis, 2008). Therefore, designing products with multiple life cycles in mind, following a set of so-called circular design principles, is an essential lever in achieving a circular economy (Lieder & Rashid, 2016). Existing research is yet to show how sourcing, supplier management and supplier relationships can contribute to improving an organisation or a value network's circularity and tangibly impact the realisation of circular design principles.

While the literature points to the importance of collaboration within a value network to achieve the transition to circularity, it provides little theoretical guidance on structuring collaboration (Brown et al., 2021) and how exactly collaboration helps organisations and their value chains become more circular (Brown, Bocken, & Balkenende, 2018). The relational view and its concept of buyer-supplier collaboration provide deeper insight into collaborative practices and their beneficial outcomes, yet there are three significant gaps:

First, the relational view is concerned how competitive benefits arise through at least one of four categories of relational rents (knowledge sharing routines, relationship-specific assets, complementary resources, effective governance) as a result of interfirm collaboration. It remains unclear how the realisation of circular design principles relates to the traditional relational rents – does it fall into one of the existing categories of relational rents or does it constitute a new type? Although in recent years some studies have investigated the benefits of buyer-supplier collaboration for general concepts of sustainability (Vachon & Klassen, 2006), a precise understanding of the mechanism how

specific collaborative practices influence the realisation of circular design principles is missing.

Second, both the relational view and the circular economy literature have been accused of ignoring transactional issues like opportunism and relationship dynamics (Faems et al., 2008). Buyer-supplier collaboration is typically thought of as a universally beneficial guiding principle for all types of relationships within value networks. Thus, the role of relationship dynamics needs to be considered when examining the effects of buyer-supplier-collaboration on the realisation of circular design principles. Additionally, it remains to be clarified whether there is an optimal level of supplier integration (the intensity in buyer-supplier collaboration) beyond which the outcome on circular design declines again.

Third, the concept of buyer-supplier collaboration was conceived in a linear supply chain understanding. Osterwalder and Pigneur (2010) originally described the value network as the way through which firms interact with their suppliers and reorganise their internal activities. But in the circular economy space, this understanding is frequently widened to include actors who are involved in, supporting, or affected by value creation activities, but not necessarily by moving goods or providing services (Brown et al., 2018). Furthermore, networks are, by definition, non-linear concepts that can more easily represent nonlinear or reverse chains, auxiliary actors as well as the collaborative notion (cf. Brown et al., 2018). Given this new understanding of how firms relate to each other in a circular context, the concept of buyer-supplier collaboration needs to be revisited, examining its applicability, and potentially adapting the concept.

In summary, the mechanism connecting buyer-supplier collaboration and the realisation of circular design principles is not adequately understood at a granular level. Granularity

in this context refers to the relevant collaborative practices, how they connect to the desirable outcome of realising design principles, how the outcome on circular design relates to relational rents, the role of relationship dynamics and the presence of any trade-offs when pursuing the implementation of circular design principles. As circular product design has as such a profound effect on overall product circularity, it is important – from both a theoretical and practical perspective – to obtain an in-depth understanding of the role and the effects of buyer-supplier collaboration during that stage.

When researching the circular economy, one is quickly confronted with the reality that while there are some common issues such as over-consumption and a lack of transparency in value networks, each industry faces a different set of challenges to a varying degree. Even within a certain industry, the most urgent issues might present themselves quite differently depending on the segment or geography. Consequently, the path to circularity will likely be context-dependent, including the guidance provided on buyer-supplier collaboration.

1.2 Research Question and Objectives

This study tackles the following research question: **How do apparel brands leverage different levels of supplier integration to realise circular design principles – increasing product integrity and product cyclability**.

Operating in the context of the circular design, I base my research on the relational view through the use of the concept of buyer-supplier collaboration. The level of supplier integration reflects the intensity of buyer-supplier integration: Low levels of supplier integration equal low-intensity buyer-supplier collaboration, and accordingly, high levels of supplier integration represent high-intensity buyer-supplier collaboration.

The desired outcome stems from the literature on circular design principles in the textile industry: Within this space, design strategies to narrow and slow resource loops (product integrity) are distinguished from strategies to close resource loops (product cyclability). Previous studies are criticised for their failure to tangibly conceptualise outcomes (Taticchi et al., 2015), relying on broad and fuzzy constructs such as 'environmental performance' or 'green supply' (Bowen, Cousins, Lamming, & Faruk, 2001; Vachon & Klassen, 2006, 2008; Zhu, Geng, & Lai, 2011; Zhu & Sarkis, 2004; Zhu, Sarkis, & Lai, 2008). Beyond that, these outcomes are not specific to the circular economy but rely on a broader notion of sustainability.

To address this issue, this research project employs a clearly defined set of (textile) circular design principles that are easy to assess and observe. The apparel industry is an enormous industry lagging far behind the goals of sustainable development and is known for being extremely fragmented, opaque to outsiders and hesitant to share information about its value networks. In an industry like the apparel sector where market share is spread over thousands of actors (Grand View Research, 2022), the importance of jointly addressing sustainability issues becomes even more apparent. Buyer-supplier collaboration, therefore, represents an opportunity for the textile industry to bring value chain actors together to raise awareness, create transparency, jointly tackle issues, and tap into the potential of collaborative circular design.

With my research, I demonstrate how more intense buyer-supplier collaboration measured as the level of supplier integration (independent variable) leads to the realisation of more circular design principles (dependent variable) compared to lower levels (i.e., less intense buyer-supplier collaboration) of supplier integration. In doing so,

I not only offer a differentiated approach to buyer-supplier collaboration in the context of circular design, but also consider the resulting rents, relationship dynamics and any trade-offs in realising circular design principles. Ideally, the learnings gained from empirically studying the textile industry can serve as a basis for guiding collaboration in other industries or with other stakeholders.

A multi-case design including 25 representatives of 22 apparel companies (brands and material suppliers) are interviewed which are supplemented with publicly available information. Typological theorizing is employed to specify the independent variables and delineate them into categories for which the researcher measures their outcomes (dependent variable). The gathered data is linked to the typological theory in an iterative process, classifying cases into the specified types. The findings show that greater buyer-supplier collaboration measured as the level of supplier integration (sharing of resources, joint planning and decision making, supplier-driven behaviour) results in a higher number of circular design principles realised than lower levels of supplier integration. Moreover, the case evidence reveals that the resulting typology acts not just as a classification instrument but can also represent a maturity model, with brands undertaking efforts to intensify their buyer-supplier collaboration in order to realise more circular design principles. There is also some initial evidence of the likely next steps for buyer-supplier dyads that have reached optimal levels of collaboration: While some anticipate engaging in more frequent joint activities as part of their close collaboration, others anticipated shifting to engaging in more supplier-driven relationships with fewer joint activities. Furthermore, insights are obtained on the relationship dynamics between buyers and suppliers: The findings shed light on suppliers' motives to partake in buyer-supplier collaboration, potential factors determining the extent to which they might be

willing to engage, as well as into what could drive or hinder a supplier's willingness to collaborate.

The research contributes to objectives at the three levels of theory, practice and society.

This study addresses the theory gap regarding the mechanism connecting buyer-supplier collaboration and the realisation of circular design principles. It clarifies the pertinent collaborative practices and any hierarchy of them, how the outcome on circular design relates to relational rents, the role of relationship dynamics and the trade-offs that persist when pursuing circular design. And finally, this thesis empirically tests and validates literature findings and thus generates deeper insights into the nature, role, and impact of collaboration in the circular economy.

On a practical level, this research project provides an understanding of how sourcing is linked to the capability to design circular apparel. It not only offers guidance on buyer-supplier collaboration practices but also provides an analytical lens to organisations and sourcing professionals, against which they can assess their practices and evaluate their suitability to transition towards circularity. It can also serve as a basis for presenting the case to senior management to adopt more collaborative supplier management practices.

On a societal level, this thesis aims to contribute the transition towards a circular economy on two levels: on one hand, by outlining another key component in the transition – sourcing and supplier collaboration in relation to circular product design; on the other hand, by empowering an organisational function that is traditionally driven primarily by cost and efficiency and contributing towards a sustainable future on a strategic level.

This thesis is structured as follows: The following chapter two, three and four contain the literature review and the conclusions derived from it in the form of an initial theoretical model. Together, these chapters establish the theoretical foundations for circular design principles in the textile industry, the relational view and buyer-supplier collaboration, as well as a section on how the relational view's findings are influenced by the circular economy. Chapter five describes the research design and methodology. In chapter six, the results of the study are presented, before being analysed in chapter seven and further discussed in chapter eight. Chapter nine contains the conclusions of the study, limitations, and outlook on future research.

2 Circular Design

This chapter represents the first part of the literature review: it clarifies the background on circular economy and then dives deeper on relevant circular design principles in the textile industry described in the literature.

2.1 Circular Economy

2.1.1 Definitions of Circular Economy

There is no universally accepted definition of the circular economy, although it does seem as if some initial consensus is forming, and thus certain definitions are more commonly referred to than others. Nevertheless, CE is still at a stage where its boundaries are not entirely clear (Merli, Preziosi, & Acampora, 2018), and since it draws on different disciplines and schools of thought, the field is yet to find harmony. One might argue that a narrow definition is not suited for a concept that aims at establishing a new socio-economic paradigm (Merli et al., 2018). But if scholars are unaware of their conceptually different understandings of CE, knowledge accumulation attempts may lead to misleading results (Kirchherr, Reike, & Hekkert, 2017).

Masi et al. (2017, p.7) identified three common types of CE definitions: Using CE to label an existing concept, CE as a prescriptive set of existing concepts and practices, and approaches that go further and seek to integrate economic, environmental, and social considerations. They found that, frequently, CE is defined as a combination of industrial symbiosis (cf. Andersen, 2007; Park, Sarkis, & Wu, 2010; Yap, 2005; Yong, 2007) and cleaner production (K. Hobson, 2016; Murray, Skene, & Haynes, 2017; Naustdalslid, 2014). Similarly, Kirchherr et al. (2017) pointed out the systemic perspective in

definitions that emphasise the necessity of a fundamental shift instead of incremental adjustments to the current system. Both studies agree that the shift to CE needs to occur at the macro, meso, and micro level, instead of just addressing it at a single level (Kirchherr et al., 2017; Masi et al., 2017.). The macro perspective typically emphasises the need to adjust the composition of industries or the entire economy, the meso-systems perspective is mainly about eco-industrial parks (EIPs) as systems or, sometimes, regional analysis, while the micro perspective considers individual firms, products, and consumers (Kirchherr et al., 2017). Table 1 contains an overview of three exemplary definitions for each of the levels.

Table 1: Typical definitions from a macro-, meso- and micro-systems perspective

Perspective	Author	Definition
Macro-systems	Murray et al. (2017)	*'The circular economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being.'*
Meso-systems	Geng, Sarkis, Ulgiati, and Zhang (2013)	*'A CE is an industrial system focused on closing the loop for material and energy flows and contributing to long-term sustainability. CE incorporates policies and strategies for more efficient energy, materials, and water consumption, while emitting minimal waste into the environment.'*
Micro-systems	Bocken et al. (2016)	*'…design and business model strategies [that are] slowing, closing, and narrowing resource loops.'*

This study operates beyond a micro-systems perspective as it goes beyond single firms. On the other hand, as the study considers dyads of buyers and suppliers and not collocated networks of firms, the macro-systems perspective is also not entirely fitting.

Kirchherr et al. (2017) argue for a holistic definition containing a systems perspective, the three dimensions of the triple bottom line, and an intergenerational element:

> *'A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.'*
>
> (Kirchherr et al., 2017, pp. 225-226)

Masi et al. (2017) critique this understanding of CE as a prescriptive set of practices while research and practice on the subject continue to evolve. They argue that there is a risk the meaning of CE will be confused before this process concludes. Instead, in their mission to reconcile some of the differences in the conceptualisation and scope of CE, the authors have proposed a different approach: unification of the CE concept based on its goals and assumptions rather than on its current implementation or proposed antecedents. They identified four core goals represented or underpinned in most of the literature:

> *'The CE as (a) a regenerative and restorative economic framework, which (b) decouples economic growth from environmental degradation and which (c) seeks to preserve economic, social, and environmental value while, d) contributing to system resilience.'*
>
> (Masi et al., 2017, p.16)

While the definition by Kirchherr et al. (2017) provides a clear and concise snapshot of the current understanding of CE, including implementation strategies and practices, Masi et al.'s (2017) work serves as a frame of reference not only for future research but also to broadly evaluate and classify emerging practices in CE and related areas. So, the conceptualisation provided by Kirchherr et al. (2017) can provide the necessary clarity – especially for practitioners – amidst the fog of diffused meaning common in trending concepts such as CE. At the same time, the understanding of the meso-level is biased towards eco-industrial parks, omitting other types of inter-firm relationships.

Masi et al. (2017), on the other hand, created a conceptual basis for the field and this study. They described CE in a more abstract way, opening up CE to the entire field of sustainability (Blomsma & Brennan, 2017) without limiting the concept to how it is currently implemented for conceptual, financial, or technological reasons (Masi et al., 2017).

In conclusion, a suitable definition for the purpose of this thesis will include both a clear understanding of what the circular economy *is* as well as *what it hopes to achieve* and remains agnostic at the analytical level. The following definition, therefore, combines elements of Bocken et al. (2016), Kirchherr et al. (2017), and Masi et al.'s (2017) work and represents a circular economy understanding of this study:

'A circular economy describes a regenerative and restorative economic system that decouples economic growth from environmental degradation. It is based on business models which replace the "end-of-life" concept with strategies to slow, narrow and close resource loops, with the aim to accomplish sustainable development and contributing to system resilience.'

(Bocken et al., 2016; Kirchherr et al., 2017; Masi et al., 2017)

2.1.2 Origins and Foundations

The principle of circularity seems to be almost as old as humanity itself: Murray et al. (2017) point to the works of William Harvey (1628) and Marcello Malpighi (1661), who inspired the book '*Tableau Economique*' on circular flow first set out by François Quesnay in 1758. The circular flow of blood around the body was viewed as a useful metaphor for economic flows (Murray et al., 2017). Even though many authors (e.g., Andersen, 2007; Geissdoerfer et al., 2017; Ghisellini, Cialani, & Ulgiati, 2016; Gregorio, Pié, & Terceño, 2018; Merli et al., 2018; Su, Heshmati, Geng, & Yu, 2013) agree that the concept of circular economy in the sense it is referred to today was only introduced later in the century, the period from the 1960s to the 1980s serves as a preamble to the full articulation of CE (Blomsma & Brennan, 2017, p.607): Concern over environmental degradation has manifested over the past century with a range of organised efforts across the globe (Doyle & MacGregor, 2017). In the 1960s, in a context of a growing desire for citizens to participate in public life, environmental movements rapidly started to expand and so did research and literature on the subject (Brulle & Rootes, 2015, p.763). It was then that Boulding (1966) described the earth as a closed and circular system

characterised by a limited assimilative capacity ('spaceship earth'), inferring that the economy and the environment ought to coexist in equilibrium.

Practical applications of circular economy to modern economic systems and industrial processes have gained momentum since the late 1970s (Ellen MacArthur Foundation, 2013c, p.30). Stahel (2019) describes circularity as a ubiquitous phenomenon governing nature and society that is present in two distinct forms: Nature, in a sense that it is governed by a self-organised system of virtuous material cycles where organic waste is food and remuneration for others. On the other hand, it enabled mankind to overcome a scarcity of resources in the early days of society by optimising the use of available natural resources available, routinely sharing and reusing as a necessity. Stahel (2019, p.21) goes on to quote the old New England Maxime '*use it up, wear it out, make it do or do without'*, with elements of today's understanding of circularity visible.

In terms of more recent theoretical antecedents of circular economy, there is no consensus among scholars. Considering the concept of CE has only recently been structured and explored in academic research, this is not surprising. In their systematic literature review, Masi et al. (2017) point out that a number of authors recognise industrial ecology (see Erkman, 1997; Geng & Doberstein, 2008; Giurco, Littleboy, Boyle, Fyfe, & White, 2014; Graedel & Allenby, 2010; Zeng, Chen, Xiao, & Zhou, 2017) and industrial symbiosis (see Peng et al., 2019; Su et al., 2013; Wen & Meng, 2015) as an early idea, focusing on the closing of resource loops in production and consumption. It becomes clear that the concept of circular economy has fragmented and deep-rooted origins that cannot be traced back to one single date or author (Ellen MacArthur Foundation, 2013b); rather, it draws on a number of broader antecedents in economic, ecological, as well as cultural or historical fields (Murray et al., 2017).

The contemporary understanding of the circular economy has evolved to incorporate different features and contributions from a variety of concepts that share the idea of closed loops (Geissdoerfer et al., 2017).

One of the milestones many authors agree on was the beginning of the 1990s when Pearce and Turner (1990) introduced the concept of a circular economic system in their study addressing the interlinkages between the environment and economic activities (Andersen, 2007). Building on Boulding's (1966) work, the authors introduce a theoretical framework where they elaborate on the shift from a traditionally open-ended economic system to a circular economic system (Ghisellini et al., 2016). Pearce and Turner (1990) argued that the environment fulfilled four distinct welfare functions: amenity values, provision of resources, a sink of residual flows, and a life support system (Andersen, 2007). Unlike economic functions, there is usually neither a price nor a market for environmental goods even if they provide a clear value to society and individuals (Andersen, 2007). The notion of the circular economy embodies the desire to substitute the prevailing traditional linear economic model with a circular one that would aim to retain the value of products, materials and resources in the economy for as long as possible (Gregorio et al., 2018) and potentially alleviate the issue of negative external effects (Andersen, 2007). Sustainable development started to be framed as an opportunity: Addressing the global challenges was seen as a way to manage risks, drive innovation and deliver economic growth (Hart & Milstein, 2003).

Unlike other related concepts such as zero waste, the circular economy clearly outlines how extending the productive life of resources is a means to create value and reduce

value destruction. Thus, the notion of the circular economy absorbs some pre-existing concepts, at least to a certain degree (Blomsma & Brennan, 2017).

2.1.3 Key Principles and Frameworks

Recognising planetary boundaries to resources and the use of energy, as well as the importance of viewing the world as a system within which pollution and waste represent defeat, lies at the foundations of circular economy thinking (Bocken et al., 2016). Or as Commoner (1971, p.300) described it: '*We must learn how to restore to nature the wealth that we borrow',* illustrating the regenerative aspirations of the circular economy. Closely related is the bioeconomy's ambition, concerned with the optimal use of renewable biological resources, including sustainable primary production and processing systems that can produce more food, fibre and other bio-based products with fewer inputs, less environmental impact, and reduced greenhouse gas emissions (European Commission, 2020).

When aiming to create closed-loop systems, one logical consequence is that there are only two possible long-run fates for waste materials: either recycling and reuse or dissipative loss (Ayres, 1989). Consequently, a circular economy works towards reducing or even eliminating the introduction of virgin materials, creating products that maintain their value and utility for as long as possible, therefore minimising the creation of waste, pollution, and emissions (Kopnina & Poldner, 2021). Calls for shifts towards renewable energy sources, the implementation of biomimicry principles, ecosystem service valuation, diversity as a characteristic of resilient and sustainable systems, as well as the re-thinking the capitalistic system, including economic measurement tools, are common (Buchmann-Duck & Beazley, 2020; Kersty Hobson & Lynch, 2016; Webster,

2013). Implicitly or explicitly, companies are challenged to take on responsibility beyond their own boundaries and to rethink their up- and downstream value networks (Geissdoerfer, Morioka, de Carvalho, & Evans, 2018).

Table 2 presents a selective overview of key frameworks pertaining or closely related to the concept of the circular economy. It summarises previous work operating at the industry level, targeting enterprise development, or centring on product design. The industry level is concerned with material flows, planetary boundaries, and economic structure. Enterprise development contains approaches to developing circular business models, optimising resource use by improving efficiency and shifting to renewable sources.

The most granular level of product design contains, among others, the principle of biomimicry, a way to (re-) design analogously to natural ecosystems (J. M. Benyus, 1997). The influential concept of cradle-to-cradle also advocates for biomimetic principles to achieve a waste-free economic system (Braungart, McDonough, & Bollinger, 2007). This includes the return of obsolete resources to a non-obsolete state as quickly and efficiently as possible while minimising leakage and pushing back the recovery horizon (den Hollander, Bakker, & Hultink, 2017; Stahel, 2019).

One of the key foundations for contemporary circular design principles for textiles emerged in the 1980s: Waste hierarchies or R-hierarchies (the name is inspired by the first letter of many principles) are a tool used in the evaluation of processes that establishes and ranks operationalization principles based on their value-retention potential and, thus, their desirability within the circular economy (Hansen et al., 2002; Potting, Hekkert, Worrell, & Hanemaaijer, 2017; Van Ewijk & Stegemann, 2016). While some authors stick to a simple trilogy of ‘reduce, reuse, recycle’ (3R) (Amelia, Wahab,

Che Haron, Muhamad, & Azhari, 2009; Diener & Tillman, 2015; Ghisellini et al., 2016; Lieder & Rashid, 2016; Xin, Han, & Hu, 2014; Xing & Luong, 2009; Yoshida, Shimamura, & Aizawa, 2007), others describe up to 10 principles (Allwood, Ashby, Gutowski, & Worrell, 2011; Den Hollander & Bakker, 2012; Potting et al., 2017; Reike, Vermeulen, & Witjes, 2018), again highlighting the confusion around the conceptualisation of CE (Vermeulen, Reike, & Witjes, 2019). Table 3 shows an overview including 10 R-principles or value retention options. It is based on a consolidation exercise done by Reike et al. (2018) which has achieved two things in particular: First, A clear distinction between a consumer (use-focused) and a producer perspective (concept and design focus) of R principles. Second, they distinguish between R principles that are

- close to the consumer, focusing on extending product life (R0-R3),
- driven by commercial activity and specialised stakeholders (R4-6),
- and traditional waste management strategies (R7-R9) (Reike et al. 2018).

R principles and waste hierarchies represent a good overview of value retention and raise awareness of the fact that the circular economy goes beyond recycling and recovery. Making these hierarchies explicit is an important step in providing guidance during the implementation of CE; otherwise, one risks that only incremental changes are achieved (e.g., improvement of recycling) without realising the broader potential of the CE concept or the core principles as a whole (Kirchherr et al., 2017; Murray et al., 2017).

Therefore, R-hierarchies heavily guide circular design principles: If waste that cannot be prevented is to be recycled or reused (Ekins, 2009), products need to be designed accordingly. Commonly described material management strategies include material efficiency, calls for longevity, and reusing, recycling and downcycling before end-of-life

products are eventually incinerated for energy recovery (Allwood et al., 2011; Balkenende, 2018; Bocken et al., 2016; Den Hollander, Bakker, & Hultink, 2017; Geiser, 2001)

Table 2: Selection of key concepts and frameworks within or closely related to the circular economy (adapted from: Blomsma & Brennan, 2017; Kopnina & Poldner, 2021)

Author (s)	Concept		Level of Application
Ayres & Kneese (1969)	Industrial Metabolism	Described material flows and energy turnover in industrial systems, analogous to a biological metabolism.	Economic system
Ellen MacArthur Foundation (2013)	Butterfly Diagram	A circular economy system diagram that illustrates the continuous flow of materials including two main cycles – the technical cycle and the biological cycle. In the technical cycle, products are kept in circulation in the economy through reuse, repair, remanufacture and recycling. In a biological cycle, nutrients from biodegradable materials are returned to the Earth, through processes like composting or anaerobic digestion.	Economic system
Georgescu-Roegen (1971) O'Neill (2012) Daly (1977)	Degrowth Economy/ Steady-state economy	Both a movement and a theory criticising the paradigm of endless economic growth, pointing out environmental and social harm caused by the pursuit of infinite growth and development imperatives.	Economic system
Raworth (2012)	Doughnut economics	A framework for sustainable development combining the concept of planetary boundaries with social boundaries, its name hinting at the shape of the visual: The centre hole of the model represents the proportion of people that lack access to essentials (healthcare, education, equity etc.), while the crust represents the planetary boundaries (i.e., the safe operating space of planet earth) that life depends on and must not be overshot	Economic system

Merli et al. (2018)	Analytical categories of circular business models	Provides analytical categories of different circular business models including access & performance model, extending product value, classic long-life model, encouraging sufficiency, extending resource value and industrial symbiosis.	Enterprise development
Pauli (2010)	The Blue Economy	The blue economy highlights potential benefits in connecting seemingly disparate environmental problems with scientific solutions based upon physical processes commonly found in nature, resulting in environmental, financial and societal benefits. The author suggests shifting focus from the use of rare and high-energy cost resources to instead seeking solutions based on simpler and cleaner technologies.	Enterprise development
Stahel (2010)	Performance Economy	As a response to the environmental challenges of high waste volumes related to mass consumption, the author challenges businesses to shift from traditional manufacturing to selling performance by focusing on smart materials, smart goods and smart solutions, decoupling revenue and wealth creation from resource throughput.	Enterprise development
Takacs, Frankeberger, & Stechow (2020)	Circular Ecosystems – Business Model Innovation for CE	Provides a path for companies to design, validate and implement a circular ecosystem with suitable business models.	Enterprise development
Weizsäcker, Lovins, & Lovins (1998)	Factor Four	Argues for radically improved resource efficiency (the idea that natural resources can and should be used at least four times more efficiently) to improve welfare and reduce pressure on the environment at the same time.	Enterprise development
Bocken et al.	Circular Product	Distinguishes between three fundamental strategies for product design	Enterprise

(2016)	Design Strategies	and circular business models: sowing and closing resource loops as strategies towards resource cycling, and the narrowing of resource flows as a strategy for reducing resource flows.	development/ Product design
Ad Lansink (1979)	Waste hierarchy	Formulated and presented the first waste hierarchy in Europe to the Dutch Parliament in 1979, which inspired European waste management legislation.	Product design
Allwood et al. (2011)	Hierarchy of Material Management Strategies	Initial thinking on waste hierarchy by framing recycling as one option in a hierarchy of material management strategies. Other options include reducing overall demand for materials by a reduced purchasing volume, making light and long-lasting products, reusing products and components, downcycling, or incineration for energy recovery.	Product design
Benyus (1997)	Biomimicry Design	A call for humans to learn from and emulate nature's design in both form and function, aiming to solve design challenges sustainably.	Product design
Geiser (2001)	Materials Matter	The author pushes for new directions in material science and presents strategies to reduce material use and eliminate the use of many toxic chemicals by focusing directly on materials (chemical) during product design, therefore creating cost-saving opportunities for manufacturers.	Product design
McDonough & Braungart (2002)	Cradle-to-cradle	A biomimetic approach to product and system design seeking to create a waste-free economic system, using the analogy of materials as nutrient cycling in healthy and safe metabolisms. The framework highlights the need to protect and enrich ecosystems and nature's biological metabolism while also maintaining a safe, productive technical metabolism for the high-quality use and circulation of organic and technical nutrients.	Product design

Table 3: An overview of value retention options or R principles ranked according to their potential to retain value and support a circular economy (adapted from Potting et al., 2017; Reike et al., 2018)

R hierarchy: Value retention options (VRO) in a circular economy		
VRO	***Consumer Perspective***	***Producer Perspective***
R0: Refuse	- Choice to buy/consume less - Reject packaging waste	- No use of hazardous materials (or virgin materials) - Production processes designed to avoid waste
R1: Reduce	- Less frequent use of goods - Longer and more careful use of goods	- Explicit step in product design: Less material per production unit of dematerialisation - Design long-lasting goods
R2: Resell/ Re-use	- Buying second-hand goods - Re-selling unused products - Consumer-to-consumer auctions	- Re-use in fabrication - Use of existing waste streams as inputs - Direct re-use as economic activity via collectors and retailers - Direct re-use of unsold returns or products with damaged packaging - Multiple uses of (transport) packaging
R3: Repair	- Repair by consumer at their place or a 'repair café' - Repair by a third-party company (organised by consumer)	- Enable (easy) repair of goods - Collect defected products in repair centres controlled by the manufacturer or a third party - Distinguish planned repair as a part of a long-term maintenance plan from ad-hoc repair
R4: Refurbish	n/a	- Replacement or repair of components with overall structure still intact, resulting in an improved product quality
R5: Remanufacture	n/a	- Disassembly of overall structure, checking, cleaning and potentially repairing components - Retention of original product quality
R6: Repurpose	n/a	- Use of discarded components adapted for another function
R7: Recycle	- Correct disposal of goods: separate waste streams/ materials	- Processing streams of post-consumer products - Ensure further use of recycled raw materials (own use, brokerage)
R8: Recover	n/a	- Capturing energy embodied in waste (incineration, use of biomass)
R9: Re-mine	n/a	- Retrieval of materials in landfills, urban mining/ landfill mining

2.2 Circular Design Principles in the Textile Industry

Creating products that can remain in the economic cycle at their highest value and utility for as long as possible is the key objective when designing circularity (Kopnina & Poldner, 2021; Kirchherr & Piscielli, 2019). In other words: resisting, preventing or reversing obsolescence at the product, component and material level (Den Hollander et al., 2017).

Although they do not describe specific design principles, Bocken et al. (2016) provide a helpful way of thinking about and structuring circular design principles. The authors, building on Braungart et al. (2007), McDonough and Braungart (2002) and Stahel (2008), distinguish three generic design approaches according to the mechanisms by which resources flow through a system (see Figure 1). Resource loops can be *slowed* through the design of long-life products and by extending or intensifying product utilisation. Second, resource loops can be *closed* with recycling when post-use resources are cascaded into the production of new products. Finally, resource loops can be *narrowed* by means of improving resource efficiency, meaning that fewer resources per product are used (Bocken et al., 2016).

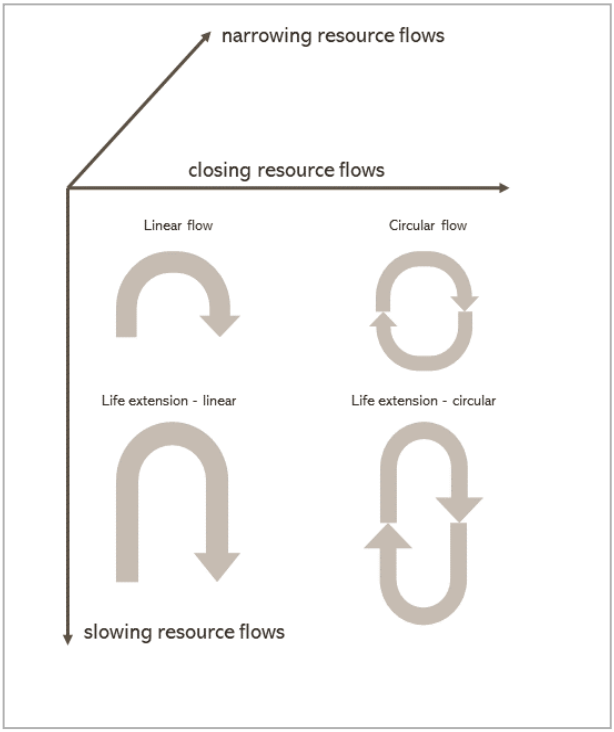


Figure 1: How resources flow through a system (Bocken, de Pauw, Bakker, & van der Grinten, 2016)

There is a broad range of circular design strategies discussed in the academic literature (see Table 4), which are often inspired by or deduced from previously described R hierarchies (Reike et al., 2018). A common issue is the lack of empirical validation for most design strategies (Proske & Jaeger-Erben, 2019), likely caused by the varying effectiveness of an applied design strategy depending on the product context: differences in environmental and social footprints or pain points without one-size-fits-all solutions require a tailored approach. While some design strategies are highly relevant in one

context, they are not applicable to others. The textile industry is an interesting use case, also because of its range of environmental and social issues, which, in turn, can be tackled with a broad range of (design) strategies. For another sector, such as jewellery and watchmaking, issues like reducing the use of pesticides or prolonging the utilisation of products might not be as pressing. Determining the effectiveness and relative importance of a design strategy on a generic level thus might prove difficult and redundant to vastly different industry contexts. For this reason, the below-employed classification was constructed in the context of the textile industry, relying on literature focusing on circular design principles for textiles. The structure leverages the work of Den Hollander et al. (2017), Goldsworthy (2014), Potting et al. (2017), and a MOOC on Circular Fashion taught by the Wageningen University & Research (WUR)[1]. Since this research examines buyer-supplier collaboration practices, the focus lies on design principles more likely to be influenced by collaborative efforts.

For the purpose of this study, a structure of design principles is created that is not overly complex but still covers the considerations essential to a product development context in a buyer-supplier collaboration setting. Therefore, circular product development is broken down into two main components: product integrity, entailing strategies to narrow and slow textile resource loops (den Hollander et al., 2017) and textile product cyclability, which is about design strategies to close resource loops (Goldsworthy, 2014). Product integrity encompasses the design principles of reducing resource use (Plank, 2019b), designing for durability (den Hollander et al., 2017; Keoleian & Menerey, 1993) and designing for extended use (EFNMS, 2016; den Hollander et al., 2017). Product

[1] Circular Fashion: Design, Science and Value in a Sustainable Clothing Industry, (University of Wageningen, 2020)

cyclability includes the design principles of designing for repair (Bakker, Wang, Huisman, & Den Hollander, 2014) and designing for recycling (Ellen MacArthur Foundation, 2017; de Aguiar et al., 2017). From the hierarchy adapted from Potting et al. (2017) and Reike et al. (2018), the R-principles of Refuse/Reduce (reduce in this classification includes some of the refuse aspects in Potting et al. 2017), Repair and Recycle are reflected as design principles. The principles of Refurbish, Remanufacture and Re-Mine are not applicable to a textile context. Re-Sell/ Re-Use, Repurpose and Recover are already partly reflected in the included principles (such as reusing components of other products as a part of recycling) and are seen as secondary in terms of applicability to the context of this study.

Table 4: An overview of circular design principles in the literature

	Design Strategy/ Principle: Design to/for…				
Classification (Bocken et al. 2016)	Narrow and slow resource loops: **Product Integrity**			Close resource loops: **Product cyclability**	
	Reduce *material & energy use*	**Durability** *physical & emotional*	**Extended Use** *maintenance & upgrade*	**Repair**	**Recycle**
Bakker et al. (2014)	•	•			•
Balkenende & Bakken (2018)			•	•	
Baumeister et al. (2013)	•				•
Bocken et al. (2014)	•	•	•	•	•
Bocken et al. (2016)	•	•	•	•	•
Braungart et al. (2007)	•				•
Brezet et al. (2001)		•	•		
Circle Economy (2014)	•	•		•	•
Chertow &	•				•

Ehrenfeld (2012)					
Crul & Diehl (2009)		•	•	•	•
De Aguiar et al. (2017)					•
De los Rios & Charnley (2017)		•	•	•	•
EMF (2013)					•
EMF (2017)		•			•
Guide et al. (2003)	•	•	•		•
Karell (2018)	•				•
Khan et al. (2018)			•		
Krikke et al. (2003)		•	•	•	•
Lieder & Rashid (2016)					•
Lilley et al. (2019)		•			
Maldini et al. (2019)		•			
Maxwell et al. (2006)		•			•
Niinimäki (2017)		•			•
Ny et al. (2012)		•			
Page (2014)		•			
Poppelaars (2014)		•			•
Proske & JE					
Rashid et al. (2013)		•	•	•	•
Sauerwein et al.		•			
Tsoulfas & Pappis (2008)	•	•			
Umeda et al. (2005)			•		

2.2.1 Product Integrity

'*Design to reduc*e' comprises design strategies to reduce the use of resources and/or the use of existing waste streams. In the case of textiles, one important goal is to design out

waste through innovative construction and pattern-cutting techniques such as 3D modelling, the use of zero waste patterns and on-demand production models (Plank, 2019b; University of Wageningen, 2020). Using existing waste streams reduces the need for virgin fabric (De los Rios & Charnley, 2017, p.111). Another aspect is reducing or avoiding the use of hazardous toxins, dyes, coatings, and physical contaminants (University of Wageningen, 2020).

'Design for durability' entails design strategies to resist obsolescence for a long product use phase, encompassing both physical and emotional durability. Physical durability is about the longevity of a garment, i.e., a slower degradation over time and the absence of planned obsolescence (Den Hollander et al., 2017; Keoleian & Menerey, 1993; University of Wageningen, 2020). Degradation can be caused by wear, fatigue or creep and can to a certain extent be countered by designing for durability (Den Hollander et al., 2017). One example is the use of high-quality fabrics that maintain their shape, colour and feel while being able to withstand washing cycles and wear and tear (Niinimäki, 2017).

Equally important is the consideration of the likely context in which the garment is going to be used. This leads us to emotional durability, which aims at creating long-lasting consumer-product attachments (Niinimäki, 2017; Page, 2014). Emotional durability is influenced by many factors, some of them can be implemented and enhanced by designers but many are difficult to control (Page, 2014). Translated into the world of garments, this could mean garments that age gracefully: '*Patina can create an emotional bond between the owner and object, either through memories of particular events or because the change to the surface is aesthetically pleasing'* (Lilley et al., 2019, p.417). Furthermore, garments without a trend-sensitive fit or style – often referred to as

'classics' – are less susceptible to emotional obsolescence (Fletcher, 2012). Another feature typically mentioned in this regard is personalisation. However, a recent empirical study found it had no effect on delaying obsolescence (Maldini et al., 2019). For this reason, personalisation was excluded from the scope of this study.

'Design for extended use' includes design strategies to facilitate maintenance and upgrades. The term maintenance refers to the *'...combination of all [...] actions [...] intended to retain it to a state in which it can perform its required action'* (EFNMS - The European Federation of National Maintenance Societies, 2016). This typically means retaining an aesthetic and hygienic condition (Den Hollander et al., 2017). In addition, there is a shift towards a non-consumerist approach in designing and selling products: fewer sales of high-end items rather than planned obsolescence (Bocken et al., 2016). When service loops are introduced to prolong the product life, considering this in the design process makes maintenance easier for the user, the manufacturer or even third parties (Bocken et al., 2016). Also, maintenance is made easier when a product and its components are easy to inspect (Shahbazi & Jönbrink, 2020). Applied to garments, this could entail fabrics that do not require dry cleaning, do not crease excessively and are not prone to smell.

Upgrading a product entails the improvement of functionality and capability of a product during its use phase (West & Wuest, 2017). Designing for upgradability intends to maximise the ability of a product to adapt its functionality according to a change in the use context (Umeda et al., 2005). Modularity, standardisation, compatibility, and interoperability are typically seen as enabling features (Chierici & Copani, 2016). One example is raincoats that can be 'upgraded' to a winter coat by using a fleece jacket as

lining with a zipper on the inside of the jacket. In the context of textiles, this may not play a major role, but it is, nevertheless, one way to slow down resource loops.

2.2.2 Product Cyclability

'Design for repair' strategies enable the repair of products either through consumers, manufacturers or third parties. Bakker et al. (2014) refer to the British Standards BS888 7-2-2009 that define repair as '*returning a faulty or broken product or component back to a usable state*'. Looking at self-repair, criteria are the use of standardised components and the use of standard interfaces to allow for a quick replacement of broken parts using a minimum number of, ideally readily available, tools. Other criteria entail the provision of (free) repair instructions and that the most fragile parts are not only known but easy to access and handle. An alternative option is to focus on expert repairs, in which case access to more specialised material and repair tools can be assumed (Balkenende, 2018). In terms of garments, this could translate into consumers being able to sew on a button but relying on an expert repair service when a dress zipper needs replacement.

'Design for recycling' refers to strategies that not only proactively design out barriers to recycling and enable recycling into same or similar quality applications but also into lower-value applications such as insulation material, wiping cloths or stuffing (Ellen MacArthur Foundation, 2017). The latter is considered problematic by some: downcycling does not enable circular flows; rather it delays a linear flow from production to waste (McDonough & Braungart, 2002). One important aspect of this design principle is the disassembly of end-of-life products (de Aguiar et al., 2017): the more components (incl. hardware and embellishments), the more complex the product architecture, and the presence of physical or chemical finishing treatments to achieve

desirable properties fuel the complexity of this process (Franco, 2017; Plank, 2019b). Thus, products with fewer components are much easier to recycle. The product architecture complexity is a major issue in textiles; In apparel, it is mainly caused by the use of material blends, the layering of different materials, and the presence of prints, elastane and trims, which include chemicals, colours/dyes and harmful substances (Elander & Ljungkvistm, 2016; Franco, 2017; Karell, 2018; Niinimäki, 2017). This complexity not only makes disassembly costly; it can also make fibre-to-fibre recycling impossible. Karell (2018) highlights the importance of developing new materials that improve the recycling process and perform well in aesthetic and functional aspects (Franco, 2017). Designing garments with full material recyclability also requires competencies in materials and their properties, reverse logistics and mandates making available the recycling infrastructure (Karell, 2018; Plank, 2019a).

2.2.3 Challenges and Trade-Offs

Designing (in a wholesome sense, including the definition of materials, production methods, infrastructure, etc.) circular garments is a challenging and complex task and requires actors to think in systems, beyond the use phase. The described design strategies have the potential to disrupt how textiles are made but require the respective skillset, value chain partners and resources. Besides, some strategies also depend on the availability of local (repair, collection, and recycling) infrastructure, the right regulatory environment (re-classification of waste and how it can be used), and, in some cases, technological advancement in materials and recycling.

Additionally, the simultaneous accomplishment of all the design strategies might not be feasible due to potential trade-offs between product integrity and cyclability. One

example is physical durability, where synthetic fibres are often superior in terms of performance characteristics but then compromise the cyclability of a garment. Moreover, a t-shirt made from 100% cotton is more susceptible to losing shape over time compared to a cotton shirt with a small percentage of elastane (Azim, Sowrov, Ahmed, Hasan, & Al Faruque, 2014), but the latter is more complex or even impossible to recycle.

Furthermore, reducing the use of virgin materials by using fabrics made from recovered ocean plastic satisfies the 'Design to Reduce' principle, but the garment will go on to release microplastics during washing, which are not only much harder to retrieve from bodies of water but also more easily enter the food chain (Clean Sailors, 2021; Kravchenko, Pigosso, & McAloone, 2020). Similarly, Harris, Martin, and Diener (2021) as well as Lonca, Muggéo, Imbeault-Tétreault, Bernard, and Margni (2018) have found that improving circularity does not automatically result in an improved environmental outcome. As an example, Lonca et al. (2018) showed that re-trading tyres improves the product's circularity but results in increased fuel consumption, therefore negatively impacting human health and ecosystems.

Van Loon, Diener, and Harris (2021) identified a need for LCAs that capture potential benefits and deficiencies of products aiming to be circular to catch the above-described pitfalls and allow for more robust claims about the product's environmental sustainability. The challenge lies in the high context dependence and the different pathways to realising a circular design principle. A priori, it is not evident what design principle is most impactful, nor is it universally the same. Besides LCAs, firms need to make deliberate decisions and evaluate their approach to ensure it achieves the desired outcome in terms of circularity and environmental impact (Bakker et al, 2014).

The previously illustrated design principles represent an overview of relevant circular design strategies in the textile industry. They serve as a working basis to determine how well a certain buyer-supplier collaboration supports circular outcomes, in that researchers can observe if and to what extent circular design principles have been realised. While the detailed impact assessment of realised design principles on overall circularity is beyond the scope of this thesis, the evaluation of approaches used to realise design principles still allows for some initial conclusions in terms of circularity outcomes.

3 Buyer-Supplier Collaboration

Buyer-supplier collaboration emerged as a form of inter-organisational collaboration from the collaborative paradigm of the relational view (Dyer & Singh, 1998; Majchrzak, Jarvenpaa, & Bagherzadeh, 2014). The relational view, a complementary extension of the resource-based view of the firm, looks at competitive advantage from an interorganisational perspective, considering dyad/network routines and processes (Dyer & Singh, 1998).

3.1 Theoretical Foundations

3.1.1 The Resource-Based View of the Firm

Unlike outside-in views that are concerned with achieving competitive advantage by exploiting external factors (Ansoff, 1965; Baden-Fuller, 1995; Bain, 1951; Porter, 1980), the **resource-based view** (RBV) is an inside-out view of the organisation: It focuses on internal resources to identify assets and capabilities that potentially help to gain a competitive advantage (Barney, 1991). The main contributors to the theory include Penrose (1959), Wernerfelt (1984), Teece (1980, 1982), Nelson and Winter (1982), Barney (1991, 1995), Dierickx and Cool (1989), as well as Mahoney and Pandian (1992). While Wernerfelt (1984) focuses on resources and diversification, Barney (1991) provides a detailed and formalised resource-based perspective at the business level (Priem & Butler, 2001). In his 1991 article, Barney examines the link between firm resources and sustained competitive advantage. He builds on two core assumptions that immobile strategic resources, meaning resources cannot be transferred without cost, are heterogeneously distributed across firms and that these differences remain stable over

time (Barney, 1991). Although the theory is mostly concerned with single-business firms, some authors (Montgomery & Wernerfelt, 1988; D. J. Teece, 1982; Wernerfelt, 1984; Wernerfelt & Montgomery, 1986; Williamson, 2007) posit how firm resources will, to varying extents, also be beneficial to employ for other product lines or markets.

Such resources must be *valuable*, *rare*, *imperfectly imitable,* and *not substitutable* (Barney, 1991; Dierickx & Cool, 1989). *Resources* are defined as an organisation's assets, capabilities, processes, attributes, and knowledge that enable strategies which improve its efficiency and effectiveness (Daft, 2004). Barney (1991) groups them into physical capital resources, human capital resources and organisational capital resources. An organisation has a *competitive advantage* when its value-creating strategy is not simultaneously being implemented by a competitor. A *sustained competitive advantag*e is present when, in addition to the previously described condition, competitors are also unable to duplicate the benefits of the strategy (Barney, 1991; Dierickx & Cool, 1989). This is the case when resources are not only valuable and rare but also imperfectly inimitable, which in turn happens for three reasons: the ability to obtain a resource due to unique historical conditions, the link between the organisation's resources and its competitive advantage is only poorly understood and thus causally ambiguous, and/or the resource responsible for the competitive advantage is socially complex (Barney, 1991; Dierickx & Cool, 1989). Additionally, for a competitive advantage to be sustained, there must not be a strategically equivalent valuable resource that is either not valuable or imitable (Barney, 1991). Therefore, rarity and value are necessary but not sufficient conditions for competitive advantage, while non-imitability, non-substitutability and non-transferability are each necessary but not sufficient conditions for sustaining an existing competitive advantage (Priem & Butler, 2001).

Peteraf (1993) suggests two additional conditions for sustained competitive advantage: ex-post and ex-ante limits to competition. Ex post limits refer to the forces limiting competition subsequent to a firm's gaining a superior position and earning rents (Peteraf, 1993). Ex-ante limits, limited competition prior to any firm establishing a superior position, are also necessary: In the absence of such limits, equally endowed firms would essentially compete away anticipated returns to achieve a superior position. Therefore, a superior position can only be the source of above-normal rents when firms have the foresight or fortune to obtain it in the absence of competition (Peteraf, 1993).

The RBV focuses on the achievement of **internal rents**, the combination of Ricardian rents and quasi-rents derived from the internal resources of the focal firm makes up (Peteraf, 1993). A Ricardian rent is '[…] *the result of the possession of a natural or man-made idiosyncratic, scarce factor*' (Sautet, 2018). It is a surplus earning above the costs to deploy and use a resource, but unlike a profit, it continues to exist in a hypothetical state of equilibrium as long the resource remains scarce (Sautet, 2018).

Lavie (2006) notes that the RBV does not consider appropriability problems and latently assumes that the appropriability of rents requires ownership, or at least complete control, of the rent-generating resources. Though the theoretical perspective of the RBV has contributed to the understanding of how firms achieve above-normal returns, it does not consider how advantages of individual firms are often linked to the network of relationships in which the firm is embedded in (Dyer & Singh, 1998).

3.1.2 The Relational View of the Firm

Going beyond a single firm's boundaries, the relational view (rRBV) posits that a firm's above-normal returns can also stem from the advantages of the relationship network it is

embedded in. To illustrate this shift, Table 5 shows the key differences between the resource-based view (RBV) and its extension, the relational view (rRBV).

Table 5: Comparison of the RBV and the rRBV along key dimensions (adapted from: Joia & Malheiros, 2009; L. Li, Lin, & Arya, 2008; Otola, Ostraszewska, & Tylec, 2013)

Dimensions	**RBV**	**rRBV**
Heritage	Economic theory of firm growth	RBV, dyadic social relations, transaction cost theory
Theoretical focus	- Firm performance - Heterogeneity and sustainable competitive advantage	- Sustainable competitive advantage - Heterogeneity and sustainable competitive advantage
Unit of analysis	Firm	Pair or network of firm
Resource locus	Internal	Interfirm dyadic relations
Resource type	Firm-specific resources that are valuable, rare, inimitable, non-substitutable, inelastic in supply	Resources embedded in relational ties and internal resources that are valuable, rare, inimitable, non-substitutable
Mechanism to achieve competitive advantage	Configuration of resources, exploiting resource heterogeneity of firms	Cooperation and co-opetition, exploiting resource heterogeneity of inter-firm relationships
Mechanism to preserve competitive advantage	Firm-level barriers: - Scarcity of resources - Property rights - Causal ambiguity - Diseconomies of compression of time - Interrelated inventory assets	Dyadic/network barriers - Causal ambiguity - Diseconomies of compression of time - Interorganisational asset connectedness - Partner scarcity - Indivisibility of resources - Institutional environment
Control of rent-generating resources	Individual firm	Collective (with exchange partner) and individual firm

By means of relation-specific investments, alliance partners can combine resources in a unique way, earning them an advantage over competing firm dyads or networks (Dyer & Singh, 1998). This view examines competitive advantage from an interorganisational perspective, looking at dyad/network routines and processes and is complementary to the RBV (Dyer & Singh, 1998).

The RBV rests on the two assumptions of resource heterogeneity and resource immobility. In a networked environment, firms are no longer conceptualised as independent entities, and alliances may contribute to resource homogeneity through resource flows among connected firms (Lavie, 2006). On the other hand, under pure resource-homogenous conditions, alliances would be formed for collusive purposes rather than for access to complementary resources (Lavie, 2006). The imperfect mobility condition is also weakened through interconnected firms: Part of the relational view's appeal stems from the idea that firms can gain access to – or 'mobilise' – resources that are otherwise considered immobile (Lavie, 2006).

Increasing specialisation and vertical dis-integration leads to networks and alliances of firms whose connections are no longer purely transactional but became more strategic and harder to imitate. Such strategic inter-firm relationships can be sources of relational rent, a '*supernormal profit'* that the alliance partners jointly generate in this exchange relationship through idiosyncratic contributions that cannot be generated by either firm on its own (Dyer & Singh, 1998). Competitive benefits resulting from inter-firm relationships typically fall into four categories: the previously described internal rents as a focus of the RBV, (appropriated) relational rents, inbound spill-over rents, and outbound spill-over rents (Lavie, 2006).

Relational rents are the common benefits that accrue when alliance partners combine, exchange or invest in idiosyncratic assets, knowledge and resources/ capabilities, and/or they employ effective governance mechanisms that lower transaction costs or create rents through the synergistic combination of assets, knowledge or capabilities (Dyer & Singh, 1998). They are extracted only from resources that are intentionally committed and jointly possessed by alliance partners (Lavie, 2006), falling into one of four categories:

- *Development of relation-specific assets*: refers to assets that are specialised in conjunction with the alliance partner (Klein, Crawford, & Alchian, 1978). According to (Williamson & Riordan, 1985), assets can be site-specific, physically-specific or human-specific. Site-specific assets refer to set-ups where successive production stages (e.g., buyer and supplier) are closely located, which reduces inventory and transportation costs. Physically-specific assets encompass transaction-specific capital investments (e.g., equipment, tools, materials) that tailor processes to alliance partners, enabling product differentiation (Clark, 1991). Human-specific assets are defined as transaction-specific know-how accumulated by the transacting parties within alliance partnerships through interaction and long-standing relationships, allowing them to communicate efficiently and effectively, enhancing quality and increasing speed to market (Dyer, 1996).
- *Knowledge-exchange routines (incl. joint learning)*: Organisations often learn when collaborating with other organisations. Von Hippel (1988) argues that value networks with superior knowledge transfer out-innovate networks with less effective knowledge-sharing routines. Alliance

partners can be a powerful source of new ideas and information that results in performance-enhancing technology and innovation (Powell, Koput, & Smith-Doerr, 1996). Furthermore, organisations also share knowledge that is tacit, difficult to codify and, therefore, hard to transfer or imitate, likely increasing the sustainability of a resulting advantage (Dyer & Singh, 1998).

- *Combination of complementary resources and capabilities:* Defined as distinctive endowments of alliance partners that jointly generate greater rents than the sum of the individually resulting rents from each partner (Dyer & Singh, 1998), and the combination of resources and capabilities can result in the creation of unique products, technologies and services. A condition to this is that the complementary resource cannot be procured in the secondary market and the resource is indivisible, incentivising the continuance of the partnership (Dyer & Singh, 1998).
- *More effective governance than competing dyads/ networks*: Alliance partners can generate relational rents through governance because it influences transaction costs (potential for lower transaction costs than competing alliances) and the willingness of partners to engage in value-creating activities (Dyer & Singh, 1998). Two classes of governance can be distinguished: third-party enforcement of agreements, including legal contracts, and self-enforcing agreements involving formal safeguards (financial or investment hostage) (Klein et al., 1978; Williamson, 1983), as well as informal safeguards such as trust, embeddedness (Gulati, 1995; Powell, 1990; Uzzi, 1997) or reputation (Larson, 1992).

Inbound/outbound spill-over rents are one-sided benefits resulting from network resources and pertain to unintended gains from the nonshared resources of the alliance partners, called resource leakage (Lavie, 2006). Inbound spill-over refers to the case where the focal firm appropriates rents, and outbound spill-over occurs when rents are appropriated by the alliance partner (Lavie, 2006).

Building trust and installing conflict resolution mechanisms can limit such leakage (Kale, Singh, & Perlmutter, 2000); still, most of the appropriation potential hinges on the good faith of the alliance partners (Lavie, 2006). Therefore, firm-specific factors, such as opportunistic behaviour, bargaining power and the absorptive capacity of alliance partners, affect their respective ability to extract spill-over rents from the partner's (unintentionally) shared resources (Kumar & Nti, 1998; Lavie, 2006; Mowery, Oxley, & Silverman, 1996).

As previously elaborated, competitive advantages are only present when the mechanisms to generate rents cannot simply be imitated by competing firms, or in this case, firm dyads and networks (Dyer & Singh, 1998). In the case of relational rents, barriers to imitation include:

- Causal ambiguity, meaning a lack of understanding of cause-and-effect interactions between resources and competitive advantage (McIver & Lengnick-Hall, 2017)
- Time compression diseconomies, referring to the fact that the faster resources are developed, the higher the costs a firm would incur – i.e., the inability to rush resource and capability development (Dierickx & Cool, 1989; Knott, Bryce, & Posen, 2003).

- Interorganisational asset connectedness, which encompasses two concepts: One, asset mass efficiencies ('success breeds success') describing the phenomenon of adding increments to an existing asset stock eased by possessing high levels of that stock. Second, asset interconnectedness states that the ease of building an asset stock not only depends on the existing stock level of *that* asset but also levels of other assets (Dierickx & Cool, 1989).
- Partner scarcity, or a firm's ability to find a partner with complementary resources and relational capabilities (Dyer & Singh, 1998).
- Indivisibility of jointly created resources that are only accessible through the alliance (Dyer & Singh, 1998).
- Institutional environment fostering trust and controlling the opportunism of alliance partners (Dyer & Singh, 1998).

3.1.3 The Relational View's Relevance to Buyer-Supplier Relationships

Over the past decades, organisations have tended to consolidate their supplier base for a number of reasons: to reduce coordination and communication efforts, achieve volume consolidation and quantity discounts, increase economies of scale based on order volume and learning curve effects, reduce lead times due to dedicated capacity and inventory, reduce logistical costs, improve customer service, as well as factors relating to relationships with suppliers. Organisations are looking to build trust through more frequent and personal communications with suppliers, to involve them in product development and better coordinate replenishment (J. Chen & A. Paulraj, 2004).

Relationships have not only become closer but more long-term as well. With increasing specialisation as well as the need to provide customers with more information regarding materials, processes, performance and, sometimes, even cost structure, the cost of sourcing and onboarding suppliers has risen (Sako & Helper, 1998). Organisations, therefore, tend to spend more time selecting suppliers and undertaking larger business volumes with longer-term contracts (Gélinas, Jacob, & Drolet, 1996; Hahn, Pinto, & Brag, 1983). In addition, organisations have recognised the strategic benefits of deliberately managed long-term relationships: Not only do they increase supplier performance (Carr & Pearson, 1999, 2002) and, thus, the performance of the overall supply network (Choi & Hartley, 1996), they can help to create a well-working and resilient network (Kotabe, Martin, & Domoto, 2003).

Closely related to the previous aspect is the fact that suppliers are increasingly involved in the development of products (Ragatz, Handfield, & Petersen, 2002; Ragatz, Handfield, & Scannell, 1997). Suppliers have been found to account for approximately 30% of quality issues and 80% of product lead-time challenges (Burt & Soukup, 1985). Organisations have traditionally involved suppliers in developing products because they hope to achieve a shorter time-to-market, improved quality, lower costs, an improved market share, a competitive advantage and/or greater intellectual capital (Glynn, 1996; Kessler & Chakrabarti, 1996). More recently, organisations have also engaged their suppliers in improving environmental performance and realising sustainability ambitions (Kang, Yang, Park, & Huo, 2018; W.-Y. Li, Chow, Choi, & Chan, 2016). One reason for this move is the realisation that a company's end-to-end supply chain emissions tend to be much higher than the direct emissions from their own operations, even more so for consumer-facing sectors (Burchhardt, 2021). Furthermore, increased pressure from

stakeholders, including customers, regulators, investors, and employees, requires companies not just to maximise their profits but to account for how, i.e., under what circumstances, these profits were made.

The relational view, on one hand, helps to understand a competitive environment that has shifted from an inter-firm (single firms competing) to an inter-value chain or value network arena (value chains competing) (Hult, Ketchen, & Chabowski, 2007; Lambert & Cooper, 2000; Zhu et al., 2008). In an era of globalised supply chains, firms perceive themselves as parts of larger networks competing with other networks with the goal of obtaining a collaborative advantage (Ahuja, 2000; J. Chen & A. Paulraj, 2004; Miles & Snow, 1986; Thorelli, 1986). In this sense, managing a value chain means designing and maintaining a network of interdependent relationships fostered through strategic collaboration (J. I. Chen & A. Paulraj, 2004, p.119).

On the other hand, the relational view provides the mechanisms to understand one source of how companies are more successful at realising circular design principles than others. Due to the fact that the theory entails a comprehensive explanation on how some companies, through the means of collaborating with value network actors, outperform their competition. Zooming in on a key collaborative opportunity in the value network, the relational view sheds light on what drives and hinders collaborative efforts for circular design both from a partnership configuration and collaborative practice perspective.

Additionally, recent global events, such as the COVID-19 pandemic or the blockage of the Suez Canal, have served to further highlight the interconnectedness of value chain actors as well as the resulting vulnerabilities (Schmid, 2021). Organisations are

becoming increasingly aware of the risks that extreme climate events, political instability and trade wars present and have started to monitor and mitigate these risks beyond their organisation's boundaries and throughout their value chain to prevent shortages or extended delivery times (Schmid, 2021). At the same time, regulators are tightening their grip, requiring firms to adhere to non-financial reporting standards and performing due diligence on their upstream value chain activities, including their social and environmental footprint (European Commission, 2022). Transitioning from a linear to circular economic system requires interactions based on collaboration in value networks; Thus, better understanding and actively engaging in collaboration with suppliers can support the transition to a circular economy (Gupta, Chen, Hazen, Kaur, & Gonzalez, 2019; Köhler, Sönnichsen, & Beske-Jansen, 2022).

3.1.4 The Natural-Resource-Based View of the Firm

The natural-resource-based view (NRBV) criticises that constraints imposed by planetary boundaries (*the biophysical environment*) are not considered in the RBV. In his seminal paper, Hart (1995) reasons that competitive advantage is increasingly rooted in capabilities driving sustainable economic activities. His framework assists companies in incorporating environmental concerns into strategic management. It consists of three strategic capabilities, the environmental driving forces behind them, necessary key resources and the resulting competitive advantage (Hart, 1995), as seen in Table 6.

Table 6: The conceptual framework of the NRBV by Hart (1995)

Conceptual Framework of the NRBV			
Strategic Capability	Environmental Driving Force	Key Resource	Competitive Advantage
Pollution Prevention	Minimise emissions, effluents, and waste	Continuous improvement	Lower costs
Product Stewardship	Minimise life cycle cost of products	Stakeholder integration	Pre-empt competitors
Sustainable Development	Minimise environmental burden of firm growth and development	Shared vision	Future position

The interconnected strategic capabilities are pollution prevention, product stewardship and sustainable development. *Pollution prevention* entails the reduction, change, or prevention of emissions and effluents during the manufacturing process; in a process of continuous improvements companies can realise a cost advantage. While companies might realise several quick wins with incremental adjustments, further reductions in emissions become progressively difficult and require broader changes in products, processes, and technology. The focus of this strategy lies on building new capabilities in manufacturing and operations. (Hart, 1995)

Internalizing the cost of environmental impacts of value chain activities is considered *product stewardship*. These environmental effects are typically analysed over a product's entire lifespan (life cycle analysis, LCA). The overlap with circular economy thoughts becomes obvious when looking at the criteria: Use of renewable materials and only at their rate of replenishment, avoid the use of harmful materials, low environmental impact in the use phase and suitability for reuse and recycling. Product stewardship allows companies to move past environmentally harmful business models, reduce liability

through redesign of products and develop new products with lower life-cycle cost. By pre-empting the competition, companies might secure access to preferred but limited resources or establish rules, regulations or standards in the market that are tailored to their capabilities. A product stewardship strategy thus guides the selection of raw materials and disciplines product design. (Hart, 1995)

Hart (1995, p.1002) defines a *sustainable development* strategy as a compelling, shared long-range vision to create the internal pressure and enthusiasm needed to realize the changes. The organisational context, which includes strong leadership and management commitment, thus provides a breeding ground for the accumulation of resources necessary for sustainable development (Hart, 1995). An organization cannot single-handedly achieve the unilateral changes needed to achieve sustainable development: broader collaboration for system redesign is needed. Therefore, a sustainable development strategy will, at some point, go beyond the company and include collaboration. Hart (1995)

3.2 Buyer-Supplier Collaboration

3.2.1 Conceptual Foundations

Buyer-supplier collaboration is defined as an intentional and voluntary interaction (linking or sharing of information, resources, activities, and capabilities) between a buying company and its supplier directed towards the achievement of a common goal or purpose that could not be achieved individually (Brown et al., 2018; Bryson, Crosby, & Stone, 2006; Cao, Vonderembse, Zhang, & Ragu-Nathan, 2010; Wood & Gray, 1991). Supplier integration is the degree to which a focal firm (strategically) collaborates with its suppliers and manages intra- and inter-organisational processes (Flynn, Huo, & Zhao,

2010), making the level of supplier integration an indicator or measure of the intensity of buyer-supplier collaboration.

This understanding of buyer-supplier collaboration is deliberately focused: It does not include the process of identifying and selecting potential partners or aspects of capturing value and attributing it to collaborating parties (for this, see: Brown, Von Daniels, Bocken, & Balkenende, 2021). Buyer-supplier collaboration in this context is also primarily a dyadic relationship, not involving additional parties such as tier-2 suppliers or actors further up the value chain, such as raw material manufacturers (as explored by Grimm, Hofstetter, & Sarkis, 2014). The purpose of this narrower conceptualisation is to keep the empirical research focused on core collaborative practices and to be able to explore these practices more deeply.

As organisations are increasingly pressured by regulators, consumers, and investors to transition to a circular economy, competitive advantage is increasingly derived from the generation of sustainable economic activities (Hart, 1995). Gold, Seuring, and Beske (2010) observe that for organisations trying to simultaneously ensure economic, environmental, and social performance, collaboration and close interaction between value chain actors become crucial. Similarly, circularity or a circular economy cannot be achieved by one organisation alone (Takacs et al., 2020); It requires supply chain actors to mesh like gears, meaning a coordinated collaboration takes place at the eye level. Gimenez and Tachizawa (2012) found that when organisations make efforts to extend sustainability to suppliers, both assessment and collaboration practices have a positive impact on environmental performance and CSR. While assessment practices are typically based on markets or arms-length transactions conducted by the buyer to evaluate and

control its suppliers (Gascoigne, 2002; Krut & Karasin, 1999), collaboration emphasises the joint development of solutions (Geffen & Rothenberg, 2000). But the authors argue that assessment alone is not sufficient to improve environmental and social performance – simultaneous implementation with collaborative practices is needed (Gimenez & Tachizawa, 2012). Similarly, Vachon and Klassen (2006) show that the development of more focused and integrated supplier bases favours greater collaborative environmental practices over monitoring activities.

Partnering with suppliers enables the focal company to share or even delegate responsibilities and risks (Lane & Bachmann, 1998) and enhances the firm's ability to achieve end-to-end management of environmental issues (Noci, 1997). Such relationships can be the source of innovation, learning and improved communication and result not only in a competitive advantage, i.e., economic performance (Zhu & Sarkis, 2004) but also enhance environmental performance (Bowen et al., 2001; Dyer & Singh, 1998; Zhu & Sarkis, 2004), or even improve manufacturing performance in terms of quality, delivery, and flexibility (Vachon & Klassen, 2008). Beyond that, Petersen, Handfield, and Ragatz (2005, p.372) present evidence that early and extensive supplier involvement results in faster product development processes, shortening time to market and saving costs. Beyond that, collaboration with suppliers fosters trust, increases contract duration (i.e., drives longer-term relationships) and enables a more efficient resolution of conflicts as well as the efficient sharing of risk, rewards, and information (Flynn et al., 2010).

Brown, Bocken, and Balkenende (2019) differentiate different levels of collaboration and their respective outcomes in terms of improved circularity. The authors find that low

levels of collaboration are usually centred on the product level, such as improving compliance, eco-design and -efficiency, leading to incremental improvements to business-as-usual by mobilising existing innovation capabilities mostly at the firm level. New market opportunities can be realised by stepping beyond firm boundaries, engaging the value chain network to gain and generate knowledge, so that novel products, services, and business models can be created. Finally, the highest levels of collaboration, involving novel cross- and multi-sector party configurations, generate dialogue, foresight, and experimentation able to unlock radical, systemic innovation. The resulting products, services and business models are impossible to achieve and implement by any individual party on their own. (Brown et al., 2019)

3.2.2 Key Dimensions of Buyer-Supplier Collaboration

Several studies mention some sort of prerequisite or **enabling factor** for buyer-supplier collaboration. On a firm level, organisations need to take a proactive stance on environmental issues, commit themselves to their ambitions in environmental and collaborative regards (Bowen et al., 2001; Pagell & Wu, 2009) and take a strategic approach to sourcing (Bowen et al., 2001). Furthermore, collaborating organisations need to invest in developing cooperative activities (Brown et al., 2018; Vachon & Klassen, 2006). A related factor is the collaborating partners', especially the involved staff's, literacy in environmental issues, the technical skills of sourcing staff as well as the presence of sourcing policies & procedures as guardrails and the implications for sourcing decisions (Bowen et al., 2001). Franco (2017) also highlights the role of an actor's supply chain position and their relative bargaining power in determining their

leverage of innovation push/pulls as well as their attractiveness as a co-innovation partner.

Regarding specific collaborations, researchers mention the importance of **mutual trust**, having shared or even **collective goals** and developing a mutual understanding of responsibilities regarding environmental performance (Brown et al., 2018; Cao & Zhang, 2010; Franco, 2017; Vachon & Klassen, 2008). Another factor is clear **governance mechanisms** and safeguards, either informally or formally (Brown et al., 2018; Petersen et al., 2005). Additionally, buyers are encouraged to ensure supplier continuity and reduced risk for suppliers: This applies in terms of the relationship continuity, but also entails support so that suppliers can stay in business, thrive, innovate, and grow (Pagell & Wu, 2009).

A key component of buyer-supplier collaboration is the **sharing of knowledge, technology or other resources** (Brown et al., 2018; Petersen et al., 2005) that can happen to varying extents, depending on the intensity and goal of the collaboration. An initial step usually includes establishing transparency (Karell, 2018; Pagell & Wu, 2009) or 'tactical integration' to manage the basic informational and material flows (Vachon & Klassen, 2006). This can go as far as suppliers and buyers 'opening their books' to share sensitive information about costs, margins, internal processes and, in the case of suppliers, detailed information about the upstream value chain. Both parties gain realistic information about trade-offs involved in achieving set goals in terms of cost and performance (Petersen et al., 2005).

Other examples include staying on top of emerging technologies, market trends and industry standards as well as leveraging complementary knowledge on technical,

financial or market feasibility regarding these technologies (Petersen et al., 2005). Exchanging tacit knowledge in strategic areas to be used for product development, technical training of suppliers (Vachon & Klassen, 2006) or building technical capabilities for suppliers and buyers represents another key aspect of resource sharing (Petersen et al., 2005). Pagell and Wu (2009) mention the practice of supplier development to improve the performance of a firm's own and other value chains. Compared to unilateral supplier development, the sharing of resources can also lead to new discoveries and joint learning (Brown et al., 2018; Petersen et al., 2005), a topic mentioned in the context of co-development activities.

A frequent context within which to observe buyer-supplier collaboration is **product or material development** (Franco, 2017; Karell, 2018), which not only requires a substantial level of information sharing but also **a continuous exchange** (Karell, 2018). Several authors (Lenvis & Gretsakis, 2001; Vachon & Klassen, 2006; Zhu & Sarkis, 2004) observed that especially addressing sustainability-related challenges in product development drives organisations to a more external orientation with increased supplier interaction and coordination. Vachon and Klassen (2008) mention collaboration to jointly reduce the environmental impact of firm activities as the main component of environmental collaboration. Related to co-development, aspects of 'mutual problem solving' or 'joint action' are also quite commonly addressed as a collaborative practice (Bryson et al., 2006; Emerson, Nabatchi, & Balogh, 2011; Petersen et al., 2005; Ritter & Gemünden, 2003; Vachon & Klassen, 2006).

When collaborating more closely, buyers and suppliers can also engage in **joint planning and decision-making** (Bryson et al., 2006; Cao & Zhang, 2010; Majchrzak et

al., 2014). Petersen et al. (2005) describe joint decision-making and planning in the process of goal setting as a means to ensure supplier buy-in for goals. Vachon and Klassen (2008) view joint planning as a way to anticipate and resolve environmental-related issues and emphasise the importance of joint decision-making in improving the environmental footprint of products. Bryson et al. (2006) distinguish deliberate, formal planning, including better distinguishing key components (mission, objectives, roles and responsibilities, project phases, implementation steps) from emergent planning where these components take shape over time.

Finally, **respective roles and responsibilities** represent another dimension of buyer-supplier collaboration, concerned with which alliance partner – buyer or supplier – assumes the driving role in the relationship. Again, there can be a conscious decision about the level of integration between buyer and supplier, as well as a clear assignment of responsibilities (incl. coordinating and administrative tasks) versus emerging or more implicit forms (Brown et al., 2021; Ritter & Gemünden, 2003). On one end of the spectrum, the buyer only consults with the suppliers to get input on specifications and design but independently makes all final decisions (Petersen et al., 2005). On the other end, the supplier drives development independently and is empowered to execute it after being informed of the requirements of the buyer (Petersen et al., 2005).

This latter approach comes close to the vertical integration of the supplier (Grossman & Hart, 1986) in the sense that the supplier is so closely integrated that it almost acts as an organisational department. Such supplier-driven relationships are commonly observed in the automotive industry, where the buyer might even own specialised tools or inputs used by the supplier to manufacture components (Lockstrom, Schadel, Moser, & Harrison, 2011; Monteverde & Teece, 1982).

A mixed form occurs when the buyer and supplier are equally involved in development and assume equal responsibility in driving the relationship, fostering co-development as well as joint decision-making (Petersen et al., 2005). The better suppliers understand the requirements and ambitions of buyers, the more they can focus their capabilities to react to these needs and come up with environmental improvements, resulting in supplier-driven innovation (Vachon & Klassen, 2008).

4 Buyer-Supplier Collaboration in the Circular Economy

4.1 Connecting the Concepts of Buyer-Supplier Collaboration and Circular Economy

The circular economy does not just trigger a technological transformation; it also disrupts existing market structures with new forms of inter-firm collaboration (Mulder, Poldner, & Vellema, 2021). Organisations' interest in forging a 'circular advantage' is being piqued, and pioneering companies are exploring and adopting circular strategies such as pursuing zero-waste manufacturing, selling services instead of products and recovering their own-brand goods for refurbishment and resale (Raworth, 2017). However, so far, the majority of organisations have struggled to translate the concept of the circular economy into their corporate strategies, business models and operations beyond incremental efforts (Khan, Daddi, & Iraldo, 2020). Raworth (2017) criticises current CE strategies for being overly top-down, opaque due to proprietary technology and patents and driven internally by companies seeking to establish control over their used products, resulting in disconnected and fragmented efforts that do not achieve the desired impact in terms of circularity.

Some scholars argue that companies need to tap into new resources (Khan et al., 2020) and develop beyond eco-efficiency (mitigate negative footprints) towards eco-effectiveness (positive interactions with the ecosystem), and firms need to develop systematic connections among involved value network actors (Braungart et al., 2007; Leising, Quist, & Bocken, 2018).

Collaboration has a proven track record when it comes to realising sustainable strategies throughout the value network (De Angelis, Howard, & Miemczyk, 2018; Pagell & Wu, 2009). Nevertheless, establishing collaborations with a diverse group of actors from the value network drives up complexity and results in challenges regarding the alignment of goals, incentives and practices conducive to the successful advancement of circularity (Köhler et al., 2022; Rajala, Hakanen, Mattila, Seppälä, & Westerlund, 2018). Therefore, understanding the key dimensions of buyer-supplier collaboration in the context of realising circular design principles is crucial (Touboulic & Walker, 2015). The link between collaboration in sustainable supply chain management and the resulting competitive advantage is well-established (Gold et al., 2010); less so is the relationship between supplier collaboration and impacts on design principles. The relational view, as a theoretical perspective concerned with inter-firm relationships, provides a useful backdrop to illustrate the necessity of buyer-supplier collaboration in the context of pursuing circular design principles.

The relational rents of the relational view can be framed as prerequisites of buyer-supplier collaboration in a circular context:

- Enhanced **knowledge-sharing routines** are required to enable a flow of information sharing to support the fundamental reconfiguration of the value network needed to develop and implement new materials, product designs, processes, and business models (O. Khan et al., 2020; Köhler et al., 2022). No organisation can achieve circularity on its own, but knowledge-sharing routines can trigger and enhance innovative activities and learning processes both within and between firms (Köhler et al.,

2022; Lozano, Bautista Puig, & Barreiro-Gen, 2021). This finding is consistent with earlier studies indicating that innovation can be linked to the suppliers or networks in which firms are embedded (Jean, Kim, & Sinkovics, 2012). In their study, Mulder et al. (2021) noted how through feedback and reflection, alliance partners shared proprietary knowledge to jointly solve unanticipated problems. A tolerance for trial and error ensued among the alliance partners, driving reconfiguration activities (Mulder et al., 2021).

- Furthermore, access to information is crucial for spotting market and collaboration opportunities as well as raising awareness of potential risks and threats (Easterby-Smith, Lyles, & Peteraf, 2009). The relational view also illustrates the incentive of relational rents, which makes alliance partners willing to even share proprietary knowledge (Dyer & Singh, 1998; Touboulic & Walker, 2015), thereby leaving both parties in a better position – in terms of competition and circularity – than they would be if they did not share information.
- Sensing and leveraging the **complementary resources** and capabilities of other suppliers is an essential component of an effective collaborative relationship (Teece, 2007; Teece, 2020). In a highly specialised and vertically dis-integrated sector like the textile industry, apparel brands need to find and work with suppliers that build on their knowledge and skills gaps, such as competencies in circular material development and insights about the upstream supply market landscape.

- Combining complementary resources and sharing knowledge in novel ways can result in **relation-specific assets** (Dyer & Singh, 1998) or a 'whole that is greater than the sum of its parts' (Aristotle). The circular transition does not just require significant capital and resource investments that are easier to make within the scope of an interfirm relationship (De Angelis et al., 2018), but the unique combination of complementary resources has the potential to unlock achievements beyond eco-efficiency (Braungart et al., 2007): fundamentally rethinking material development and sourcing processes, how and with what material apparel is made, what purpose a garment serves and what its life-cycle will look like. Thus, investing in co-specialisation is a key factor in successfully establishing circular supply networks (Gold et al., 2010).
- Successful buyer-supplier collaboration rests on **effective governance.** On one hand, sharing knowledge and resources creates room for the opportunism of alliance partners, a threat which can be addressed through formal or informal governance mechanisms (Fey & Birkinshaw, 2005). On the other hand, effective governance mechanisms ensure an effective organisational setup for collaboration as well as an adequate, targeted, timely and flexible flow of information (Beske, Land, & Seuring, 2014; Mulder et al., 2021; Teece, 2020). As a result, knowledge-sharing is optimised, complementary resources can be fully leveraged, and relationship-specific assets are deployed effectively (Mulder et al., 2021).

Implementing circular design principles through buyer-supplier collaboration also illuminates links between the relational view and the natural resource-based view. Through the collaborative realisation of design principles, apparel brands find ways to:

- reduce resource use and waste generation, initiate the closing of resource loops
- avoid the use of hazardous chemicals in material and production processes
- re-design products in a way that minimises environmental impacts by making them durable, versatile, easy to maintain and repairable.

The realisation of circular design principles contributes to the interconnected strategic capabilities of pollution prevention and product stewardship. The two principles 'Design to Reduce' and 'Design to Recycle' can be linked to the capability of *pollution prevention:* It entails the reduction, change, or prevention of emissions, effluents, and waste during the manufacturing process (Hart, 1995). Internalising the cost of the environmental impacts of value chain activities is considered *product stewardship* (Hart, 1995).

The overlap with circular design principles becomes obvious when looking at the criteria of the product stewardship capability: using renewable materials and only at their rate of replenishment, avoiding harmful materials, lowering environmental impacts in the use phase and ensuring suitability for reuse and recycling (Hart, 1995). A product stewardship strategy thus guides the selection of raw materials and disciplines product design (Hart, 1995). All the described circular design principles are conducive to developing a product stewardship capability.

In summary, buyer-supplier collaboration is not just beneficial but indispensable for implementing circularity: Alliance partners acquire and develop requisite resources necessary for circular outcomes (Batista, Bourlakis, Smart, & Maull, 2018; Bauwens et al., 2020; Defee & Fugate, 2010; Khan et al., 2020; Mulder et al., 2021) and develop governance mechanisms to effectively leverage them (Mulder et al., 2021). Compared to a linear setting, where interfirm collaboration is a beneficial practice in terms of competitive benefits, in a circular context, there is no alternative. Already decades ago, Hart (1995) linked sustainable strategic capabilities with competitive benefit and argued that inter-organisational collaboration is an instrumental factor in achieving the unilateral changes needed for sustainable development. **An in-depth understanding of the dimensions of buyer-supplier collaboration, i.e. the specific collaborative practices, necessary to achieve the implementation of circular principles is missing** (Kirchherr et al., 2018; Köhler et al., 2022).

To achieve a **granular view of collaborative circular design** the following is required:

- The **necessary and/or beneficial collaborative practices** supporting the realisation of circular design principles.
- Knowledge on any **hierarchy within these practices**, to provide insights on the prioritization and sequence the practices ought to occur in.
- An understanding of **rents generated** through the collaborative practices: Do the generated (relational) rents or the mechanisms through which they are generated change in the context of collaborative circular design? Are there additional rents and how are they generated?

- A grasp of the **relationship dynamics**, including **barriers** and **conducive factors** for circular design collaboration.
- How **trade-offs** when realising circular design principles **are addressed**, including whether and how collaborative practices can contribute to resolving or mitigating them.

In a linear context, authors have warned of potential downsides to supplier collaboration, despite its benefits. For instance, a supplier can forego an opportunity to build economies of scale and compete successfully in a low-cost position (Dyer, 1996). A buyer might become overly dependent on a supplier's knowledge and gradually lose the ability to specify the requirements needed when sourcing an alternative supplier (Fine & Whitney, 1996). Generally, a single-source strategy comes with inherent continuity risks (Singh & Mitchell, 1996). Scholars, therefore, argue for a sweet spot regarding the level of supplier integration trying to balance the desired relational rents and concentration risk exposure (Corsten & Felde, 2005). While the implementation of a circular economy may not have advanced far enough for economies of scale considerations to become a core concern of value network actors, the **question remains as to whether there is a desirable level of buyer-supplier collaboration, or rather, supplier integration, to achieve optimal circularity**.

4.2 Suggested Theoretical Model

This study attempts to connect buyer-supplier collaboration practices with the realisation of circular design principles, hoping to achieve more granularity in understanding the varying dimensions of buyer-supplier collaboration and how they support the realisation of circular design principles. Therefore, I am interested in how closely buyers and

suppliers collaborate and whether there is an optimal level of intensity, or a so-called sweet spot, as opposed to a 'more is always better' relationship. The intensity of buyer-supplier collaboration in this initial theoretical construct is, therefore, represented as the level of supplier integration because the latter concept per definition represents an indicator of the intensity of buyer-supplier collaboration (see 3.1). Supplier integration is comprised of the following factors: frequency of interaction, sharing of resources, joint planning and decision-making, as well as respective roles and responsibilities. These factors represent the key aspects identified in the previous literature review as well as the scope of collaborative practice studies in this research.

The realisation of circular design principles constitutes the desirable outcome and is divided into product integrity (design to reduce, design for durability, design for extended use) and product cyclability (design for repair, design for recycling). The categorisation of product integrity (strategies to narrow and slow resource loops) and product cyclability (strategies to close resource loops) serves to distinguish the design principles according to two key dimensions and provides a basis for further analysis of the empirical insights; for example, to observe the emphasis brands place on one or the other dimension or the connection they have to different levels of supplier collaboration or different profiles/ combinations of collaborative practices. The circular design principles were identified and elaborated on in the previous literature review and are tailored to the research context of the apparel industry.

Level of Supplier Integration – Intensity of Buyer-Supplier Collaboration in Product	
Dimension/ Variable	**Construct Source**
Frequency of interaction	Bryson et al. 2015; Emerson et al. 2011; Zhu & Sarkis 2004; Vachon & Klassen 2006
Sharing of information/ technology/ resources	Petersen et al. 2005, Vachon & Klassen 2006/2008)
Joint planning & decision making	Cao & Zhang 2010; Petersen et al. 2005; Vachon & Klassen 2008; Bryson et al. 2006; Majchrzak et al. 2014
Engaging in co-development of materials	Franco 2017, Vachon & Klassen 2006/2008, Karell 2018, Lenvis & Gretsakis 2011
Driver of activities	Petersen et al. 2005; Brown et al. 2021; Ritter & Gemünden 2003; Vachon & Klassen 2008

Desired Outcome: Realisation of Circular Design Principles	
Dimension/ Variable	**Construct Source**
Product Integrity • Design to Reduce: *reduced use of resources* • Design for Durability: *resist obsolescence – either physical or emotional* • Design for Extended Use: *facilitate maintenance & upgrades*	adapted from den Hollander et al. 2017
Product Cyclability • Design for Repair: *self-repair, manufacturer repair, 3rd party repair* • Design for Recycling: *facilitate the use in future cycles*	adapted from Goldsworthy et al. 2014

Figure 2: The initial theoretical model based on the reviewed literature as a basis for the following empirical work

A visual representation of the initial theoretical model shown in **Fehler! Verweisquelle konnte nicht gefunden werden.** synthesises the previously reviewed literature in the space of buyer-supplier collaboration, collaboration in the circular economy, as well as circular design principles. The previously described outcomes of buyer-supplier collaboration (see 3.2.2) include improvements in both environmental and competitive performance. The realisation of circular design principles surely falls under the category of environmental performance. Considering the complexity inherent to the realisation of circular design principles, I argue that organisations, through collaborating with suppliers, become better equipped to put circular design principles into practice. In consequence, I proposition that higher levels of supplier integration will result in the realisation of more circular design principles compared to low levels of supplier

integration. No supplier integration can be assumed to result in no or limited realisation of circular design principles. These hypotheses are in line with the findings of previous studies (see 2.3) in that collaboration with suppliers improves the resource profile of alliance partners in a way that cannot be achieved by any of the involved actors on their own.

5 Research Design and Methodology

This chapter describes the path that was taken to answer the chosen research question and clarifies the research context and the underlying paradigm, as well as the specific research steps that were taken, including their methodology. The first section outlines the context and overall approach, the second section delineates the case selection process, and the third section is dedicated to the iterative process of collecting and analysing data.

5.1 Context and Approach

A case study is an exploration of a 'bounded system' (i.e., an organisation) through detailed, in-depth data collection, involving multiple sources of evidence (Creswell, 2012; Yin, 2018). The aim is not to produce statistical generalisations but to obtain holistic, contextual, and in-depth knowledge (Eriksson & Kovalainen, 2016) and to pursue analytical generalisations (Yin, 2018). For the purpose of this study, a multi-case design is used: An initial theoretical construct informs the study, and data is linked to the emerging theory in an iterative process (Eisenhardt, 1989). Multiple sources of evidence are used to produce a well-defined theoretical construct that is then compared with each case as well as the literature (Eisenhardt, 1989). Each case incrementally increases the researcher's ability to generalise findings (Eisenhardt, 1989).

The chosen approach, typological theorising, allows addressing the complexities in the initial theoretical model without oversimplifying, creating an inventory of all possible cases and clarifying the similarities and differences between them (George & Bennett, 2005). It is the theory that specifies independent variables and delineates them into categories for which the researcher measures cases and their outcomes. This allows for

the generation of not only hypotheses on how these variables operate individually but also allows for some contingent generalisations about how and when the variables produce effects on specific dependent variables. The variables can be specified as nominals, ordinals, or intervals. In other words, typological theories specify the pathways through which combinations of independent variables and types relate to outcomes, the dependent variable. This approach recognises the reality that outcomes can come about through different pathways (equifinality) (George & Bennett, 2005, p.235). It leverages some features typically associated with quantitative work for the benefit of providing more structure to the data analysis and making the resulting conclusions more powerful.

A common criticism of this approach, and qualitative research methods in general, is the lack of (statistical) generalisation. Bennett, a co-author of one of the seminal works on case study methods, counters this argument with the metaphor of a murder investigation: The goal is not to find thousands of pieces of evidence in circumstantial hints but to combine the critical information into a strong chain of evidence (A. Bennett, 2021). At this stage of maturity within the research field, it is important to explore and understand the mechanisms behind buyer-supplier collaboration and circular design principles comprehensively. This is especially important given that the desire to realise circular design principles is only just gaining traction in the textile industry and obtaining a sufficient number of data points for large-N statistical methods is likely to prove challenging. Also of note is the industry's wariness to open up and share information, hindering the acquisition of participants. At the same time, this study can lay the foundations for future quantitative work potentially extending beyond industry borders.

In this study, supplier integration represents the independent variable and is examined according to the following dimensions: coordination and frequency of interaction;

sharing of information, technology, and other resources; respective roles and responsibilities (supplier vs. buyer-driven activities); and presence of joint decision-making and planning.

The dependent variable, or the desired outcome, is the realisation of circular design principles. Possible values include the number of realised design principles (design to reduce, design for durability, design for extended use, design for repair, design for recycling). The specification of the dependent variable benefits from the tangible nature of design principles and the clear definition and differentiation of them as opposed to being a vague construct that proves hard to observe and measure.

In typological theorising, each dimension or variable is then assigned a range of possible values (A. L. George & Bennett, 2005). The challenge here is to strike the balance between capturing the richness of the phenomena and not getting lost in a multitude of types. Each new variable affects the number of types. At the same time, excluding a potentially relevant variable can harm the validity of inferences more than the inclusion of unspurious variables. This consideration differs from statistical research, where each additional variable requires a corresponding increase in cases for positive degrees of freedom (A. L. George & Bennett, 2005).

Table 7 includes an overview of possible values for each dimension of the dependent and independent variables in this research. Four variables are dichotomous, and two, frequency of interaction and the number of realised design principles, are represented as a scale. These scales are defined based on existing studies and validated by industry experts.

Table 7: Possible values of independent and dependant variables as well as possible integration archetypes that represent combinations of IVs.

	Dimension/ Variable	**Possible Values**	**Variable Type**
IV	Frequency of interaction	low (1-2 per year), medium (2-5 per year), high (6+ per year)	*ordinal*
IV	Share information/ technology/ resources	yes/no	*nominal*
IV	Joint planning & decision making	yes/no	*nominal*
IV	Engage in co-development	yes/no	*nominal*
IV	Driver of activities	buyer/ supplier	*nominal*
DV	Number of realised circular design principles	none (0), low (≥1, <3principles), medium (3-4 principles), high (>4 principles)	*ordinal*

The next step entails detailing the property space, a long list of all possible combinations of expressions of the independent and dependent variables, reflecting different causal paths, called types. The types delineate the area of investigation and focus the data analysis activities, making complex phenomena more tangible and manageable. Ideally, the types are mutually exclusive and exhaustive in that every case fits into a type and only one type. Types should be designed in a way to minimise within-type variation and maximise between-type variation. The goal is to identify characteristics or clusters of characteristics that differentiate instances of the phenomenon. Ultimately, typological theorising aims to identify the variety of causal patterns that can lead to the outcome of interest, assess the causal properties or powers of factors and determine the conditions

under which these patterns occur. In deductive typological theorising, this process is guided by theory (A. L. George & Bennett, 2005).

While a fully specified typological theory provides hypotheses on all mathematically possible types, this study follows a deductive approach in that a theory-based initial framework defines the property space and focuses on types (i.e., combinations of variables) that are likely and have the biggest implications for theory-building (George & Bennett, 2005, p.235).

For this reason, starting with all mathematically[2] possible types, the property space is reduced by eliminating impossible and highly unlikely types. This process is also called logical compression (Elman, 2005):

- If the frequency of interaction is low, it is unlikely that buyers will share information or resources or engage in joint activities (decision-making, planning or co-development) at a meaningful level.
- If no information or resources are shared, it does not make sense for joint activities to happen.
- If the frequency of interaction is high, it is assumed that at least sharing of information and resources takes place – otherwise, there is no reason to interact at this rate.
- The supplier can only realistically assume a driving role when the level of interaction is medium or high, resource-sharing and co-development occur, as well as joint decision-making and planning.

[2] Mathematical in the sense that as a starting point, all combinations of IV and DV are listed, regardless of how plausible or unlikely they are.

- Co-development activities can take place without joint decision-making and planning, given that the buyer remains in a strong driving role.

The types remaining after the logical compression, as presented in Table 8, are suited to the previously described research objective, so that no further reduction of the property space is required. It does seem, however, that the IV interaction frequency is not a good determinant of the dependant variable, as a high interaction frequency can result in high, medium, or low DV outcomes. Heeding the advice of George and Bennett (2005) and erring on the side of caution, the interaction frequency is kept as a variable, as the premature exclusion of a variable can harm the validity of inferences more than the inclusion of an irrelevant variable. Whether or not design principles are considered as 'realised' will be determined based on the self-assessment of the studied subjects, as well as any publicly available information such as websites, own and third-party reports, certifications, etc.

It is important to note that the below presented typology is understood as a starting point going into the case interviews – intensive iteration between cases and the typology is expected – representing a mix of inductive and deductive means (George & Bennett, 2005, p.239). Initially, the theoretical model, typology and questionnaire were challenged and validated in expert interviews with researchers in design/fashion, as well as textile industry experts. This step ensures that the chosen circular design principles, as well as the operationalisation of supplier integration, are relevant and appropriate. Additionally, a pilot study was conducted to further test and validate the interview guidelines, gain some initial learnings on the interview procedure and eradicate any major weaknesses in the research design (Yin, 2018, p.55-57).

Table 8: Overview of all possible types, i.e., excluding types eliminated in the previously described logical compression.

	Interaction Frequency	Share Resources	Joint Planning & Decision Making	Co-development	Driver	Outcome
A	high	yes	yes	yes	supplier	high (>4)
B	medium	yes	yes	yes	supplier	high (>4)
C	high	yes	yes	yes	buyer	medium (3-4)
D	medium	yes	yes	yes	buyer	medium (3-4)
E	high	yes	yes	no	buyer	medium (3-4)
F	medium	yes	yes	no	buyer	medium (3-4)
G	high	yes	no	yes	buyer	medium (3-4)
H	medium	yes	no	yes	buyer	medium (3-4)
I	high	yes	no	no	buyer	low (≥1, <3)
J	medium	yes	no	no	buyer	low (≥1, <3)
K	low	yes	no	no	buyer	low (≥1, <3)
L	low	no	no	no	buyer	none
M	medium	no	no	no	buyer	none

I chose the textile industry as a research context due to its size combined with its atrocious environmental and social footprint. The textile industry is the third biggest manufacturing industry (after automotive and electronics): Globally, it generates over 1.5 trillion Euros every year and employs about 60 million people. If it were a country, its GDP would be the seventh largest, and an estimated 100 million households' livelihoods depend on the cotton industry alone (Buchel, Roorda, Schipper, & Loorbach, 2018).

This immense industry runs on a dirty mechanism: extracting large volumes of non-renewable virgin resources to produce clothes that are often short-lived. Textile production accounts for about 10% of global greenhouse gas emissions and uses vast quantities of hazardous chemicals and water, and in many regions where the latter is

scarce (Ellen MacArthur Foundation, 2017). Consumerism first fuelled an acceleration of fashion creating the phenomenon of fast fashion, where brands like Zara managed to achieve a design-to-retail time of about five weeks and started to introduce more than 20 different collections a year (Nguyen, 2020). Recently, we witnessed the further evolution into the vicious cycle of ultra-fast fashion, with players like Shein, Fashion Nova and Missguided releasing hundreds or even thousands of articles – daily (Coresight Research, 2017). The availability of short-lived trendy items marketed by influencers feeds the consumer's desire to buy even more, at a price point that does not reflect the true cost, environmentally and socially (Nguyen, 2020). Thirty per cent of apparel produced is never sold, and over 50% of garments are disposed of in under a year; a staggering amount is only ever worn once (Sharecloth, 2018). Every year, an average European consumes 26kg of textiles and produces 11.3kg of textile waste (Manhshoven, 2019).

Disposing of textiles usually means landfill or incineration, so that the value of the materials is lost. Only around 1% of textiles are recycled into similar-value items, and around 12% get transformed into lower-value applications such as insulation material. Furthermore, around 0.5 million tonnes of plastic microfibres – equivalent to more than 50 billion plastic bottles – resulting from the washing of textiles are estimated to be released into the ocean each year. Also of concern is the poor and hazardous working conditions of garment workers, often involving modern slavery and child labour. (Ellen MacArthur Foundation, 2017)

5.2 Case Selection

For the case studies, I recruited relevant personnel (sourcing, design, CSR) or supplier representatives with the following company profile: small to mid-sized, mid-range

everyday wear brands based in Europe with already moving towards achieving circularity and sustainability. As the targeted cases would typically only yield 1-2 interviews per case, I aimed for a total number of 15-20 cases. The aim is not to produce statistical generalisations but to obtain holistic, contextual, and in-depth knowledge (Eriksson & Kovalainen, 2016) and to pursue analytical generalisations (Yin, 2018). Striving for minimal differences in parameters outside of the typological theory can facilitate analysis. If the selected cases only or mostly differ in the independent variables, it is less likely that a factor not included will cause the differences in the dependent variable. Therefore, companies similar in industry, market segment, offering, size and ambition are targeted, then highlighting differences in the ways suppliers integrate circular design principles and, in turn, how many circular design principles they are able to realise.

As a result, I interviewed representatives from apparel brands and suppliers active in the outdoor and sports sector, and a second cluster centred on workwear. Both clusters share similarities in that garments must fulfil considerable functional and performance characteristics. Compared to B2C players, workwear has the advantage of higher volumes, longer use cycles and retaining a connection to their end-user. At the same time, some public actors within the workwear clusters are subject to public procurement standards that can influence both a buyer's and supplier's scope of action.

The companies agreeing to be included in the study were of different sizes, unfortunately, a factor which will have to be considered in the analysis to rule it out as a determining factor of the desired outcome and potentially clouding the analysis.

Although the initial idea was to interview multiple representatives per company, in many cases, this proved too difficult to accomplish. Beyond that, many interviewed companies

were unwilling to disclose their suppliers, or the suppliers were unwilling to participate. At the same time, the person interviewed must be among the most knowledgeable on the topic within the company and can be trusted to offer well-rounded insights. Furthermore, for most companies included in the study, there is a significant amount of publicly accessible information available, which, especially in combination with the interview insights, proved to be valuable to the data analysis.

Table 9 includes an anonymised overview of interviewed companies, including some descriptive characteristics for context.

Table 9: An overview of interviewed and anonymised companies including some descriptive characteristics

Case	Interviewee	Role	Type	Industry	Ownership
1	1	Founder	Brand	Outdoor	Private
2	2	Founders	Brand	Outdoor	Private
3	1	Founder	Suppl.	Supplier	Private
4	1	Founder	Brand	Business	Private
5	1	Co-Founder	Brand	Sport	Private
6	1	Owner	Brand	Workwear	Private
7	2	Founders	Brand	Outdoor	Private
8	1	Owner	Brand	Sport	Private
9	1	Brand Development & Comms.	Suppl.	Supplier	Private
10	1	Procurement	Brand	Workwear	Public
11	1	Procurement	Brand	Workwear	Public
12	1	Head of CSR	Brand	Outdoor	Private
13	1	Founder	Brand	Everyday	Private

14	2	Head of Vendor Control, VP Product & Apparel	Brand	Outdoor	Private
15	1	Owner	Suppl.er	Supplier	Private
16	1	Head of CSR	Brand	Outdoor	Private
17	1	Owner	Brand	Outdoor	Private
18	1	CSO	Brand	Outdoor	Private
19	1	Head of CSR	Brand	Outdoor	Private
20	1	Co-Founder	Brand	Outdoor	Private
21	1	Sustainability Manager	Brand	Everyday	Private
22	1	Procurement	Brand	Workwear	Public

5.3 Data Collection and Analysis

The primary data source is semi-structured interviews, which were supplemented with publicly available materials and documents such as websites, annual reports, and media texts. Whenever interviewees granted me access to not publicly available materials, such as communications with suppliers and internal documents, these materials were also included in the analysis. Interview questions fell into one of three categories: organisational context as a short introduction, buyer-supplier collaboration practices and examples as well as circular design principles. Interviewees from apparel companies were asked to elaborate on their relationship to key suppliers and/or mention examples where they collaborated closely with a certain supplier as well as why and how that came about. Supplier representatives were asked about their perceived bargaining power compared to the buying company, as well as their views of the relationship and its different aspects, especially regarding who they perceive to be in a driving role in the relationship. In all interviews, the focus lay on giving interviewees the possibility to

share as much as possible and using the questions mainly to guide conversation when needed to ensure relevant information is captured.

Interviews were recorded and transcribed with the permission of interviewees. The second step was the choice of analytical technique: It is important to note that data collection and analysis are not two entirely separate processes but intertwined and iterative (Eriksson & Kovalainen, 2016). First, I assembled individual case reports, including a general, thematic case description (Eriksson & Kovalainen, 2016). This description serves the purpose of creating a holistic configuration by linking empirical patterns, such as themes and processes (Eriksson & Kovalainen, 2016). The tool MAXQDA, a software for qualitative data and text analysis, supported this process. During the within-type analysis, I performed a preliminary classification in the initial model, which created the opportunity to refine the typology and/or distinguish between different types (George & Bennett, 2005, p.253). As common in typological theorising, there were iterations between both theory and case evidence as well as within-case analysis and cross-case comparisons (George & Bennett, 2005, p.254).

Next followed a cross-type analysis, where types (and the classified cases) were compared with each other and the theoretical model. At this stage, I applied the analytical technique of pattern matching, where I compared empirical patterns with those predicted in theory (Yin, 2018, p.175). Cases that fit within the same type according to their independent variables were compared and were assumed to have the same outcomes. If this was not the case, this 'deviant case' suggests that either the preliminary measurement or the classification was inaccurate for one or both cases and that there were additional variables to be considered (A. L. George & Bennett, 2005). Cases that were the same for

all measured independent variables except one and that differed in the dependent variable allowed for the most-similar case analysis (George & Bennett, 2005; Seawright & Gerring, 2008). If an exogenous variable can be ruled out as the source of outcome variation, the difference in outcome could be attributed to a difference in the independent variable (A. L. George & Bennett, 2005).

The analysis of cases within the property space could also be particularly informative in theory development. One example is a most-likely case where a single variable has such an extreme value that it strongly determines a particular outcome (A. L. George & Bennett, 2005). Based on the initial theoretical model, this does not seem likely, but the possibility was kept in mind when analysing the empirical data. The cross-case report forms the conclusion of the data analysis and includes a comparative component to ensure that marked differences in individual cases do not undermine the multi-case findings (Yin, 2018).

Through this process, the theoretical model was refined in that variables were added or left out, and possible values could be refined, affecting the resulting types. The goal was a set of empirically tested types to explain how different levels of buyer-supplier collaboration affect the type and number of circular design principles realised by an apparel company. From the adapted model, practical implications could be derived that are valid to the apparel industry and potentially to other industries as well.

6 Results

One of the main challenges of case study research is the structured presentation and analysis of results. Having studied more than 20 cases, reporting by individual cases would lose the reader. Instead, this chapter clusters the insights according to the initial theoretical model presented in section 4.2. As can be gathered from Table 9, a total of 22 companies and 25 interviewees are included in the study, which is supplemented by publicly available information such as company reports, websites, etc.

Figure 3 contains an overview of key descriptive information about the cases. Furthermore, the interviews with experts, beyond validating the research approach and initial theoretical model, resulted in additional contextual information and expert opinions on the research question.

Structure of the Chapter

To provide some more context and enrich the following analysis of the included cases, the initial section provides useful descriptive information: When evaluating the types in the following chapter, it is important to consider the effect of descriptive characteristics on the dependent variable or the evaluation of independent variables.

The second section is dedicated to the research-related observations, starting with the level of supplier integration (independent variables), moving on to the circular design principles (dependent variable), and finally, some further observations related to the theoretical model more broadly. For each component of the initial theoretical model, the gathered evidence is presented, and examples are provided for further illustration of the described phenomena. As the cases are anonymised, they are referred to by their number throughout the next two chapters.

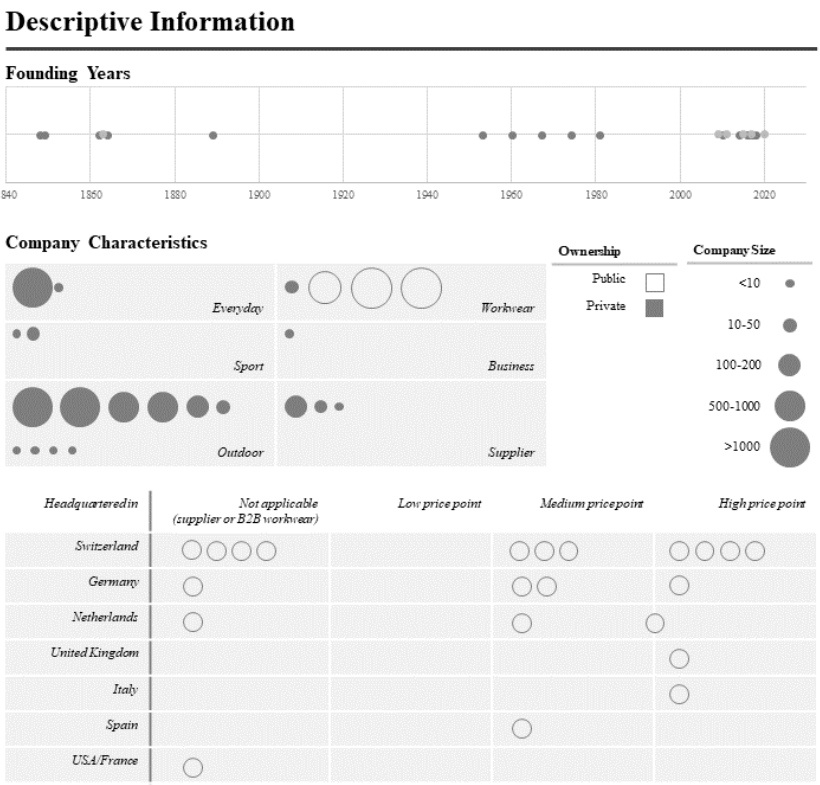


Figure 3: An overview of descriptive case information

6.1 Descriptive Information

Descriptive information is structured according to the following dimensions: Company age, market segments, price point, ownership structure, company size, location and buyer-supplier relationships.

Company Age

In terms of company age, there are three clusters: One group of cases was founded after the turn of the millennium, the second was established in the post-war era after 1945, and the oldest cluster falls between 1848 and 1890. The latter also contains public entities whose founding coincides with or falls within the range of the establishment of a country. The youngest cluster of companies had a strong sustainability ambition since their founding, whereas other companies either clarified or developed their sustainability ambitions over time. This means there is a set of companies who intentionally integrated sustainability ambitions in their foundations from the start versus others that have transitioned or are transitioning towards the adoption of sustainable practices.

Market Segments

The study cases can be grouped into the six market segments of *Everyday, Sport, Outdoor, Workwear, Business* and *Suppliers*. The segmentation is purpose-related in that it reflects different use cases of apparel (as opposed to gender or geographic-based segmentation). For this study, it is useful to consider the requirements of different apparel use cases, such as varying performance or aesthetic requirements.

The **Outdoor** segment is traditionally less affected by fast-changing trends than Everyday and Business segments. On the other hand, the Outdoor segment must create apparel that is durable to be enjoyed by the consumer over time and use synthetic, non-recyclable and complex material blends and coatings to achieve the desired performance characteristics (water- and wind-proof, breathable, lightweight) (Gardetti & Torres, 2017).

The architecture of this segment's average product tends to be complex, meaning a product is made of many different materials and components (Novak & Eppinger, 2001). A complex product architecture makes it time- and resource-intensive, and it may even be impossible to break down the product, separate materials and recycle them at the end of the use phase. This factor, combined with the low availability of ecological materials and components, makes the realisation of circular design principles more complex (Franco, 2017). Similar points can be made for the **Workwear** segment, as the included companies supply employees in physically demanding jobs.

In contrast, the **Everyday** and **Business** segment are more susceptible to trends, tend to have a shorter product lifespan and more aesthetic requirements, but simpler product architectures and fewer performance requirements. These segments typically face more price pressure than performance apparel (Outdoor, Sport, Workwear) that can justify a higher price point with the performative characteristics of the product.

In this study, **Outdoor** is by far the most represented segment, including almost half the studied cases (10), followed by Workwear (4 cases) and Suppliers (3 Cases). Within **Workwear**, cases 10, 11 and 22 are public organisations that source large volumes of workwear for their workforce. In all these cases, a large proportion of employees do not spend their workday behind a desk, making the apparel characteristics more similar to the **Outdoor** and **Sports** cluster, as opposed to **Business**. Case 6 is a workwear producer, supplying companies like 10, 11 and 22, but it also offers apparel with characteristics similar to that of the Business cluster.

Price Point

The cases observed operate at a medium to high price point, with an almost even split. Since most cases fall within the Outdoor segment, this segment was used as a baseline to group cases into price point categories: Taking the example of a jacket, a high price point was an average price USD>200, a medium price was USD150-200, and a low-price point referred to items USD<150. Since the product range of most brands varies and can target different price points, the grouping is indicative.

Supplier and Workwear segments are excluded from this analysis, as their pricing is not easy to compare with consumer-facing brands.

Ownership Structure

With three exceptions, the studied companies are privately owned. Publicly owned companies face procurement constraints, which limit their scope of action regarding selecting suppliers and entering into a relationship with them. They must adhere to public tender procedures, which place a lot of emphasis on the selection criteria and limit the permitted contract duration.

After a certain period, one case mentioned 7 years, the selected supplier's competitors can insist on a new public tender. This 'expiration date' on the buyer-supplier relationship limits the extent to which close relationships can be formed and does not incentivise investment into the partnership or collaboration for either party.

The buyer is also bound by the pre-defined selection criteria, resulting in more supplier monitoring as opposed to supplier collaboration (Gimenez & Tachizawa, 2012). The buyer can steer the outcome, to a certain degree, by carefully engineering the selection criteria – e.g., when aiming for a Swiss supplier, case 10 focused on certain third-party

certifications (Fair Wear Foundation), requiring warehousing as well as speedy and guaranteed delivery. To this end, case 10 relies on a specialised professional service provider. Ultimately, the sourcing mechanism is fundamentally different as it is also separated from supplier management: The supplier executes on a given set of requirements and is monitored throughout (Case 22). There is little room for joint growth or development.

Case 22 and case 11 mentioned that they foster dialogue with industry associations and other publicly owned entities to exchange best practices in selection, governance and innovation.

On the other hand, prospective suppliers need to make their entire value chain transparent and commit to freezing this value chain – switching value chain partners/ suppliers requires approval. The buyer, having to justify its actions to the public, can enforce certain standards through the tender. Compared to privately-owned companies, transparency and compliance with environmental and social standards is, therefore, not such an issue.

Company Size

There is a considerable range of company sizes in the sample: The smallest companies have less than 10 employees, then there are clusters with 10-50 employees, 100-200 employees, 500-1000 employees, and five cases with more than 1000 employees. In four of the cases, not all employees are connected to the apparel business.

Location

All study subjects are headquartered in Europe, and half of the cases are headquartered in Switzerland. Nowadays, most apparel value chains have a global footprint. While the

place where a company is headquartered says nothing about its geographic footprint, differences in the local culture, values and regulatory environment influence a company's scope of action, including its sourcing and supplier management practices.

Buyer-Supplier Relationships

The study includes three cases of suppliers, cases 3, 9 and 15. Interesting to know is that Case 3 acts as a supplier to cases 8 and 19 (see Figure 4), which makes it possible to analyse buyer-supplier collaboration from both the buyer and the supplier side in these

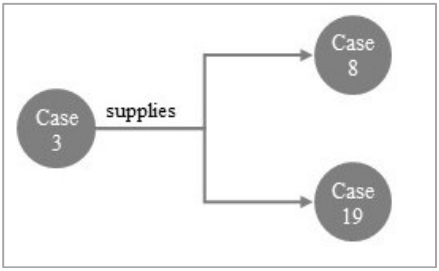


Figure 4: Disclosed buyer-supplier relationships

instances. It is possible that there are more buyer-supplier relationships that are not publicly known or were not disclosed in the interviews.

6.2 Research-Related Observations

This section is dedicated to presenting the results for each of the independent and dependent variables of the initial theoretical model (see 4.2). A case-by-case overview of observed buyer-supplier collaboration practices and realised circular design principles can be found in Table 10. This classification is the result of the conducted interviews as well as publicly available materials, such as the brand's website and reports.

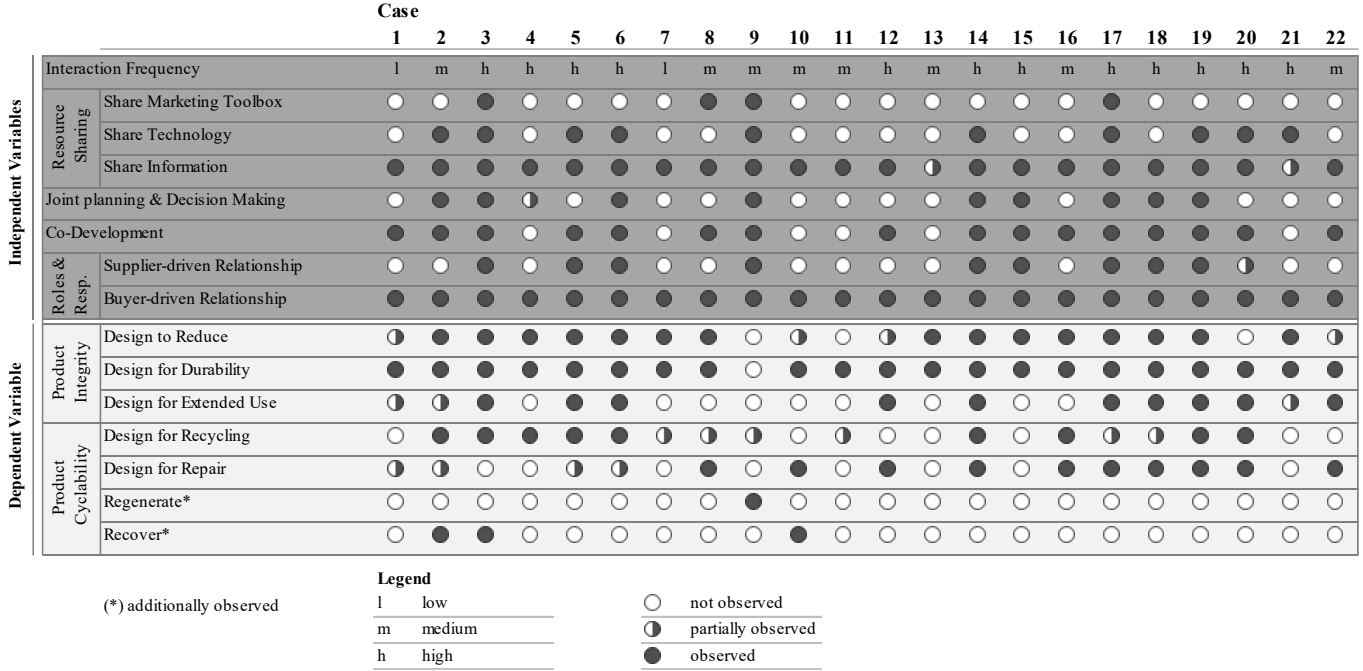
Structure of the Section

The independent variables include the sharing of resources, the coordination and frequency of interaction, engagement in the co-development of materials or the customisation of existing materials, the presence of joint decision-making and planning, and the respective roles and responsibilities (buyer- vs. supplier-driven relationships). The results for the independent variables are presented in 6.2.1.

The dependent variable is the number of realised design principles. To reiterate, the design principles are categorised into product integrity (design to reduce, design for durability, design for extended use) and product cyclability (design for repair and design for recycling). The results regarding dependent variables can be found in 6.2.2.

Further observations that go beyond the immediate scope of the research but are still relevant to the initial theoretical model are presented in 6.2.3.

Table 10: Overview of observed buyer-supplier collaboration practices (dark grey) and circular design principles (light grey)



6.2.1 Level of Supplier Integration

This section describes the result structured according to the practices of interaction frequency, resource sharing, joint planning and decision-making, and roles and responsibilities, including key examples and empirical nuances. Table 10**Fehler! Verweisquelle konnte nicht gefunden werden.** contains an overview of the extent of observed supplier integration on a case-by-case basis.

Unsurprisingly, the shared examples illustrate how practices are intertwined, complicating the categorisation of examples. For instance, co-development relies on sharing information and joint decision-making and can also include supplier-driven activities. From an analytical point of view, this is not an issue. But to reduce duplications in presenting results, and improve reader guidance, examples are explained once in detail and referred to in an abbreviated version if needed to evidence a second or third practice.

Interaction Frequency

The observed interaction frequency is high in more than half of the cases, meaning buyers and suppliers interact at least on a bi-monthly basis.

A typical interaction point is **annual performance reviews** (case 6, 17, 22) where the buyer also presents their strategy and objectives. Cases 6, 17 and 18 described dedicated supplier events for this purpose. Case 18 conduct a CSR event for suppliers twice a year and acknowledged how the virtual-only exchanges during the pandemic have taken away some of the ‘closeness’ of the relationship. To them, that personal interaction is an important foundation for their success.

The cancellation of **industry events** and the reduction of business travel during the pandemic have taken away another opportunity to meet and interact in person, and many interviewees were looking forward to taking up these activities again (cases 2, 8, 11, 18, 22)

Another common type of interaction is a **(bi-)annual quality or sustainability audit** (all cases) where the supplier undergoes a thorough assessment. If not done by a third party, representatives from the brand will often spend considerable time at the supplier site, connecting with different business units, gathering information and fostering personal connections. The cases conducting such audits described how they take time to discuss results with their suppliers, especially if major gaps were identified. Any identified gaps might then be addressed through the previously described supplier development activities.

Many interviewees (cases 4, 5, 14, 17, 20) described frequent and regular interactions (monthly, (bi-) weekly, or even daily) to foster the above-described exchange of ideas, feedback, and other information. They emphasised the importance of highly frequent interaction as well as informal interaction to achieve the desired outcomes in collaboration, such as successful product development, short reaction times to market developments, etc (cases 3, 6, 14, 15, 17, 19).

A common occurrence is a **fluctuation in frequency** – typically more intense in times of product development or moments of crisis (such as the pandemic) (cases 13, 14). Case 1 took the view that the more professional the supplier, the fewer interactions required. Case 1 appreciates this mechanism, as it enables them to focus their efforts on their core business.

Case 19 has formalised their collaboration with the supplier(s) in a **project setup** with monthly project meetings, steering committee meetings, as well as dedicated workstream meetings. Both the buyer and supplier leadership are part of interactions, not just sales/procurement organisations of the respective parties.

Resource Sharing

Sharing of resources was observed in all cases except one to a varying degree. In some cases, information is shared by leveraging suppliers' expertise or by providing feedback on supplier inputs in the context of product development. In cases 3 and 9 – suppliers that developed a new type of material – they described the importance of educating the buyer on its unique characteristics, how to pick the right quality for their product and how to handle it. Beyond that, the supplier also invests in educating a broader audience at conferences and academic textile institutions.

Transparency in the value chain refers to the one-sided sharing of information required by many buyers from suppliers. Some (case 4, 7, 13, 18) hinted that suppliers – even more so in traditional crafts – are quite protective about obtaining information regarding their value chain out of fear of being circumvented and perceiving value chain access as a key component of their competitive edge. For cases subject to public tenders, this is less of an issue, as disclosing the entire value chain is a condition of entering into a business agreement. On the other hand, cases like 3 (a supplier) and the suppliers of 18 recognised the increased demand for transparency as an opportunity to gain an advantage over competitors.

> *'I think that the biggest sustainability challenge right now is about actually getting the right information and getting transparency from suppliers, about*

materials and about what is... sort of like some nitty-gritty information from them. […] t's difficult to get information. But sometimes I think that's because they don't have it really sort of at hand […]. Sometimes we're asking questions that probably they're not used to being asked. So, we have to kind of like ask questions and... yeah... I mean that we have to push that a little bit, […] it's good for them as well. They start to think about certain aspects.' – Case 7

Open cost calculation is another type of information sharing (case 6, 11, 15, 19) in an effort to switch from 'negotiating over the size of cake slices to growing the entire cake': margins, potentials and pain points are identified and serve as inputs to then jointly develop a more sustainable and competitive product. Case 15 described an example where they approached their buyer to communicate a cost-driven price increase. Instead of insisting on the price increase, they jointly identified areas where both buyer and supplier could decrease the cost to circumvent the price increase.

'*…We had to say: sorry we need to raise the price by 3%. This is several hundred thousand francs of difference, a huge drama. So, we said that we have a different approach. We asked our buyer what we both could do to circumvent the price increase and were able to come up with truly amazing ideas. You know, before, we would send our fabrics to [location X in Switzerland], where the buyer staff needed to unload and warehouse the goods. Two days later, the goods were sent to [location Y in eastern Europe] – because this was how it has always been done. It kept everyone busy, and the buyer felt at ease to have the material in-house. When I, as a supplier, challenged them and asked them if they actually do anything with the material, we realised there was nothing,*

> *really. We jointly decided that it sufficed to send over samples. But you need trust for that! […]. For me as a supplier, the damage is much bigger if I had to go pick up faulty goods in location Y if the buyer asks me to. So now we jointly optimised, sending the goods directly to Y, saving cost, driving down CO2 emissions, and reducing personal resource use, admin effort, and we also save time'.* – Case 15

While the connection to the circular economy is not obvious at first glance, it represents an effort to collaboratively reconfigure business practices, improving the relationship, rethinking the operating model and, therefore, securing a future where both alliance partners can continue on their journey to develop towards circularity.

Some reported to **exchange ideas** for new materials (cases 5, 8, 20) and products (cases 2, 9, 17, 20) or even business ideas (case 17). While this exchange can remain a one-sided impulse (cases 2, 8, 17, 20) that the supplier or buyer may or may not act upon independently, in some instances, this translates to the supplier becoming actively involved in product development (cases 2, 3, 9, 17).

> *'... We need to support our buyer by educating them on our material. We ask about the product they have in mind, what outer material they will use and what look they are going for. Then we can help them chose the right material type and quality.'* – Case 19

Cases 2 and 17 described the example that these impulses inspired the research and development work of suppliers to the extent that they can offer a new and innovative product to all their buyers. Buyers are more connected to the consumer and can offer the supplier unique insights on market trends and future demands (case 20).

Beyond that, Case 3 started to encourage their buyers to engage in the collection of their products at the end of their useful life, so that case 3 can extract the material and recycle it.

Educating and developing suppliers (cases 6, 11, 12, 16, 17, 19, 20) is another frequently observed form of resource sharing. Cases 12, 14 and 17 mentioned their supply manual, detailing standards and requirements that suppliers need to adhere to. If a supplier has gaps, the buyer offers training and further resources to the supplier, or even encourages or supports them to obtain a third-party certification (case 18).

Case 6 steps beyond the buyer-supplier dyad and extends the development of suppliers to the supplier-supplier level, coming together to jointly reflect on past issues and mistakes and how to address them in the future. For example, if one supplier is struggling with lead times, another supplier with good scores on lead time might have some recommendations. Beyond that, together the group of suppliers and the buyer evaluate how they can best support the struggling supplier to improve.

The buyer also encourages their suppliers to come forward with challenges and questions so that other suppliers may help them out. The goal is to foster a sense of community among suppliers, for them to take on a collaborative mindset when approaching each other, focusing on how to best satisfy customer needs (growing the cake) instead of competing over more business with the buyer (increasing the slice).

> '*[…] we invited them for a week to [location in Europe]. And that was brilliant because and you must understand that there were Pakistani people, Indian people, Chinese people, and they all came together here in our company […]. They think we are competitors of each other because we all make workwear with [buyer], [buyer] is our customer. So, they were like tied up and the, yeah,*

a little bit scared to talk to each other. But then we said, No, we have selected you because together you make a good supplier base. You know, we have to make full collection for our customer, […] We have one big pie to share.' – Case 6

Case 14 mentioned the exchange with other buyers of the same supplier, to coordinate requirements as well as trainings and certification efforts. Both cases 14 and 18 mentioned the challenge for suppliers to deal with different buyer standards, requiring different certifications and resulting in unmanageable amounts of red tape and certification fees.

Case 12 elaborated on an example where they study sustainability best practices – in this case, a photovoltaic plant on the factory roof – at suppliers to promote them among their wider supplier networks. Such improvements indirectly influence the realisation of the 'design to reduce' principle, as the emissions and energy use per unit of material are driven down.

Supplier development is usually closely linked not just to sharing information, but often requires financial investments as well – as observed in cases 6, 12, 17 and 21. Cases 6 and 21 highlighted instances where suppliers require additional staff to fulfil buyer requirements. Case 17 hoped that their new supplier would already start out with a better understanding of sustainability so that they as a buyer would not need to invest the same amount into upskilling as they did with their long-standing suppliers.

Beyond sharing information, buyers and suppliers also **share technology**, typically in the context of co-development, which is further described in one of the following

paragraphs. And of course, sharing information requires personnel resources on both the buyer and supplier side.

Cases 3 and 9 included an example of **sharing a marketing toolbox** (such as hangtags, video and image files) with suppliers to support them in communicating material benefits to the end consumer. Case 3 even conducted an LCA (life cycle assessment) to show the drastically reduced water use of their material versus the conventional material.

Joint Planning & Decision-Making

Joint planning and decision-making can take on different forms, but the sharing of information constitutes a prerequisite for buyers and suppliers to engage in this practice.

One common theme is **joint problem-solving**, which is described as highly beneficial (cases 2, 9, 17, 14). In the section on information sharing, the case 6 example shows how suppliers and the buyer come together to jointly discuss and solve challenges related to sustainability (also, material efficiency, i.e., design to reduce realisation in case 17), quality, lead times, and more. Either the buyer or the supplier discloses a specific challenge, within the context of a periodic review, or, spontaneously, the other party can provide inputs or potential solutions. This open dialogue creates a fruitful environment for innovation and builds trust.

Similarly, the open cost calculation observed in a few cases creates a basis to jointly identify improvement potentials.

The pandemic made the vulnerability of value chains obvious, and there are examples like cases 14 and 17 that viewed their suppliers as allies in tackling the challenges of COVID-19. The buyers did not cancel any of the orders made but halted production. The suppliers, in turn, agreed to more flexible payment terms and to store the materials, semi-

finished as well as finished goods. When it became clear that the Outdoor segment was facing a huge boom, the brand was able to ramp up production quickly and managed to fulfil the increased demand. The value chain also profited off the fact that other chains were not as fast in reacting to the market upturn. Acknowledging the responsibility, a buyer can have for its suppliers if the supplier in question generates a considerable proportion of sales with a certain buyer, there is an argument to be made for continuity: Protecting not only the livelihoods dependent on that buyer-supplier transaction but also carrying a relationship through a tough situation collaboratively creates a basis for future joint activities: Both alliance partners grow closer through the hardship and improve their joint problem-solving capabilities that they then can continue to apply to jointly improve circularity. If the relationship disintegrates or one of the alliance partners goes out of business, the other is left to either rebuild a relationship, including the potential search for a new partner.

Case 1 also recognised the benefits of joint problem-solving and shared how they, as a small player with low purchase volumes, are struggling to find suppliers who are willing to enter into such a relationship with them. In one example, the supplier even opposed the development of a sustainable material with higher bursting-strength[3] as he perceived this as cannibalising his own business.

> *'We approached our [type of material] supplier and said: We want this burst of strength to improve the durability and sustainability of the garment. The supplier does not understand that. He thinks it makes no sense because he will*

[3] When fabric is subjected to pressure, the fabric begins to expand in all possible directions at the same time, eventually beginning to burst; this pressure limit is called bursting strength (Textile Advisor, 2020).

sell less. So, he then said, he will not develop this material, it would not help his business.' – Case 1

In response to this conundrum, case 5 tries to join forces with their manufacturer to meet the minimum order quantities of suppliers. In some cases, sustainable materials are available, but the minimum order quantities are too high for a small brand. Case 5 contains an example where they found a paper polybag to package and ship clothing items. The manufacturer acted as an orchestrator; They approached some of their other buyers to convince them to switch to paper bags as well. The combined purchase was then high enough to meet the required quota.

Case 11 described how they did joint annual planning, actively looking to utilise capacity during suppliers' downtimes, which often happen before Christmas or right after the summer holiday period. During the pandemic, case 11 was also proactively reaching out to suppliers to inquire about the number of COVID cases to offer support, security and potentially adapt planning.

While several cases mentioned the benefit of sharing the same goal, not many explicitly engage their suppliers in **joint planning** in terms of ambitions for circularity. Case 17 reckons that they will likely continue to grow and develop with their current strategic suppliers. Their ambition is to develop something like a joint vision and to agree on a common strategic direction towards sustainability.

Joint planning and decision-making can also take place in the **context of co-development activities**. Two examples stood out: Cases 2 and 14 had a clear idea of what new materials they wanted to develop and, therefore, planned the development process with their suppliers. Case 19 entered into a contractually formalised

collaboration, which entails the typical planning activities associated with steering and managing a project.

Co-Development

Engaging in the co-development of materials or the customisation of existing materials was a commonly observed collaboration practice. Not all cases engaged in the practice continuously, with some (such as case 22) only giving a single example. But except for cases 4, 7, 10, 11, 13 and 21, examples of co-development of materials that realised one or more circular design principles or even business models were observed throughout (representing almost 80% of the cases) and were multifaceted.

Cases 4 and 2 emphasised how developing sustainable and functional apparel is a challenging process that is strongly driven by creatively executing a set of technical requirements.

Case 12 recognises that co-developing with their suppliers to them is a **'business as usual' practice** in product development. In the development process, they also ask staff to test the new materials (including washing) to provide feedback to the supplier: How does the material wear, fit and feel, has the material kept its shape, how long does it take to dry, does it pull unnecessarily, and so on.

Case 17 not just regularly co-developed materials with their suppliers, such as wood fibre fleece, using old tires for pants or coffee grinds as padding for pants, they continuously worked together with suppliers to improve the repairability and the, what they call, material efficiency – represented in this thesis under the 'Design to reduce' principle. Beyond that, case 17 was developing a rental model and relies on the expertise of their supplier to determine the implications a rental model has for material performance

requirements, such as material strength, chosen method of construction and the overall product architecture. They mention that suppliers actively seek them out to collaborate because they appreciate the opportunity to develop sustainable materials and solutions as well as the inspiring dialogue.

Case 6 was **building their capability to design for recycling** together with their supplier community: When the first recycled yarn came from the spinning mill, it was not very strong. Under normal circumstances, a weaver might have rejected the yarn. But because he is a part of the supply community, he knows the spinning mill and the recycler and will accept the challenge. The weaver might run the machines slower to take pressure off the yarn, and the recycler, getting the feedback of low strength, can include more polyester to strengthen the yarn. The buyer's role does not require technical expertise – that capability is provided by suppliers – but is responsible for the successful orchestration of the collaboration in the value chain and ensuring a smooth flow of information. The buyer-supplier collaboration has moved beyond a dyadic relationship and encompasses the entire value network.

A number of cases shared examples of how **waste was turned into new materials**:

Case 14's ambition was the development of a circular technical membrane. Since they do not have their own in-house development facility, they went looking for partners and, over the period of two years, developed a material that is now part of their regular collection.

Case 18 described how a supplier impulse inspired a co-development process resulting in a product range made from leftover fabrics, branded as limited-edition products. They also shared that at the beginning of their journey to circularity, they had to overcome

resistance from suppliers that were doubtful of the quality and durability of materials such as recycled polyester and organic cotton. Similar to case 6, the supplier base came together with the buyer to jointly work on improving the quality and durability of the materials. Currently, these impulses happen informally and are a result of the decades-long relationship between buyer and suppliers. But the interviewee expects co-development with suppliers to become a more routine practice in the future.

Like case 18, case 1 appreciated how suppliers familiarise themselves with the sustainability ambitions of their buyers and come up with new materials. In this case, the co-development was not as collaborative but still relied on the close coordination of inputs from buyers in the material development process. As a small brand, with low purchase volumes, they struggled to find suppliers who were willing to co-develop. The development process could be lengthy, and if the potential volume at the end is only a few thousand yards of fabrics, suppliers were unwilling to invest.

Case 5, on the other hand, considered its small size an advantage as the low purchase volume could be an attractive pilot size for suppliers before they rolled out the material to their bigger clients. They relate an occasion where one of their factories asked them to work with a newly developed material made from flower waste.

Case 2 was not satisfied with the available materials on the market and sought out a supplier to co-develop a material according to their requirements as a circular brand. The brand closely accompanied every development step and got involved in technical details (yarn selection, weaving method, fabric treatment, dyeing), and the resulting material is now their intellectual property. In other instances, the brand was not as closely involved in the development process, and the collaboration resembled what was previously described for case 1: The brand provided the supplier with requirements and ideas, and

the supplier was more independent in the technical development process, frequently checking whether the development was moving in the right direction.

Some interviewees shared some thoughts on the **ideal level of involvement** in the development process: Case 2 appreciated others' close involvement in the development process but also recognised that due to resource constraints, it might not be a feasible operating-model long-term. Cases 1, 2, 7, 8, 14 and 16 revealed how they hoped to leverage the complementary resources of buyers (i.e., market knowledge) and suppliers (i.e., technical expertise). Case 2 even had the ambition to create its own development team to drive circular innovation with their manufacturers and material suppliers.

The three cases of material suppliers (3, 9, 15) shared the view that they supported buyers' ambitions with their technical expertise. Case 9 explained how they customised their materials based on the buyer's product and its use context, either helping the buyer to determine the material requirements if they were not clear or following the given material requirements of a buyer that had a clear idea in mind. To that end, the supplier had a textile developer on the team, providing the specialised technical expertise needed in fabric customisation.

Case 3 disclosed how its entire business sprang from a conversation with clients and the identified need for a sustainable alternative to virgin down.

The observed co-development examples were **not formalised through contracts**, except for one case: Case 19, together with its biggest manufacturer, started a project that involved developing 'the most sustainable supply chain', including raw materials, preliminary processing, assembly and transport. With their project partner, they jointly identified pain points and potentials that they then addressed with structured efforts.

Roles & Responsibilities

As evident from the previous paragraphs, the observed buyer-supplier relationships could not be easily classified into either buyer- or supplier-driven relationships. Going back to Table 10, it becomes clear that in a bit more than half of the cases predominantly buyer-driven behaviour was observed (cases 1,2, 4, 7, 8, 10, 11, 12, 13, 16,17,20, 21, 22). Cases 1, 4 and 13 went as far as to say that it was them as a buyer who mostly needed to drive the relationship and push for what they wanted – sustainable and circular materials.

In cases 11 and 12, both well-established firms who had already embarked on their sustainability journey some years ago, it seemed like they as buyers were more mature than their suppliers. Therefore, they make conscious efforts to pass on their sustainability ambitions and practices to their upstream value chain, in the spirit of continuity and to develop their own value network as a whole.

The tender processes required for the public entities, 10, 11 and 22 likely also tipped the balance of the relationship towards a more buyer-driven dynamic.

In the remaining 11 cases, there were examples where the relationship was both buyer- and supplier-driven. None of the observed cases described purely supplier-driven relationships. All the cases had developed or are looking to develop close relationships with their suppliers that create a safe space where both parties trust each other, and ideas and feedback can be openly shared (described in detail, among others, by case 21). The observed collaboration between buyer and supplier reflects an interplay or a 'two-way street' (case 5) of buyer- and supplier-driven behaviours.

The previous paragraphs contain examples where buyers shared an idea or ambition about a material or component with certain characteristics or the supplier had come up with a new or adapted material that they presented to the buyer. There were moments in

co-development where either the buyer or the supplier assumed the driving role depending on what capability was needed at that stage. The buyer typically assumed a more driving role when it came to upskilling and developing suppliers, at the same time relying on the supplier to become proactive when establishing transparency beyond the tier-1 supplier.

There was a shared understanding that the relationship goes beyond the transactional level, and both buyers and suppliers perceived themselves as parts of one value network rather than individual entities needing to bargain for their share of earnings. Practices such as open cost calculation, buyers invested in keeping their suppliers in business through the pandemic, year-long development projects as well as case 19's project involving a sustainable supply chain are evidence of this trend.

Case 19 stated, in their view, suppliers became more proactive not just because they wanted to support a buyer's ambitions regarding circularity out of goodwill. Suppliers became increasingly aware of the 'risk of doing nothing', i.e., failing to achieve net-zero in the next 10 years among other goals. This might mean losing their business to a competing supplier who can fulfil the environmental standards of the buyer. Both buyers and suppliers knew that the main environmental impact does not happen at the buyers' headquarters or in retail stores, so to them, collaborating with the buyer in developing a sustainable supply chain was a strategic and business-driven decision.

> '[…] *the supplier understood that if they are not net-zero or climate-neutral in ten years, then they are no longer the right supplier for us. They also understood that our big CO2 impact is not in [headquarter location in Europe], or in the retail stores, and that it is irrelevant whether we drive a Tesla or a traditionally fuelled car. It makes no difference to the total CO2*

emissions. They [the suppliers] *have understood that if they cannot position themselves sustainably, i.e., CO2-neutrally, then they will be out of business in ten years. […] They also think very carefully about how and in what they invest. I think that will be the big transformation lever.'* – Case 19

6.2.2 Realised Circular Design Principles

Table 11 contains a re-cap of the realised circular design principles on a case-by-case basis. Aggregating this view into Figure 5 creates an understanding of where the studied cases have placed their emphasis so far. Design principles related to product integrity were more prevalent than principles pertaining to product cyclability. Two additional principles, Regenerate and Recover, came up during the interviews that were not part of the initial theoretical model.

The most realised design principle was 'Design for durability', explicitly mentioned by all except one of the cases. Out of all cases, 15 cases declared that they adhered to the 'Design to Reduce' principle, and 3 more cases disclosed their initial or partial efforts or ambitions regarding this principle.

Almost half of the cases (10 cases) reported implementing 'Design for Extended Use', 'Design for Repair' was realised in 10 cases, and 'Design for Recycling' in 9 cases.

Table 11: Overview of the realised circular design principles case-by-case

Dependent Variables		Case	1	2	3	4	5	6	7	8	9	10	11
	Product Integrity	Design to Reduce	◑	●	●	●	●	●	●	●	○	◑	○
		Design for Durability	●	●	●	●	●	●	●	●	○	●	●
		Design for Extended Use	◑	◑	●	○	●	●	○	○	○	○	○
	Product Cyclability	Design for Recycling	○	●	●	●	●	●	◑	◑	◑	○	◑
		Design for Repair	◑	◑	○	○	◑	◑	○	●	○	●	○
		Regenerate*	○	○	○	○	○	○	○	○	●	○	○
		Recover*	○	●	●	○	○	○	○	○	○	●	○
		Total excl. Regenerate/Recover	2.5	4	4	3	4.5	4.5	2.5	3.5	0.5	2.5	1.5
		Resulting DV Outcome	low	med	med	med	high	high	low	med	low	low	low

Dependent Variables		Case	12	13	14	15	16	17	18	19	20	21	22
	Product Integrity	Design to Reduce	◑	●	●	●	●	●	●	●	○	●	◑
		Design for Durability	●	●	●	●	●	●	●	●	●	●	●
		Design for Extended Use	●	○	●	○	○	●	●	●	●	◑	●
	Product Cyclability	Design for Recycling	○	○	●	○	●	◑	◑	●	●	○	○
		Design for Repair	●	○	●	○	●	●	●	●	●	○	●
		Regenerate*	○	○	○	○	○	○	○	○	○	○	○
		Recover*	○	○	○	○	○	○	○	○	○	○	○
		Total excl. Regenerate/Recover	3.5	2	5	2	4	4.5	4.5	5	4	2.5	3.5
		Resulting DV Outcome	med	low	high	low	med	high	high	high	med	low	med

**newly observed*

Legend

○	not observed
◑	partially observed
●	observed

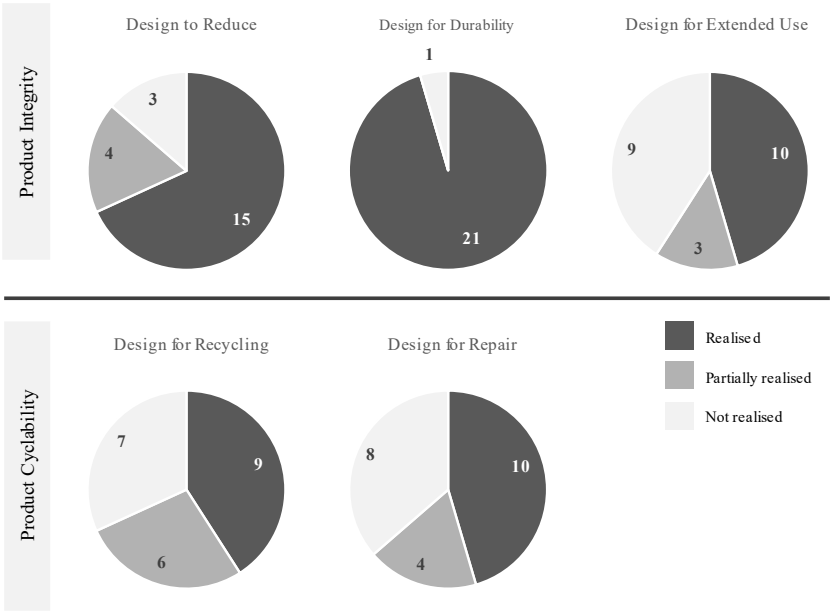


Figure 5: Aggregated view of realised circular design principles included in the initial theoretical model

5.2.2.1 Product Integrity

Design to Reduce

This principle comprises design strategies to reduce the use of (virgin) resources and/or the use of existing waste streams (Plank, 2019b; University of Wageningen, 2020).

This principle was pursued in several cases, but their motivation was often related more to cost efficiency than sustainability goals. One common expression of this practice is the **minimisation of production waste**.

For example, case 17 referred to this principle as material efficiency for which they created a KPI to establish comparability across products. Like cases 1, 8 and 20, they

worked in collaboration with suppliers to improve material efficiency by optimising patterns or pattern placement on the fabric.

> *'That is one* [design principle] *where we work extremely closely with our producer, […] because it's always a question of how do I lay out the patterns? Or how do I improve the patterns so that I get a higher material efficiency out of them. There are really just great things… I'm always thrilled by the creativity that comes out of the mutual dialog.'* – Case 14

Case 21 was in the process of working with an academic institution to launch a zero-waste project tackling their fabric scraps. Case 2 was working on products made in a round knit and seamless process, which had no cutting waste because there was no roll of fabric to cut a pattern from.

Case 12 shared how the complex architecture of the technical garments leads to complex shapes, which makes optimising patterns and their placement more difficult. They have started looking into using wider fabric rolls as it allows placing patterns differently and reducing cutting waste. In addition, they have started a product line made from end-of-roll fabric, like the previously described example of case 18. Like case 18, case 12 was also looking at where and what fabric leftovers they accumulated, to find ways to use them.

Case 6 explained how in workwear and corporate fashion, the manufactured quantities are very high and the designs rather simple, with limited hardware, trims or prints. This makes the efficient use of materials easier. If there was a choice between a lighter and heavier fabric with comparable strength, they would convince the customer to opt for the lighter fabric. This was also the case for alternatives to hazardous materials. To support these discussions, they included an LCA to make the environmental benefit tangible.

Another common theme is the **use of recycled materials**, avoiding virgin material use.[4] Case 12 also used recycled downs in most of their products. Similarly, case 7 focused on using recycled materials to achieve a simple aesthetic, without many additional components, such as buttons or other hardware. They did try to optimise the material use but not to the point of zero-waste patterns as this would take away from their form and design.

Case 14 also used recycled materials, parts of which came from their own resource loops (pre- and post-production waste) that were used to produce new polymers, yarn, fleece and other materials.

Recycled polyester was a standard material for case 18, who were working on increasing the use of recycled cotton and down. An obstacle for them was the potential impact on quality, performance and durability – characteristics quite essential to an outdoor brand. Case 2 shared how this issue was most evident in post-consumer recycled materials where there can be fibres of differing quality that undergo different production steps, treatments, dyeing processes and finishings. During their use phase, they were treated and washed differently, making the resulting product quality after recycling unpredictable. Conversely, post-production waste is homogenous and does not face the same quality issues.

Case 2 uses an **existing waste stream**, local wool, and created a unique material from it. Because the sheep were not kept for their wool due to the sale of that type of wool not being profitable, as opposed to merino sheep, the wool was either thrown out or turned

[4] Not to be confused with 'Design for Recycling': While the use of recycled materials can lead to a product that is recyclable, it does not have to be, e.g., if it ends up as part of a complex material blend.

into fertiliser. The natural proteins in the wool make the fabric water-repellent, avoiding further treatment of the fabric.

Case 13 said that, if possible, they opted for the use of deadstock fabric[5] and worked with workshops within a 10-km radius to avoid long transport routes. Case 8 also relied on suppliers in Europe to shorten transportation.

Case 15 underlined the importance of the **geographic proximity of suppliers** to buyers and their markets: As case 10 said, short and closely knitted value networks can respond more quickly to fluctuations in demand, reducing stock-keeping levels and overproduction.

Another topic is the **avoidance of plastic packaging**, called polybags. Case 5 has found a paper alternative, which still allows them to offer the customer an unpackaging experience. Case 18 faced resistance from retailers and customers when trying to abandon polybags. Consumers, over the year, have learned to expect a plastic-wrapped product, or they fear that the product received is not new or faulty. Retailers dictate conditions under which they accept clothing, and up until now, polybags have remained an industry standard, most of all in the Americas. But the company has started successful pilots in Europe with unpackaged backpacks and plans to extend this practice.

Sports and Outdoor segments produce functional apparel and, as such, the **use of chemicals to achieve certain performance characteristics** (e.g., make garments water-repellent, windproof, breathable, …) is prevalent. A large number of cases (2, 5, 6, 8, 12, 14, 15, 16, 17, 18, 19, 20, 21) reported that they not only made deliberate decisions about

[5] Deadstock fabric is left-over fabric of other apparel brands. Traditionally, brands have held on to deadstock fabrics for a few seasons before sending them to landfill. Recently, deadstock fabric is being increasingly re-sold to be used by other brands.

what chemicals and processes they would use (referencing lists, refusing the use of chemicals that are carcinogenic or contain heavy metals) but also evaluated the waste generated during manufacturing and processing, including potential impacts on water, air and the general environment.

Case 10 **avoids overproduction** of uniforms by implementing demand planning measures while still securing availability by optimising stock management and shortening delivery times and routes. But they opted to give employees a yearly budget for uniforms, which can incentivise them to use up that allowance even if they do not need a new uniform.

Case 14 took a **customer value perspective** and has created modular products such as the 3-in-1 jacket that covers more use cases, i.e., seasons, weather conditions and different outdoor activities. Ideally, consumers then only need to own one versatile jacket instead of three, reducing resource use. Similar concepts can also be found in cases 16, 17, 18, 19 and 20.

Design for Durability

Design for durability entails design strategies to resist obsolescence for a long product use phase, encompassing both physical and emotional durability. Physical durability, around which most conversations centred, is about the longevity of a garment, i.e., slower degradation over time and the absence of planned obsolescence (Den Hollander et al., 2017; Keoleian & Menerey, 1993; University of Wageningen, 2020).

This principle is the most commonly observed.

Unsurprisingly, **physical durability** is a key design principle for the Outdoor segment and was cited by cases 1, 2, 7, 12, 14, 16, 17, 18, 19, and 20. Producing a long-lasting

garment that serves its user well, even in tough conditions, for many years lies at the core of their activities.

> *'[…] sort of part of the heritage of who we are was about making products that are fit for purpose: So, we recognise we're designing for climbers, mountaineers, you know, high-adventure activity, and without getting too extreme, they actually can become the difference between either a good trip or a bad trip, or life and death in a situation. We have to make sure that our products – and they are used to get to the summit of Everest – […] so they have to be built to work and be built for performance, which means we have to design them for tough conditions. We have to design them for longevity.'* – Case 18

These brands were careful in selecting high-quality fabrics, finishings, trimmings and confectioning. Cases 14 and 1 noted how they analysed in detail how the garment would be used– which snaps, buttons and zippers would be opened and closed frequently? What areas experience stress? These parts got reinforced.

Case 18 has followed the philosophy of durability for so long that now they see people wearing garments that were handed down from their parents or grandparents, some items even dating back to the founding years of the company.

Case 8 highlighted the importance of the **price point** – a high-quality item will cost more so consumers buy fewer items and take better care of them. Albeit brands must be careful not to price themselves out of the market. Case 1, offering children's clothing, is committed to using comfortable and high-quality materials. Taking the example of

Cordura[6] that they used for pants: Competitors only used the material for certain areas, not the entire garment. But using a high-quality Cordura that is also soft to the touch and comfortable to wear is very expensive, requiring the brand to maintain a balancing act.

At the same time, they faced the dilemma of wanting to produce more circular garments, but the **circular alternatives available were often not as durable** or did not match the performance characteristics of traditional materials. Cases 1 and 21 explored mono-fibre fabrics, which would be suitable for recycling. Both brands opted for fabrics containing a few per cent of elastane because its durability is much better. They argued that based on an LCA under current conditions, a shirt was the most sustainable if it could remain a shirt for as long as possible, so they prioritised durability over recyclability.

Emotional durability aims at creating long-lasting consumer-product attachments (Niinimäki, 2017; Page, 2014). This is an issue Workwear was not confronted with as uniforms stay the same for 20 years in case 22, 13 years for case 10, and the average customer of case 6 keeps their apparel for five years. The products were not only made to last physically they also do not go out of fashion. These garments only got discarded if they were at the end of their (physically) useful life. Producing the same product over a long time unlocks economies of scale, helps to overcome learning curves and eases stock management due to a longer planning horizon and limited amounts of new products that trigger old ones to be phased out.

[6] Cordura is a very robust, abrasion-resistant, textured nylon. The slightly roughened surface gives Cordura a pleasant feel. It has a quick-drying and water-repellent finish, so moisture beads off. Unlike cotton, polyester and conventional nylon, Cordura has a much higher abrasion resistance (Extremtextil, 2017).

Even the Outdoor Segment was not as affected by trends as other fashion segments – case 12 ran a seasonal design process but only launched twice a year, not four, eight or more times that is common practice for everyday-wear brands.

Cases 2, 7, 18 and 21 made conscious efforts to design simple and timeless garments that could become wardrobe staples. For cases 2 and 18, that meant avoiding seasonal colours or trendy designs. They looked at designs that have changed very little in the past decade to inspire their own work.

Case 13 was trying to tell the story of a traditional craft and its artists through their products, fostering an emotional connection. When consumers form emotional attachments to garments, they are more likely to look after them and keep them longer.

Design for Extended Use

This design principle includes design strategies to facilitate maintenance and upgrades. This typically means retaining an aesthetic and hygienic condition.

A commonly (cases 1, 3, 5, 6, 12, 14, 17, 18, 19, 20, 21, partially cases 2 and 22) named practice is the **ease of maintenance** in terms of washing. The garments do not require dry cleaning or environmentally harmful care products.

Case 1 shared how they avoided materials like down or silk that are harder to care for.

Most facing brands interviewed provided extensive care instructions with their product and/or online. If there was a personal sales interaction, verbal information was provided, referencing the more detailed written materials. Educating consumers on how to best wash their garment, how often washing is needed (often less than expected, as shared by cases 2 and 5) and how garments can be refreshed without washing was another way brands implemented this design principle. One of the materials used by case 5 contained

a natural antibacterial agent, making a garment wearable multiple times before requiring a wash – this information was even featured on the product tag. Less washing not just preserves resources; the strain of washing also contributes to wearing out a garment, making less washing a maintenance measure in and of itself.

For some materials, as case 14 highlighted, washing was required more frequently to preserve the membrane. Besides the written and verbal guidance, the brand offered a washing and waterproofing service for time-constrained consumers or consumers who hesitated to wash their functional garments themselves. On top, cases 12 and 14 have launched their own washing liquid tailored to functional garments.

Modular products offered by cases 14, 16, 17, 18, 19 and 20 allow the separate washing of layers, or if needed a replacement or upgrade. This takes into account the differing strains and life spans of different materials and avoids an entire product becoming obsolete due to a single component wearing out.

Case 20's jacket was made of a cotton material (mono-material[7]) that is waterproof because of its special weaving and because it swells when wet. If a consumer did not like the material's appearance after a few years, the brand offered to wax the jacket to maintain the water-repellence and reinstate the aesthetic properties.

Case 8 expressed frustration that besides all the measures taken, care tags got cut out and information provided online was forgotten. Thus, they were looking at ways to engage their customers and educate them on how to best take care of their products to preserve their aesthetic and functional properties.

[7] A fabric or material made from a single type of fibre or material (i.e., no blends)

5.2.2.2 Product Cyclability

Design for Repair

'Design for repair' strategies enable the repair of products either through consumers, manufacturers or third parties. Bakker et al. (2014, p.11) refer to the British Standards BS888 7-2-2009 that define repair as '*returning a faulty or broken product or component back to a usable state*'.

Well-established brands and subject matter experts in apparel develop **intuition and experience regarding the potential weak spots** of a product (cases 5, 14, 17, 20, 22). The basic idea is to avoid the need for a repair by making a product durable.
Known weaknesses are push buttons, so case 20 either opts for alternative fastening or attaches push buttons to webbing tape to easily remove and replace the button if it breaks. Another measure is to not sew zippers in between layers but sew them on top, again to make replacement easier.

> *'But what we are doing now is making sure that we design things that are not made from the same group of materials and, therefore, cannot be recycled together, so to speak, in such a way that they are removable and can be removed very easily. But that has also been exemplified in the past. The military very often did this, because in the military, for example, it was always a matter of all things being very easy to repair, and that's how we keep it.'* – Case 20

Case 17 conducted an **internal audit on new products**, testifying to the fact that a product was repairable. This report also called attention to any consciously made trade-

offs between other principles such as recyclability and durability: E.g., opting for a stronger zipper that is not interchangeable.

Another observed activity is the **tracking of defects** for the sake of continuous improvement: Case 22 remained in close contact with their in-house laundries to spot any common defects. Case 14 collected defects in a structured manner and ran statistical analysis.

A handful of cases **offered support to consumers** in case of repairs: Case 20 enabled customers to either make simple repairs themselves or have a product repaired at a local tailor. Cases 5 and 2 followed a similar approach. Cases 1, 6, 8, 12, 14, 17, 18 and 19 offered in-house repair services. Case 12 was clear that their favoured repair mode was an in-house repair with specialised equipment. They have established service centres across the globe so customers can send in their broken products for repair relatively close to them. One exception is that the service centres are not equipped to deal with heat seal seams – they can be repaired at times, but the repair might not be as invisible, which is something the brand usually prides itself on.

When consumers need a repair, a first point of contact is the **retailer**. Case 12 encouraged their retailers to send in defective products for repair instead of just replacing products. Consumers have also gotten used to expecting a replacement for higher price point items. The brand tried to offer a voucher on top of the repair to avoid replacing a product and having a repairable garment go to landfill.

Cases 14 and 18 benefitted from their own retail network with local repair workshops. Case 18 offered consumers the opportunity to get their products repaired at the retailer, or if more complex, it got sent to a specialised repair company. Furthermore, they had an

extensive set of video tutorials online to show customers how to do small maintenance tasks. Customers could even order small repair kits to replace specific components (i.e., buttons).

Some cases disclosed **challenges and concerns** in relation to the repairability of their products:

Case 6 did offer repairs but struggled with managing the cost: Because repairs were done in Europe and the garments were produced in Asia, the repair could cost more than a new product. Customers, therefore, often opted for a replacement.

Case 11 did not specifically design for repair but required their employees to repair their own uniforms and corporate wear and also offered some repairs by tailors, similar to case 10.

Case 7 called out that because of their focus on durability and the technical nature of their garments, repairs beyond replacing a snap were complex since the seams were sealed. In the latter case, a repair requires special equipment and needs to be done at their factory.

Case 21 admitted that in their product range containing basic everyday wear, repairs were not as common, and consumers got their products replaced.

Design for Recycling

This principle refers to strategies that not only proactively design out barriers to recycling and enable recycling into same or similar quality applications but also strategies that enable recycling into lower-value applications (Ellen MacArthur Foundation, 2017, p.20).

‘Design for Recycling’ was the least realised principle, and many cases reportedly struggled with its requirements. The providers of workwear (6, 10, 11, 22) pointed out that due to protected patterns and logos, decommissioned garments could not just be circulated at will, adding an additional level of complexity. But it was easier for them to collect and sort their decommissioned product than brands in the B2C business.

As mentioned previously, companies in the business of selling technical garments were largely **unwilling to compromise on durability and performance for recyclability**.
Case 1 stated that its focus is durability, as they see this as more sustainable than a recyclable product that does not last as long.

Checking and reporting on a product’s recyclability before launching it formed part of the previously described audit undertaken by case 17. They faced the making same trade-off but tried to make the decisions consciously and justify each decision against recyclability. They were also part of cross-industry working groups, including recyclers, take-back systems and material and chemical developers, to extend the scope for textile recycling.

Similarly, case 12 managed to launch two products using **mono polymer materials** (100% recycled fabric and most trims and zips made from recycled polyester) suitable for recycling, yet they needed to expand the realisation of ‘Design for Recycling’ across its entire product range.

In case 7, they had a shell that was mono-material, and the lining was of a different material but could be taken out. In theory, both could be recycled separately, but they were working on a mono-material (polyester) product that could be recycled in its entirety.

This is what case 20 has been doing, sticking to mono-materials whenever possible and refusing any materials that shed microplastics or have them easily detach, which would mean a different material was needed. Case 20 optimised its material flows for a technical cycle[8] vs. a biological one. They also had partners that upcycled decommissioned products into different products and were looking into how they could design their products differently, as the next step in upcycling.

Case 14 has managed to set up **recycling of their production waste** into new materials and has created a recycled and recyclable membrane. They have started to consider the product's next life after use during the design process, simplifying products and avoiding materials unsuitable for recycling.

Case 19 has established its own recycling loop by taking back old climbing ropes (mono-material), shredding them, turning them into a granulate that can be made into a yarn and finally into t-shirts. The resulting t-shirt again is a mono-material product that can be recycled. The ropes account for a big part of the company's CO2 footprint at the product level, so that the recycling of these products makes a real impact.

Considering the recycling of synthetic fibres, the **infrastructure** to do so is largely missing, as correctly noted by case 12. But cases 12, 14, 16, 17, 20 and 21 agreed on the need to develop and market recyclable products now in the hope that the recycling processes will be in place by the time the product has reached the end of its useful life within the next 5-15 years.

[8] Products in a technical cycle are reused, repaired, remanufactured, and recycled. In a biological cycle, biodegradable materials are returned to the earth through processes like composting and anaerobic digestion (Ellen MacArthur Foundation, 2020).

Cases 2 and 5 represented **exceptions to this trade-off between durability and recyclability**: Case 2 chose a different route; in that they were unwilling to compromise its product's circularity and do not work with synthetic fibres. Case 2 spent a lot of time in sourcing and developing its materials, and case 5 looked at materials and then evaluated how and in what product they could be used, with the ambition that a product can decompose and leave no trace. Both cases shared the principle that they did not use a material or create a product where they were not clear what will become of it at end-of-life and were satisfied with that outcome. This meant the product could be recycled or was biodegradable. One example was their t-shirt; whenever repair was economically unviable, it could simply be supplied to the manufacturing of new shirts.

Case 5 focused on using natural mono-fibre materials to simplify recycling or biodegradation at the end of product life.

Case 2 recognised that not every functional garment is sold to an extreme mountaineer; these products are often used for commuting. The performance of their natural materials might not match the synthetic alternative but satisfies the needs of its average urban user.

One challenge they faced was that even with organic materials, biodegradability is not a given. For trimmings, case 2 used small amounts of leather. Even vegetal tanned leather will take a long time to decompose because the purpose of tanning is to make animal skin durable.

Case 3, a material supplier, did not only use existing waste streams as inputs for the material but made efforts to feed the material back again into the circuit at the highest value possible. They were aware that down cannot be endlessly recycled to be used for clothing, but they have found ways to still extract value from feathers that were previously considered waste: Feathers that were not or no longer suitable to be cleaned

and used in the textile industry could be turned into fertiliser or as a component in bioplastic (case 3).

Regenerate and Recover

During the interviews, two additional practices came up, namely regenerate and recover. **Regenerate** encompasses efforts beyond avoiding environmental harm, adding value to nature and its restoration. Case 9 developed a unique bio-based material whose origin plant contributes to the reforestation of former oil palm plantations, actively involving and providing a living wage for local communities in the process. In a sense, the practice goes beyond the 'Design to Reduce' principle, as it not only avoids harm but actually has a positive environmental and social impact.

Recover is a principle at the lower end of the R hierarchy (see section 2.1.3) and entails the recovery of energy from waste. Cases 10 and 22 are such examples; they confessed that their upcycling efforts had been unsuccessful so far, but that the waste was used for energy recovery through waste incineration. This is not ideal from a circularity point of view since much of the resource's value is lost in the process, but it is still preferable to landfill.

6.2.3 Further Observations

This section contains further observations that are related to the initial theoretical model but go beyond the immediate scope of the research question. Nevertheless, these observations constitute noteworthy insights that enrich the research and can potentially serve as a basis for future research.

Motivations and Benefits of Collaboration

The previous sections illustrate how apparel brands relied on their suppliers' expertise to a varying extent. Some, like case 17, leveraged their supplier to drive the realisation/ improvement of circular design principles. Others, like case 12, engaged in more of a 'trickle-down' approach, helping their suppliers improve their sustainability footprint in a collaborative way (vs. just dictating and monitoring standards). And some, including cases 18 and 19, did both.

Collaboration was mentioned as a key success factor by most interviewees – but the reason they gave for its importance varied: Some of the smaller companies argued that they had no alternative, such as bargaining power, to collaboration. The only way to achieve their goal was to convince suppliers of their mission and attract their interest in the challenge to get them on board.

Along a similar line of thought, collaborative relationships were seen as a **prerequisite for transparency**, establishing a trusted partnership with suppliers so that they become open to sharing information. With the textile industry being so fragmented, even bigger brands are small in the grand scale of things, so that the mechanism of relying on bargaining power is of limited effectiveness, as case 19 reported. Case 8 noted that approaching suppliers with a well-known brand name can be helpful in getting their attention.

Many agreed that the **only way to achieve circularity is through collaboration** – no organisation can achieve it in isolation.

> *'You can't do it on your own! The technology is not there, the consumer buying is not there, the materials aren't there, the retailer engagement isn't there! We*

have to do this! And it's not even as an industry; It's as a cultural change we need to make. And I think everyone has to do their bit. We are very clear about taking responsibility for the bit we can influence and change today. But we're also, as you've heard, pushing back down our supply chain, both with our fabric mills and with our factories, to encourage them to do what they can.' – Case 18

The time where buyers simply dictated their requirements is over, said case 20, and resource scarcity, climate change and the volatility of global supply chains drive collaborative relationships. Case 6 relayed how such a relationship creates safety for the supplier to admit to problems and mistakes early and proactively without fear of losing their contract. Case 6, as a buyer, together with other suppliers, therefore, has an opportunity to address any issues in a timely manner and not when they have already caused damage.

'… *There are two things you said which make my hair go like this* [gestures to demonstrate how hair would stand up straight] *[…] power and […] yeah bargaining. You know, this is the really old-fashioned, horrible way of doing business together. I cannot understand that, still, there are companies who work like this because it's no fun. It's no good. It's for nobody. There is no benefit in this system because if you dominate it, then there is fear, and if there I,s the people get lame and that does not benefit anybody.'* – Case 6

Cases 2, 17, 18 and 19 agreed that the collaboration needs to go beyond (direct) suppliers and include actors along the entire value chain, extending the depth of collaboration beyond the dyad to the broader network.

'I do believe that it is the imperative of the hour that all players in the value chain have to consider: "hey, what is my part or what is my role in somehow overcoming the global challenge called climate change. I don't think that's going to work anymore in the old-school paradigm transactional, so me this, you that, all good. It needs more. Because the interdependencies between the individual actors are so obvious and striking. We need to find a new way of dealing with them, one that doesn't interpret the interdependencies in a transactionally negative way, but instead turns them into energy and transformational power."'

– Case 19

Contrary to others, cases 1 and 4 perceived the need for close-knit collaboration with suppliers **as a phase during the transition** to a circular economy. Once established, actors can potentially afford to place more emphasis on their core activities and have more transactional relationships with up- and downstream value chain actors.

On the other hand, cases 5, 6, 9, 14, 17, 18 and 19 stressed the importance of buyer-supplier collaboration and how it is a cornerstone of their competitive and sustainability performance as well as their identity, almost to the point that collaborative relationships are a **moral imperative** to addressing climate change. Case 18 shared how they feel responsible for their suppliers and the livelihoods that depend on them, to the extent that they will support them through the improvements after a failed audit rather than simply abandoning them in favour of a new supplier.

'Yeah, we work closely with them [the suppliers], we speak with them regularly, […] They are an extension of who we are. […] So we will work with

the factory to make sure that they are at least meeting minimum standards; […] This isn't ... it wasn't a question of "because they missed the audit target or result, we would walk away from them". What we would do is work with them to achieve the standards that we would expect as a minimum and also to understand where the improvements are and how we can best support them through those improvements.' – Case 18

As an example, cases 14 and 17 reiterated how their close supplier relationships pandemic-proofed the value chain and made it **resilient**. Cases 6 and 12 described their key suppliers as an extension of who they are as a company, describing an **identity-creating** aspect.

Personal Connections

Cases like 6, 8, 11, 15 and 22 hint at another factor – the actual people in place interfacing with buyers or suppliers. Some of these relationships not just outlasted several employers but represented an immensely valuable resource to the respective value chain actor.

'In the textile industry, there are so many producers, so many of whom are good and so many of whom do the same thing. But in the end, you stick with one because of a personal bond or because a performance suits you.' – Case 8

The resources in the form of personal contacts, connections, and extensive expertise these people bring with them allow a company to accelerate its collaborative journey because these key employees know whom to work with and how to work with them successfully. And they benefit from a network effect: one case noted how, when visiting

factories, they meet many other manufacturers or suppliers because these businesses are often geographically concentrated and ‘everyone seems to know everyone’.

Beyond that, case 15 mentioned how their expertise not just directly benefitted the buyer but also helped buyers ask the right questions to other suppliers. Being able to connect at a personal level opens up the way for rapid decision-making and the ability to (re)act and respond faster compared to more bureaucratic setups.

7 Analysis

While the previous chapter presented the result in a structured manner, the purpose of this chapter is to make sense of the observations, put them into the context of the initial theoretical model outlined in 4.2, understand any outliers or 'deviant' cases and adapt the theoretical model.

The chapter is structured as follows: After presenting the classification of the cases into the typology outlined in the initial section, a type-by-type analysis, connecting the observed types to relevant theory, is conducted. Types without observations are then discussed, followed by a cross-type analysis, before concluding with the final analysis.

7.1 Typology Classification and Considerations

Chapter 4 introduced a typology based on the reviewed literature and Table 12 shows the classification of studied cases according to this typology. For reference, each combination of IVs and DV is referred to as a type and designated alphabetically, so as to not mix up types with cases, which are numbered. As indicated by the table, cases fitting the types A, D, E, G, H and I were observed.

The following three paragraphs outline three considerations relevant to the case classification.

*Table 12: Overview of observed types. The case numbers with a * indicate a deviation not predicted by the model*

	Interaction frequency	Share resources	Joint planning & decision making	Co-developm.	Supplier-driven activities	Realised CPD	Observed Cases
A	**high**	**yes**	**yes**	**yes**	**yes**	**high (>4)**	5*, 6, 14,17, 18, 19
B	*med*	*yes*	*yes*	*yes*	*yes*	*high (>4)*	-
C	*high*	*yes*	*yes*	*yes*	*no*	*medium (3-4)*	-
D	**med**	**yes**	**yes**	**yes**	**no**	**medium (3-4)**	2
E	**high**	**yes**	**yes**	**no**	**no**	**medium (3-4)**	4
F	*med*	*yes*	*yes*	*no*	*no*	*medium (3-4)*	-
G	**high**	**yes**	**no**	**yes**	**no**	**medium (3-4)**	12, 16, 20*
H	**med**	**yes**	**no**	**yes**	**no**	**medium (3-4)**	8, 22
I	**high**	**yes**	**no**	**no**	**no**	**low (>1, <3)**	21
J	**med**	**yes**	**no**	**no**	**no**	**low (>1, <3)**	10, 11, 13
K	**low**	**yes**	**no**	**no**	**no**	**low (>1, <3)**	1*, 7
L	*low*	*no*	*no*	*no*	*no*	*none*	-
M	*med*	*no*	*no*	*no*	*no*	*none*	-

Upfront Adaptation of the Typology

As there were no cases with exclusively supplier-driven relationships, the initial typology was adapted as follows: The typology now indicates whether the buyer-supplier relationship demonstrates supplier-driven behaviour (yes) versus relationships that are exclusively buyer-driven (no). The variable is renamed supplier-driven activities. The original categorisations stem from Petersen et al. (2005) who present a spectrum where

suppliers drive development independently. In this study, there are only mixed forms of behaviour. A possible explanation is the lower maturity of collaborative buyer-supplier relationships in the textile sector versus more integrated industries, such as automotive, where supplier-driven development is common (D. Bennett & Klug, 2012; Tang & Qian, 2008).

Classification of Supplier Cases

The three cases of suppliers (3, 9, 15) are not classified because the model draws conclusions about the relationship between an apparel brand's relationship with their suppliers and the design principles realised. Nonetheless, the disclosed buyer-supplier relationships will enrich the type-by-type analysis of the respective buyer and enhance the understanding of the phenomena by providing an additional perspective.

Treatment of Additionally Observed Design Principles

The case interviews revealed two additional design principles, Regenerate and Recover, that are not included in the initial design principles.

Regenerate is only followed by one of the suppliers, and suppliers are not categorised in the typology (case 9). Compared to the other design principles, Recover is low-ranking in the R-hierarchy, meaning that it fails at maintaining the value of resources in the economic loop, as a large proportion of resource value is lost in energy recovery. Furthermore, it does not require the same amount of design effort as other principles.

7.2 Type-by-Type Analysis

This section contains the type-by-type analysis. As there are many types, each section includes a visual (see Table 13 to Table 20) so that readers can navigate the typology, as well as an initial paragraph describing the type and listing the observed cases.

7.2.1 Type A

Type A encompasses cases where the interaction frequency with suppliers is high, resources are shared, and there are joint planning and decision-making activities as well as co-development. The resulting outcome of this combination of BSC-practices is many circular design principles are realised. In summary, high levels of supplier integration led to more design principles being realised.

Type A is the only observed type with a better outcome on the DV predicted by the initial theoretical model and was observed in cases 5, 6, 14, 17, 18 and 19. With six cases, this is the most commonly observed type.

Table 13: Type A in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A	high	yes	yes	yes	yes	high (>4)	5*, 6, 14, 18, 17 19
B	*med*	*yes*	*yes*	*yes*	*yes*	*high (>4)*	
C-H						medium (3-4)	
I -M						low (>1, <3)/ none	

All cases of this type deliberately invest in and leverage a collaborative relationship with their suppliers as they have recognised the importance of such a relationship in their journey towards circularity. All cases classified in this type possess relationship-specific human assets and relationship-specific know-how accumulated by buyers and suppliers through interactions and long-standing relationships, allowing them to communicate efficiently and effectively and enhancing quality and increasing speed to market.

Type A cases have established effective mechanisms to govern the relationship, although they differ across cases. Cases 5, 6, 14, 17 and 18 seem to coordinate the collaboration

within the scope of a common framework agreement between the buyer and supplier. Case 19 has taken the step to formalise the collaboration in a dedicated project, including dedicated agreements and a formal governance structure.

Case 3 acts as a material supplier to case 19, resulting in a product made from only two types of material (shell and filling) satisfying the principles of 'Design to Reduce', 'Design for Durability', 'Design for Extended Use', 'Design for Repair' and partly 'Design for Recycling'.

Case 6, a workwear brand, does not just exhibit examples of dyadic buyer-supplier collaboration but has elevated the collaboration model to a network-oriented approach where suppliers get to interact and coordinate with suppliers and even where customers get to meet suppliers to strengthen relationships throughout the entire value network. Hence, this case is unique in its collaborative maturity: It accomplished the shift from competing at a single-firm level to a value network level.

For case 6, maintaining close and informal relationships with suppliers is a practice they expect to continue. Observations like this call into question the likelihood supplier integration based on interaction and joint activities will be replaced by a relationship style that relies on standardised interfaces and the division of labour. Much as it is impossible to predict the future, it is worth noting that the evolution in supplier integration could play out differently in a circular context than in linear settings.

Case 5, a brand in the sports segment, is not entirely in line with type A as they are missing the joint planning and decision-making. Describing the difficulty in finding suitable suppliers to partner with hints at the presence of partner scarcity, an imitation barrier described in the relational view.

Since case 5 mentioned how they have recently found a supplier they are in the process of building a relationship with that entails joint planning and decision-making, and because they are still a new brand, they were classified as type A. Assessment of the case within a year would likely yield the same classification. Another factor driving this evaluation is the presence of supplier-driven behaviour: Case 5 mentions examples where suppliers approached them to pilot new materials made from existing waste streams.

7.2.2 Type D

A medium interaction frequency, the presence of resource sharing, joint planning and decision-making and co-development in a buyer-driven relationship and a medium outcome on the DV constitute type D. There are two differences with type A cases, namely that the interaction frequency is lower, and the outcome is not high, but medium (between 3 and 4 principles realised).

Table 14: Type D in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C	*high*	*yes*	*yes*	*yes*	*no*	*medium (3-4)*	-
D	med	yes	yes	yes	no	medium (3-4)	2
E	high	yes	yes	no	no	medium (3-4)	4
F	*med*	*yes*	*yes*	*no*	*no*	*medium (3-4)*	-
G	high	yes	no	yes	no	medium (3-4)	12, 16, 20*
H	med	yes	no	yes	no	medium (3-4)	8, 22
I -M						low (>1, <3)/ none	

Case 2 is the only observed case for this type, a relatively young brand in the Outdoor segment with a strong ambition to achieve circularity.

So far, they have developed a physical relationship-specific asset through co-development, a proprietary circular material.

Their development trajectory clearly points towards type A: They are on track to realising quite a few design principles. But, currently, the impetus to develop new circular materials or adapt existing materials to realise circular design principles is driven by the brand. The brand is working towards establishing a human-specific component in their relationship-specific assets, establishing long-standing and trusted partnerships, enabling bilateral resource-sharing. They are trying to engage suppliers beyond a transactional relationship by positioning themselves as a small-scale pioneer suitable for piloting radical new ideas that can potentially be rolled out on a larger scale with other buyers.

Without a well-known brand name and a certain purchase volume, suppliers seem less willing to engage proactively, pointing to a power-related dynamic that is further explored in the cross-type analysis.

7.2.3 Type E

Type E entails a high interaction frequency, resource sharing, joint planning and decision-making but no co-development or supplier-driven behaviour in the relationship. The outcome on the DV and, therefore, the number of design principles realised is medium.

Table 15: Type E in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C	*high*	*yes*	*yes*	*yes*	*no*	*medium (3-4)*	-
D	med	yes	yes	yes	no	medium (3-4)	2
E	high	yes	yes	no	no	medium (3-4)	4
F	*med*	*yes*	*yes*	*no*	*no*	*medium (3-4)*	-
G	high	yes	no	yes	no	medium (3-4)	12, 16, 20*
H	med	yes	no	yes	no	medium (3-4)	8, 22
I -M						low (>1, <3)/ none	

Case 4 is the only observed case for this type. Case 4 reported a similar issue to case 2, finding it difficult to engage suppliers in a collaborative relationship as a small brand.

To case 4, the most fruitful collaboration is also supplier-driven; they expect suppliers to bring their expertise to the table to support the realisation of circular design principles.

Since the interview, they have partnered with other small brands with circularity ambitions to join forces in sourcing materials, bundling volumes, and, therefore, piquing the interest of suppliers to invest in the relationship.

Furthermore, suppliers are more willing to co-develop materials with bigger buyers because of the investments needed. The outcome of such co-development efforts is a Cradle-to-Cradle certified material that is exclusively available to the co-developing buyer, and not to other interested buyers. Through the buyer collective, case 4 hopes to circumvent this issue in the future.

These efforts again indicate a trajectory towards type A, working towards higher levels of supplier integration to realise more design principles.

7.2.4 Type G

Another type with a medium outcome on the DV is type G, characterised by high interaction frequency and co-development activities, but no joint planning and decision-making or supplier-driven activities in the relationship. Cases 12, 16 and 20 are classified into this type.

Table 16: Type G in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C	*high*	*yes*	*yes*	*yes*	*no*	*medium (3-4)*	-
D	med	yes	yes	yes	no	medium (3-4)	2
E	high	yes	yes	no	no	medium (3-4)	4
F	*med*	*yes*	*yes*	*no*	*no*	*medium (3-4)*	-
G	high	yes	no	yes	no	medium (3-4)	12, 16, 20*
H	med	yes	no	yes	no	medium (3-4)	8, 22
I -M						low (>1, <3)/ none	

Cases 12 and 16 stand out in that they as buyers not just have a clear ambition towards circularity but exhibit a 'pull-dynamic' by diffusing that ambition to their suppliers and throughout the value chain more unilaterally compared to types that demonstrate supplier-driven behaviour.

Even more so with case 12, that is one of the biggest buyers for some of its suppliers and supports them extensively in improving processes and standards through regular interaction, training and sharing of resources. At the same time, they also have an extensive supplier manual detailing the quality, social and environmental standards a supplier needs to adhere to, as well as regular audits to enforce these standards.

On one hand, dealing with transaction cost economics, screening the market and selecting and onboarding new suppliers with the risk of not sufficiently improving supplier performance in terms of quality and sustainability can easily exceed the cost incurred when choosing to work with existing suppliers.
On the other hand, firms feel a moral responsibility to not deny suppliers a significant part of their business, providing further reason to stick with an existing supplier base.

Another example of the 'diffusing' mechanism is case 16, which through co-development activities with its suppliers not just obtains materials with the desired circularity characteristics but enables the suppliers to sell these materials to other buyers, enabling them to re-configure their business in a sustainable way and incentivise collaboration.
In both cases 12 and 16, it is not clear whether their goal is to mainly ensure that their buyer standards are met and secure the respective materials or if the aim is to move towards type A with more proactive suppliers.

Case 20 is different in that the trajectory towards type A is evident: The case is an outlier in that there was an example of supplier-driven behaviour that is not expected for type G. However, according to the interviewee, this was limited to an occasion where the initial idea to improve a material came from the buyer, which is why the supplier-driven dot in Table 10 is only half-filled. Therefore, classification as type G seems justified.
The brand has considerable expertise in circularity and is sharing that knowledge with its suppliers to eventually help them step into a more proactive role, including decision-making. Because case 20 is convinced that close collaboration is essential to the

realisation of circular design principles while maintaining competitiveness, its shift to type A is clear.

7.2.5 Type H

Medium interaction frequency, resource-sharing and co-development resulting in a medium level of circular design are the features of Type H. Two cases, 8 and 22, are observed for this type, which have a lower interaction frequency than type G.

Table 17: Type H in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C	*high*	*yes*	*yes*	*yes*	*no*	*medium (3-4)*	-
D	med	yes	yes	yes	no	medium (3-4)	2
E	high	yes	yes	no	no	medium (3-4)	4
F	*med*	*yes*	*yes*	*no*	*no*	*medium (3-4)*	-
G	high	yes	no	yes	no	medium (3-4)	12, 16, 20*
H	med	yes	no	yes	no	medium (3-4)	8, 22
I -M						low (>1, <3)/ none	

Case 22, constrained by the previously described public procurement characteristics, is focusing more on monitoring compliance with pre-defined criteria. The ‘expiration date’ on the buyer-supplier relationship hinders investment in relation-specific assets and the development of competitive governance mechanisms. Information-sharing is extensive in that suppliers are obligated to disclose information about their entire value chain but more unilateral since there is less opportunity for the buyer to upskill the supplier. To be awarded the contract, the supplier must already fulfil the criteria defined in the tender.

Still, the case achieved a medium level of circular design. Both cases 22 and 8 focus on creating high-quality and long-lasting workwear that is easy to maintain and repair. It is

an example of how a certain level of circularity can be achieved without the high-tech (re-)development of materials and products.

Compared to case 22, case 8 is less advanced in enabling the extended use of products but has already sought to reduce the number of materials used in a single product and make them recyclable.

Compared to previously described types, the co-development activities of the two cases in this type do not represent routine activities but rather isolated incidents. Both cases primarily leverage what is available on the market. One example is case 8, which sources recycled and recyclable materials from case 3.

7.2.6 Type I

Type I has a high level of interaction and resource sharing, resulting in the realisation of very few circular design principles (at least 1 but less than 3 principles).

Table 18: Type I in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C-H						*medium (3-4)*	
I	high	yes	no	no	no	low (>1, <3)	21
J	med	yes	no	no	no	low (>1, <3)	10, 11, 13
K	low	yes	no	no	no	low (>1, <3)	*1*, 7*
L	*low*	*no*	*no*	*no*	*no*	*none*	
M	*med*	*no*	*no*	*no*	*no*	*none*	

The observed case for this type, case 21, describes itself as being at the beginning of their circularity journey. They are supported in this learning journey by academic institutions and non-governmental organisations.

Currently, their most frequent interactions are with manufacturers and not material suppliers. According to the interviewee, this is common for Everyday wear, unlike Sports and Outdoor segments, which are also involved and closely interacting with material suppliers. Furthermore, case 21 relies mostly on steering via monitoring, requiring materials to fulfil third-party label environmental and social standards.

If the brand identifies improvement opportunities where they have synergies with manufacturers (improving recyclability, living wage), they offer support by sharing personnel or financial resources. Case 21, therefore, seems representative of its segment that is overall less mature in its buyer-supplier collaboration.

The product range of case 21 is mostly made of cotton, as opposed to other cases with highly technical products. To minimise or even eliminate production waste, they have a collaboration with an academic institution. Beyond that, the products are meant to be simple and long-lasting, both from a physical and emotional durability perspective. Case 21 admitted that they deliberately do not create mono-fibre products because including a small percentage of elastane makes their shirts much more durable. Beyond that, the products are easy to maintain, and the brand is working on ways to educate customers about resource-efficient care (washing frequency, etc.).

Case 21 also recognised the importance of long-standing relationships as a lever to engage suppliers, perceiving themselves as a buyer with a low spending volume. Again, in an industry this fragmented, there are very few big players and an immense number of small value chain actors. To case 21, the future of their circularity ambitions lies in a collaborative partnership with both manufacturers and material suppliers – another type A development trajectory.

7.2.7 Type J

The only difference between type I and J is that the interaction frequency is medium in type J. Cases 10, 11 and 13 fit within this type. Each of these cases has realised less than three circular design principles, resulting in a low DV outcome.

Table 19: Type J in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C-H						*medium (3-4)*	
I	high	yes	no	no	no	low (>1, <3)	21
J	med	yes	no	no	no	low (>1, <3)	10, 11, 13
K	low	yes	no	no	no	low (>1, <3)	*1*, 7*
L	*low*	*no*	*no*	*no*	*no*	*none*	
M	*med*	*no*	*no*	*no*	*no*	*none*	

The cases share an emphasis on durability but otherwise have set different priorities. While case 11 is making efforts in improving recyclability, cases 13 and 10 have implemented (case 13) or made progress on (case 10) 'Design to Reduce'.

These cases do not engage their suppliers beyond the sharing of information. As previously outlined for case 22 (type H), cases 10 and 13 are subject to public tenders. In consequence, they obtain detailed information about the value chain and their suppliers upfront, but once a supplier is selected, there is a limited scope of action.

Case 13 described how by working with small-scale artisans, they are faced with hesitance to open up due to the need to protect their craft. Therefore, the brand tries to offer them an opportunity to share their artistry in a way the craft can be preserved and respected. The brand is moving towards a broader understanding of sustainability leaning more towards the social dimension than pursuing circularity as the main goal.

7.2.8 Type K

Type K includes cases that have a low interaction frequency and share resources, in this instance, information but do not engage in joint activities. The number of realised circular design principles is low. Cases 1 and 7 are observed to be of this type.

Table 20: Type K in a simplified overview of types

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven instances	Realised Circular Design Principles	Cases observed
A-B						*high (>4)*	
C-H						*medium (3-4)*	
I	high	yes	no	no	no	low (>1, <3)	21
J	med	yes	no	no	no	low (>1, <3)	10, 11, 13
K	low	yes	no	no	no	low (>1, <3)	*1*, 7*
L	*low*	*no*	*no*	*no*	*no*	*none*	
M	*med*	*no*	*no*	*no*	*no*	*none*	

Both cases 7 and 1 mentioned how the power imbalance between them as small brands with low spend volumes and bigger suppliers acts as a barrier to collaborating more closely. The considerations in type D regarding this issue also apply here (see 6.2.2).
Case 1 does not entirely fit the type, as they had some, although isolated, occasions of co-development with a supplier. Due to the challenges faced in further engaging suppliers and the limited nature of co-development, the case was still classified within this type.

While case 7 leverages suppliers' technical expertise on materials and hopes to achieve the desired value chain transparency through a cooperative mindset towards suppliers, their ambition in collaboration to go beyond that stage is not as articulated as in other cases. Case 1 also expressed its wish to find suppliers that can work and deliver independently, so that the brand can focus on its core business.

Mostly, both cases are left to their own devices to implement circular design principles. Like type H, the cases observed to be type K leverage their expertise to scan the supply market for materials fulfilling their criteria and leverage what is available.

Both have ambitions to become circular, and both have considerable expertise and appear to be deliberate in their design decisions. Both cases favour (physically and emotionally) durable products, but case 1 has made more effort to extend use and repairability, while case 7 is pursuing efforts towards recyclability. Still, neither brand can offset the lack of buyer-supplier collaboration with expertise to (fully) realise more circular design principles.

7.3 Types Not Observed

Not all types in the theory-based typology were observed in the empirical part of the study. There are no observations for types B, C, F, L and M, representing almost 40% of the types in the typology (see Table 21).

Table 21: Overview of types not observed

	Interaction frequency	**Share resources**	**Joint planning & decision making**	**Co-development**	**Supplier-driven activities**	**Realised Circular Design Principles**
B	med	yes	yes	yes	yes	high (>4)
C	high	yes	yes	yes	no	medium (3-4)
F	med	yes	yes	no	no	medium (3-4)
L	low	no	no	no	no	none
M	med	no	no	no	no	none

Type B

The observed cases demonstrated that whenever resource sharing, co-development, joint decision-making and planning occur, interaction frequency tends to be high. This explains the relatively high number of type A cases and the absence of type B cases. Buyers with such a high level of supplier integration tend to interact frequently with their suppliers. Again, type B is a remnant of the Petersen et al. paper, with the idea that suppliers can be so closely integrated that they can execute independently based on inputs given by the supplier or even through direct access to buyer systems. The relationship becomes so well-rehearsed that both supplier and buyer can focus more on their core business, due to the division of labour, and less on collaborative activities. As previously outlined, this does not seem to be the case in the apparel industry presently.

Type C

Since the typology, lacking purely supplier-driven relationships, was adapted to distinguish between purely buyer-driven relationships and relationships demonstrating some supplier-driven behaviour, the absence of observations for case C is not unusual: If buyers and suppliers interact frequently, share resources, engage in joint decision-making and planning as well as co-development activities, supplier-driven activities are to be expected. This assessment is further supported when looking at type G, where there are three observed cases. The only difference to type C is the absence of joint decision-making and planning, resulting in buyers that assume a strong driving role in the relationship.

Type F

The lack of observations for type F is not as readily deduced. The combination of joint decision-making and planning and a lack of co-development seems to be uncommon, but since there is an observation for type E that shares this characteristic, this is not a sufficient explanation. Therefore, it is possible that type F cases would be observed if the number of cases included was increased.

Types L and M

The lack of observations for L and M is not surprising since the case sourcing strategy focused on entities with existing efforts towards circularity or sustainability. With types I, J and K, there are still observed types with a low outcome, which are useful to analyse to understand the relationship between buyer-supplier collaboration and the realisation of circular design principles along a broad spectrum of outcomes.

Implications for the Typology

Since there are plausible arguments explaining the absence of observations for types B and C, they are excluded from the typology. Following the principle of parsimony, preference is given to the simpler model explaining the observed outcomes.

Types F, L and M are kept under the assumption that they are likely to be observed with a larger number of observed cases and a case selection strategy not requiring existing circularity or sustainability ambitions.

Table 22: Updated typology after elimination of types B and C

	Interaction frequency	Share resources	Joint planning & decicion making	Co-development	Supplier-driven relationship	Realised Circular Design Principles
A	high	yes	yes	yes	S	1_high
D	med	yes	yes	yes	B	2_medium
E	high	yes	yes	no	B	2_medium
F	med	yes	yes	no	B	2_medium
G	high	yes	no	yes	B	2_medium
H	med	yes	no	yes	B	2_medium
I	high	yes	no	no	B	3_low
J	med	yes	no	no	B	3_low
K	low	yes	no	no	B	3_low
L	low	no	no	no	B	4_none
M	med	no	no	no	B	4_none

Total: 11 Types

7.4 Cross-Type Analysis

Overall, the empirical study supports the central hypothesis of this research project that a higher level of supplier integration, i.e., more buyer-supplier collaboration, leads to the realisation of more circular design principles. The details of this positive relationship between IV and DV are elaborated further in this and the following section.

7.4.1 Outliers

Of the 19 cases classified[9], three cases did not fit neatly into the theory-derived typology. According to A. L. George and Bennett (2005), the presence of outliers or 'deviant cases'

[9] Three suppliers were not classified into the typology, see 6.1

is caused by either an inaccurate preliminary measurement or classification or that there are additional variables to be considered

Type A: Case 5 is missing the joint planning and decision-making activities expected for type A. Since the brand was in the process of setting up this collaborative practice, this outlier falls under inaccurate measurement. The measurement is not inaccurate in the sense that the interview does not accurately represent the case's overall context.

Type G: Case 20 reported one example of supplier-driven behaviour that runs counter to the characteristics of type G. Furthermore, the behaviour stemmed from the impetus of the buyer. Using a dichotomous scale to measure the presence of practices comes with the challenge of determining where to draw the line. There was only one reported example when other cases with supplier-driven behaviour have reported multiple and more purely supplier-driven examples. Furthermore, case 20 fits well in the other criteria of case G. Therefore, the outlier can also be attributed to an inaccurate measurement caused by the limited scale.

Type K: Case 1 reported a single example of co-development that is not expected in type K. The situation is similar to case 20 – should a single example, seen in the context of other cases that engage in continuous co-development efforts with suppliers, lead to a 'yes' on the dichotomous scale? As with case 20, the deviance is recorded and documented but does not warrant an adjustment of the typology. Furthermore, the interviewee reported a preference for a clear division of labour with suppliers to be able to focus on the core business. Therefore, the classification as type K seems justified.

As expected, the empirical reality does not align completely with theoretical predictions. Yet, the clash is not significant enough to warrant adaptations to the types in the form of additional independent variables, as the deviations can be easily explained.

7.4.2 Outcome Determinant Factors

Grouping the types by outcome, as done in Table 23, enables an analysis of the factors that distinguish the types according to the four DV clusters: *high*, *medium*, *low* and *none*. For each outcome except 'none'[10], the number of observed cases is similar, although there are significant differences by type.

Only Type A leads to a *high* DV outcome, setting itself apart from types with a medium, low or no outcome for supplier-driven behaviour. The lack of types with a low level of supplier integration leading to a high outcome supports the claim of a positive relationship between IV and DV.

To achieve a *medium* outcome for the number of realised design principles, many roads lead to Rome, including types D, E, F, G and H. Compared to types resulting in a low outcome, types D-H feature joint decision-making and planning and (type D)/or (types E, F, G, H) co-development. Therefore, a medium level of supplier integration leads to a medium outcome for realised design principles. Despite the equifinality of medium-outcome types, they are clearly distinguished from types with a high, low or no outcome.

Types I, J and K that lead to a *low* DV outcome differ from types with '*none'* as an outcome through the practice of resource-sharing.

[10] The rationale for the absence of types L and M resulting in 'none' as an outcome is outlined in 6.3

Table 23:The remaining types clustered by outcome of the dependent variable (number of realised design principles)

	Interaction frequency	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised Circular Design Principles	Cases observed
A	high	yes	yes	yes	yes	high (>4)	5*, 6, 14, 17, 18, 19
D	med	yes	yes	yes	no	medium (3-4)	2
E	high	yes	yes	no	no	medium (3-4)	4
F	med	yes	yes	no	no	medium (3-4)	-
G	high	yes	no	yes	no	medium (3-4)	12, 16, 20*
H	med	yes	no	yes	no	medium (3-4)	8, 22
I	high	yes	no	no	no	low (≥1, <3)	21
J	med	yes	no	no	no	low (≥1, <3)	10, 11, 13
K	low	yes	no	no	no	low (≥1, <3)	1*, 7
L	low	no	no	no	no	none	-
M	med	no	no	no	no	none	-

In summary, the differences in outcomes can be traced back to differences of the independent variables, suggesting that no major determining factors were inadvertently left out.

7.4.3 Non-Determinant Factors

None of the independent variables serves as a single determining factor of an outcome. But there is one independent variable whose removal does not affect the explanatory power of the model.

The type-by-type analysis confirmed that the frequency of interaction is not a good determinant for the dependent variable. There are types with a high frequency of interaction resulting in high (type A), medium (types E and G) and low (type I) DV outcomes. Potentially, the case evidence could have unveiled nuances in justifying the presence of the independent variable in the typology, even if in an adjusted way like the IV for Roles & Responsibilities. However, the empirical results do not support this claim. In the interest of parsimony, interaction frequency is thus eliminated from the model, as it is not useful in understanding how outcomes come to pass. The outcomes can be explained with the remaining variables.

Hence, as described in Table 24, several types can be collapsed into one: E/F, G/H, I/J/K, as well as L/M. The merger of types results from eliminating the only distinguishing factor between E/F, G/H, I/J/K, and L/M, respectively.
In consequence, there is now a single type for the outcomes high, low and none, and 3 types with a medium outcome.

The remaining six types are named HIGH CPD OUTCOME, MED CPD OUTCOME 1, MED CPD OUTCOME 2, MED CPD OUTCOME 3, LOW CPD OUTCOME and NO CPD OUTCOME, representing the unidirectional spectrum of supplier integration and the realisation of circular design principles. The types are renamed using a new naming convention to clearly set them apart from the previous stages of the analysis, avoiding any ambiguity when referring to types in the text.

Table 24: Resulting compression of types through the elimination of the IV interaction frequency

	Share resources	Joint planning & decision making	Co-development	Supplier-driven activities	Realised CDP	Implication of elimination	Resulting Type
A	yes	yes	yes	yes	high (>4)	-	**HIGH CDP OUTCOME**
D	yes	yes	yes	no	medium (3-4)	-	**MED CDP OUTCOME 3**
E	yes	yes	no	no	medium (3-4)	Collapse into one type	**MED CDP OUTCOME 2**
F	yes	yes	no	no	medium (3-4)		
G	yes	no	yes	no	medium (3-4)	Collapse into one type	**MED CDP OUTCOME 1**
H	yes	no	yes	no	medium (3-4)		
I	yes	no	no	no	low (≥1, <3)	Collapse into one type	**LOW CDP OUTCOME**
J	yes	no	no	no	low (≥1, <3)		
K	yes	no	no	no	low (≥1, <3)		
L	no	no	no	no	none	Collapse into one type	**NO CDP OUTCOME**
M	no	no	no	no	none		

7.5 Concluding Analysis

This section concludes the analysis and contains the updated model as well as some conclusions on key areas of the study:

- A nuanced view of the realised circular design principles – what design principles are realised and why (7.5.2)
- A maturity perspective, framing the types as stages of maturity in realising circular design principles (7.5.3)
- How firms subject to public procurement procedures potentially need a different development trajectory than buyer-supplier collaboration (7.5.4)

7.5.1 Updated Model

The thorough analysis of case evidence and theory has resulted in several adaptations and refinements to the initial typological theory. The updated model and the six final types are shown in Figure 6.

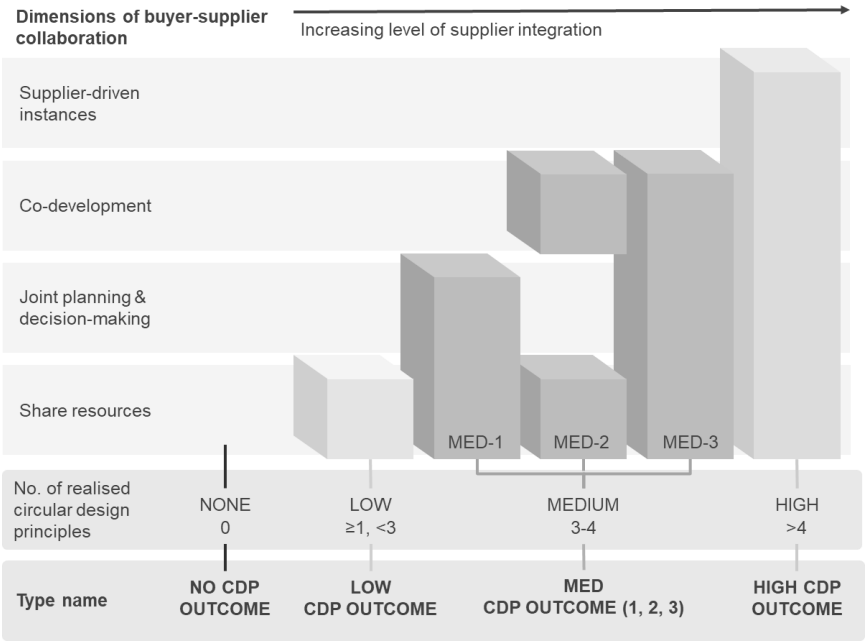


Figure 6: Updated model resulting from the adapted typology

To recap, the combined IVs reflect the level of supplier integration. The results have shown how a high level of supplier integration leads to more circular design principles (HIGH CDP OUTCOME) being realised, a medium level of supplier integration leads to a medium number of design principles (MED CDP OUTCOME) being realised, a low level of supplier integration results in few design principles being realised, and, by

exclusion (LOW CDP OUTCOME), no supplier integration leads to no circular design principles (NO CDP OUTCOME) being realised.

While there is only a single type to describe no, low, and high outcomes regarding the number of circular design principles, there are three sub-types to for a medium outcome. One of the benefits in typological theorizing is the ability to model equifinality – showing how the same outcome (in realised circular design principles, the DV) can come about through varying combinations of collaborative practices (IV). In this instance, a medium number of realised design principles can be achieved through resource sharing combined with joint planning & decision making and/or co-development. Comparing the three sub-types to each other, there is evidence that engaging in co-development activities is more impactful when it comes to the number of realised circular design principles, as the cases observed for MED CDP OUTCOME 3 and MED CDP OUTCOME 1 are scoring better on number of realised circular design principles than it is the case for the MED CDP OUTCOME 2 type.

In this model, the realised design principles are counted and not further distinguished, accounting for the possibility that brands may choose to prioritise the design principles differently. In any case, the following section contains a more nuanced analysis of the findings on realised design principles.

7.5.2 A Nuanced View of Circular Design Principles

So far, as stipulated in the DV, the analysis has mostly been concerned with the number of design principles realised. The goal of this paragraph is to re-introduce some nuance regarding the circular design principles to deepen the understanding of what design principles companies choose or manage to implement.

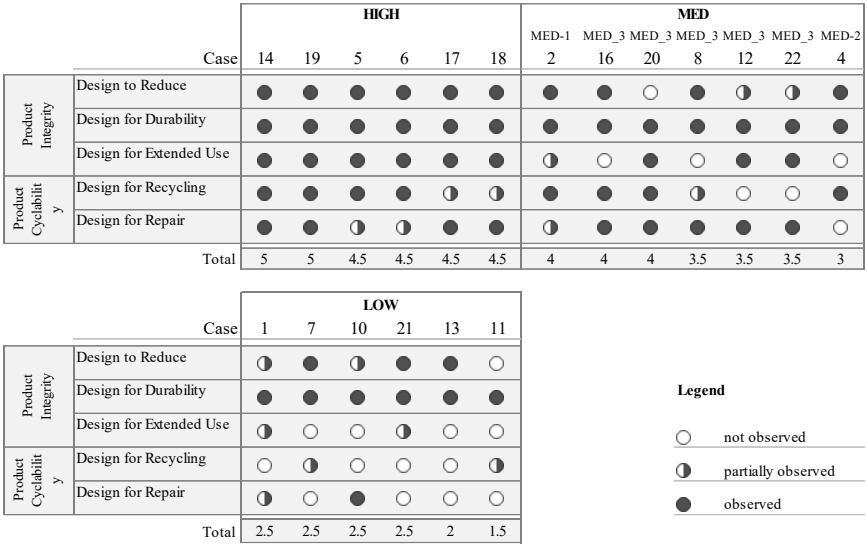


Figure 7: Realised circular design principles by type, arranged by descending order

Figure 7 shows which circular design principles were realised by type and arranged in descending order of number of realised principles. Moving from case 5 towards the right, it appears that the first gaps occur in 'Design for Repair' and 'Design for Recycling'. Further down the line, cases also tend to have gaps in 'Design for Extended Use'. None of the three is common in the LOW CDP OUTCOME type.

The implementation of design principles like 'Design to Reduce' and 'Design for Durability' require fewer radical adaptations in the product architecture and design process since they have been at the core of product development for segments like Outdoor and Sports before companies started on their circularity journeys. According to Brown et al. (2019), only mobilising existing capabilities leads to incremental improvements, i.e., a LOW CDP OUTCOME.

Yet, for both ‘Design to Reduce’ and ‘Design for Durability’, we have seen case examples taking these principles a step beyond ‘business as usual’. To name two examples:

Case 14, beyond optimising pattern design and placement, has managed to drastically reduce its production waste by feeding cutting waste back into the manufacturing of yarn. Case 2 recognised that more durability is not always better: Its target audience, probably not unlike the target audience of many outdoor brands, is mostly active urban people, not professional mountaineers. Their proprietary material is more than durable enough to satisfy the user’s requirements, but the company waives installing additional durability measures so as not to compromise the product’s recyclability. It is an example of how new market opportunities can be realised by stepping beyond firm boundaries, engaging the value chain network to create a novel product (Brown et al., 2019).

One of the less commonly observed principles is ‘Design for Extended Use’, including strategies to facilitate maintenance and upgrades. Although mostly concerned with creating products that are easy to care for without the use of environmentally harmful products and educating consumers on how to best care for their garments, that is not all there is. Modular products do not just allow the washing and upgrading of parts separately but can also cover a wider range of use cases, eliminating the need for the consumer to buy and own a separate product for each use case. One such example, shared among others by case 17, is a 3-in-1 jacket usable in a variety of seasons and weather conditions.

For this study, the realisation of design principles is measured using a dichotomous scale, for the sake of reducing complexity and creating clarity. Yet, examples like the above

described illustrate the various nuances in a design principle. Just because a case has been assessed as having realised a design principle, it does not mean there is no more potential for further growth.

As described by interviewees, ‘Design for Recycling’ represents a bigger departure from ‘business as usual’, and its pursuit is often perceived as a trade-off between durability and performance.

Regarding ‘Design for Recycling’, this study features cases that leverage what is available in the market, relying on suppliers for support in working with these materials. Suppliers, in turn, benefit from the insights gained regarding requirements and potential fields of application to focus their development efforts.

In other examples, materials, components and products are jointly developed with suppliers. Both pathways underline the complexity of realising ‘Design for Recycling’ due to the many influencing factors and dependencies: Does the product go into a technical cycle or a biological cycle? By whom is the recycling done? What recycling processes and infrastructure are available in target markets? What happens with the recycling output and who owns the goods throughout recycling? These and other considerations make it unsurprising that companies find this principle one of the hardest to implement. In many cases, the processes or infrastructure required to recycle are not available yet, at least not at scale and globally. By choosing one approach and not knowing the potential outcome, a value network risks investing a lot of resources and ending up betting on the wrong horse.

A common practice within ‘Design for Repair’ is avoiding a potential repair altogether by developing awareness of potential weak spots (experience and/or tracking of defects)

and addressing them. At times, the mitigation strategy makes the product more durable but can affect the repairability once a product does break due to the speciality equipment required to carry out the repair. To call attention to such trade-offs and elicit deliberate decisions, case 17 has implemented an internal audit report. A key consideration in this design principle is whether repairs are to be done in-house, by the customer or by a third party. There is no right or wrong answer; the decision depends on the product, the potential repair, and the third-party infrastructure available, such as qualified retailers and repair centres. It is important that the brand makes a conscious decision and adapts its product design accordingly.

Designing for circularity is no easy feat. The list of requirements a product needs to fulfil is long, complex and at times requires compromises. It is a task best shared with other competent value chain actors, such as material suppliers and manufacturers, as demonstrated by the model generated in this research. Furthermore, this section has shown how within each principle, there is a developmental trajectory towards circularity beyond a dichotomous scale. This trajectory can look different for each company, depending on its segment, product architecture and target audience.

7.5.3 A Maturity Perspective

One of the previous sections, 7.4.3, highlighted how interaction frequency alone is not helpful in determining the extent of supplier integration. In turn, just interacting frequently with suppliers does not guarantee a better outcome regarding the realisation of design principles. There need to be additional joint activities in place.

The case evidence of MED CDP OUTCOME and LOW CDP OUTCOME types establishes that many are actively working towards intensifying buyer-supplier

collaboration for the purpose of improving their circularity. Therefore, the different types can also be understood as maturity stages.

LOW CDP OUTCOME types have different routes in the 'race to get a HIGH CDP OUTCOME': They can either start with engaging in co-development activities and then building the joint planning and decision-making or vice versa. To achieve the final push towards the HIGH CDP OUTCOME type, the supplier needs to be empowered to become proactive, creating room for supplier-driven behaviour in the relationship.

Intuitively, this might not seem surprising: According to the relational view, the benefits or rents result from the idiosyncratic contributions of both parties (Dyer & Singh, 1998). Therefore, a buyer-supplier collaboration only fulfils the reciprocal nature of an exchange relationship if both parties drive the relationship to some extent. This study has demonstrated that buyer-supplier collaboration can be successful in terms of realising circular design principles with an unequal distribution of power in driving circularity. Still, the case evidence confirmed that to realise the full potential of the relationship, the buyer cannot be solely responsible for driving the collaboration.

7.5.4 The Exception of Public Procurement

More than once throughout the results and analysis section, I stumbled upon the constraints of public procurement when it comes to buyer-supplier collaboration. Compared to privately-owned companies, the mechanism at play is fundamentally different due to the public tender. The fixed contract dates hinder the establishment of long-term relationships and incentivise a transactional relationship over one where both parties invest resources in growing and developing themselves and the relationship.

The three cases observed in this study achieved low (2 cases) and medium (1 case) outcomes regarding realised circular design principles. Looking at potential development trajectories, the question arises whether the practices outlined in this model are feasible within their procedural limitations. The model performs well in terms of classifying cases that are subject to public procurement but has potential limitations when it comes to its applicability as a maturity model.

Although the rules surrounding public tender were perceived as constraints to further buyer-supplier collaboration, they are in place for a reason: It is in the public's interest that these contracts are awarded in a transparent and comprehensive manner. Some might argue that while private corporations may have an interest – financial, strategic, moral, etc. – to invest in pushing suppliers to achieve performance goals, this is not a matter for the public sector.

8 Discussion

The thesis investigated the question of how apparel brands leverage supplier integration to realise circular design principles. The findings address the existing gap in the literature regarding understanding the link between buyer-supplier collaboration and circular design principles and provided insights in the areas of collaborative practices, resulting rents, relationship dynamics incl. hindering/ driving factors, and the trade-off in realising of circular design principles. The insights and resulting theoretical implications for each of these areas are discussed in the following paragraphs.

8.2 Collaborative Practices

The findings confirmed the assumption of the initial theoretical model that greater buyer-supplier collaboration measured as the level of supplier integration (sharing of resources, joint planning and decision making, supplier-driven activities) generates more circular design principles than lower levels of supplier integration.

Gimenez and Tachizawa (2012) state how organisations need to implement collaborative practices with their value network partners, as supplier assessment practices were not found to have a positive impact on the environmental footprint of a product. The study confirmed that the relational view's concept of buyer-supplier collaboration is not just beneficial but a necessity in the context of pursuing circular design principles: Looking at the high number of realised design principles within type A confirms the argument made by Von Hippel (1988) that value networks with superior knowledge transfer out-innovate networks with less effective knowledge-sharing routines. Type HIGH CDP OUTCOME cases not just recognise suppliers as a powerful source of new ideas or expertise to

support the implementation of such ideas (Powell et al., 1996), they have also found mechanisms to successfully tap into that potential. The examples of collaboration provided powerfully illustrate how the combination of complementary resources, such as knowledge of market dynamics and consumer preferences of buyers, and the in-depth technical expertise of suppliers can result in the development of more circular materials and products (Dyer & Singh, 1998).

Examples like case 2 that co-developed a new wool-based material epitomise how buyers and suppliers can, through the combination of complementary resources, achieve game-changing improvements to materials (Handfield & Bechtel, 2002; Schliephake, Stevens, & Clay, 2009). With a clear goal of eco-effectiveness and circularity in mind, the dyad fully leveraged respective capabilities, carefully considered the material's properties (biodegradable) and the garment's use context (urban), as well as the material and the garment's life cycle (existing waste stream) (Braungart et al., 2007). In contrast, no example was observed where a dyad managed to realise a medium or high number of design principles without the presence of collaborative practices.

The findings of this thesis confirm the argument made by Hart (1995), identifying collaboration as an instrumental factor in developing capabilities in pollution prevention and product stewardship. However, the empirical findings go beyond confirming the necessity. The developed model provides a new-found granularity on the necessary and relevant practices of buyer-supplier collaboration in a circular context: resource sharing, joint planning & decision making, co-development, and supplier-driven activities were found to be the relevant dimensions of buyer-supplier collaboration driving the realisation of circular design principles. Furthermore, there is a clear sequence or hierarchy to these practices: dyads engaging only in resource sharing only realised a low

number of circular design principles. This resonates with the five-phase model of circular technology emergence through inter-firm collaboration (matching, idea, experimentation, engineering, commercialisation) put forth by Mulder et al. (2021) insofar that alliance partners exchange ideas and share information. The model in this study differs from Mulder et al. (2021) in that compared to what they call the 'idea phase', it distinguishes between sharing resources and joint planning and decision-making activities: Cases have reported sharing resources without going on to establish a joint vision or engage in any other planning activities. Doing so already reflects a higher maturity in supplier integration associated with the MED CDP OUTCOME 2 type. Mulder et al.'s (2021) experimentation phase is analogous to a MED CDP OUTCOME 1 type, but MED CDP OUTCOME 2 and LOW CDP OUTCOME are not reflected in their phases. Hence, this study does not just add two more incremental maturity stages; It also highlights the equifinality of MED CDP OUTCOME types that can be achieved through different collaborative practices (LOW CDP OUTCOME type activities + joint planning and decision making AND/OR co-development). The remaining two phases in Mulder et al.'s (2021) model shifts the focus towards the go-to-market activities of the co-developed circular technology, which fall outside the scope of this thesis. Instead, the HIGH CDP OUTCOME type adds a further increment in distinguishing the different intensities of buyer-supplier collaboration, where the buyer pushes the supplier, creating opportunities for supplier-driven behaviour in the relationship. Therefore, the typology, when conceived as a maturity model, demonstrates how the collaborative buyer-supplier relationship can be built once a partner is selected.

In summary, the study not only provides a way to conceptualise buyer-supplier collaboration and different maturity stages in a circular context, but also presents clear

guidance to apparel brands seeking to leverage their collaborative potential with suppliers. The framework lays out the respective pathways through which buyer-supplier dyads can advance from a few to a high number of realised circular design principles. Section 8.3 on relationship dynamics delves deeper into why there can also be unexpected barriers or complications in supplier engagement. However, the previously outlined guidance only applies organisations in the private sector, as organisations subject to public procurement procedures were identified as an exception regarding the applicability of the maturity stages (see section 7.5.4).

Furthermore, buyer-supplier collaborative practices were mostly examined through a dyadic lens, but examples like case 6 (type HIGH CDP OUTCOME) with such a close-knit value network made up of a buyer and several suppliers can no longer simply be reduced to a collection of dyadic ties (Lavie, 2006), exposing the need for a network perspective on buyer-supplier relationships: Dense networks with agents extensively connected (Coleman, 1994) and strong ties referring to frequent, reciprocal and friendly exchanges (Granovetter, 1973; R. E. Nelson, 1989) facilitate the emergence of trust and promote cooperation. Moreover, the diversity in knowledge creates knowledge spill-over, enhancing innovation (Feldman & Audretsch, 1998; Kogut, 2000). Similarly, Karla Magruder, founder of 'Accelerating Circularity', noted how achieving a circular economy is *'...like birthing a baby. We don't birth a baby one arm at a time [...] it comes out, it's whole. [...] There are people that are working on parts of the system, but to get the system functioning, it's got to happen! You got to put it all together!'* She articulates the importance of circular economy research iterating between a network or systems perspective and what is called the 'frog's eye view' in German – the detailed view of each system component. Examining a network perspective can open up even more

powerful ways in which to collaboratively realise circular design principles and support the journey towards circularity. This thesis has showcased one such example, having implications for future research that are further described in the following chapter.

8.2 Resulting Rents

Section 3.1.2 on the relational view of the firm outlines how four categories of relational rents accumulate as a result of interfirm collaboration: knowledge sharing routines, complementary resources, relation-ship specific assets and effective governance. As Table 25 illustrates, the collaborative practices can all be mapped to a main corresponding relational rent. Although several authors (Bryson et al., 2006; Emerson et al., 2011; Köhler et al., 2022; Vachon & Klassen, 2006; Zhu & Sarkis, 2004) list interaction frequency as a key dimension of buyer-supplier collaboration, this study found that by itself it is not helpful in determining the level of supplier integration and has no influence over the realisation of design principles. This finding is not surprising considering how interaction frequency is not contributing directly to any relational rent (i.e., no knowledge sharing routines can happen even with frequent interaction when there is no resource sharing).

Table 25: Collaborative practices mapped to the main corresponding relational rent

Collaborative practice	**Corresponding main relational rent**
Share resources	Knowledge sharing routines
Joint planning & decision-making	Effective governance
Co-development	Relationship-specific assets
Supplier-driven activities	Complementary resources

According to the relational view, competitive benefits in the form of a 'supernormal profit' can result from any one of the relational rents. When studying relational rents without knowing the results of the study, one might be tempted to frame the realisation of circular design principles mainly as a relationship-specific asset. But interestingly, this study has shown, that when it comes to the realisation of circular design principles, a so-called 'supernormal outcome on circular design' (achieving a HIGH CDP OUTCOME type), can only result from a combination of *all* relational rents. Companies pursuing this goal therefore have no choice but to pursue all four relational rents simultaneously, as specialisation is not an effective strategy in this case.

Section 4.1 has outlined how this thesis shows connections between the rRBV and NRBV. From a practitioner point of view, this connection has already become clear over recent years. There are several developments showcasing the convergence of the notions of 'being competitive' and 'being sustainable/ circular' (Rattalino, 2018): Regulators, consumers and investors place pressure on organisations to operate in a socially responsible manner and in line with planetary boundaries. Germany has recently passed a supply chain act imposing significant obligations regarding compliance with human rights and environmental standards on large domestic companies, including accountability for the misconduct of suppliers (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ), 2022). Violations entail serious consequences, such as fines and exclusion from publicly awarded contracts (CSR in Deutschland, 2022). The EU is expected to pass even stricter regulations on the same issue within the next two years. Besides growing demand for sustainable products and services, investors increasingly require companies to not just track how much profit was

made but *how* that profit was made. Furthermore, employees also tend to favour companies that adhere to sustainable business practices, according to a study conducted by IBM (2021).

This study has contributed to illustrating the connection between rRBV and NRBV from a theoretical perspective. The resulting framework confirmed the relational view's core tenet of how alliance performance is driven by the quality of ongoing relational processes (Dyer & Singh, 1998; Faems et al., 2008), although the performance aspect is framed differently: Instead of above-average economic return, the study was concerned with measuring the outcome on circular design principles, which is more aligned with the key capabilities within the NRBV (Hart, 1995). Building on Table 25, Table 26 describes how that 'supernormal outcome on circular design' resulting from the four relational rents connects to the two interconnected strategic capabilities of product stewardship and pollution prevention. While all design principles are conducive to building product stewardship, only product cyclability contributes to pollution prevention.

We recall from section 6.2.2, a higher prevalence of principles related to product integrity (design to reduce, design for durability, design for extended use) compared to design principles pertaining to product cyclability (design for repair, design for recycling). There are indications in the case evidence, that product cyclability seems to be harder to implement and is more often achieved by types of HIGH CDP OUTCOME. This leads to the suggestion that lower levels of supplier integration may lead to some success in product stewardship, but higher levels of product stewardship as well as the pollution prevention capability building are restricted to high levels of supplier integration. Although this claim needs to be supported through further research, it appears that, like 'supernormal outcomes on circular design', 'supernormal' outcomes on

interconnected strategic capabilities of the NRBV may require the combination of all relational rents.

Table 26: Linking the rRBV and the NRBV through the model of this thesis

Collaborative practice	**Corresponding main relational rent** *(rRBV)*		**Outcome on circular design/ realised CDP**	**Resulting interconnected strategic capability** *(NRBV)*
Share resources	Knowledge sharing routines		Product Integrity →	Product stewardship
Joint planning & decision-making	Effective governance			
Co-development	Relationship-specific assets		Product Cyclability →	
Supplier-driven activities	Complementary resources			Pollution prevention

8.3 Relationship Dynamics

Relational alliance literature promotes an alliance governance strategy in which partners rely on trust – positive expectations regarding the other alliance party in a risky situation (Lewicki, Tomlinson, & Gillespie, 2006; Rousseau, Sitkin, Burt, & Camerer, 1998) – to address issues of safeguarding and coordination, including supplier development (Faems, Janssens, Madhok, & Looy, 2008). Trust increases the alliance partner's willingness to engage in extensive information-sharing as it reassures alliance parties that knowledge exchanged will be used for the greater good of the alliance, reduces perceived opportunistic hazards and the need for formal safeguarding mechanisms, and builds on a legacy of successful collaboration (Faems et al., 2008). Strong, trustful, and collaborative

buyer-supplier relationships are commonly framed as a more desirable alternative (Touboulic & Walker, 2015: Vachon & Klassen, 2006; Youn, Yang, Hong, & Park, 2013) to structural alliances, relying on power and compliance (Boyd, Spekman, Kamauff, & Werhane, 2007).

Several of the smaller brands observed reported how, in the absence of any coercive or bargaining power, a collaborative approach must be pursued by default. The awareness of how knowledge-sharing routines between alliance partners can trigger and enhance innovative activities and learning processes between firms (Köhler et al., 2022; Lozano et al., 2021) motivates smaller brands with a strong circularity ambition to convince suppliers of their mission and secure the supplier's collaborative contribution. However, these efforts were not always successful. The relational view has been criticised for overemphasising aspects like relational embeddedness and ignoring transactional issues like opportunism (Faems et al., 2008). Indeed, there is little research within the collaborative paradigm that offers a more nuanced view of collaboration, including considerations about power imbalances (Hoejmose & Adrien-Kirby, 2012; Touboulic & Walker, 2015; Walker, Miemczyk, Johnsen, & Spencer, 2012), necessitating a more in-depth consideration of supplier engagement, which follows in section 8.3.1.

On the other hand, the empirical evidence supported the framing of the resulting types of LOW CDP OUTCOME, MED CDP OUTCOME and HIGH CDP OUTCOME in a maturity model. Both the literature and empirical findings do not present a unified view on whether higher levels of supplier integration are always better in terms of competitive or circularity outcomes as opposed to the possibility of an ideal level beyond which any potential drawbacks outweigh the benefits. A more detailed discussion of the maturity model and an ideal level of buyer-supplier collaboration forms section 8.3.2.

8.3.1 The 'Ugly Truth' of unexpected Power Dynamics

In their research that included stakeholders from the apparel sector, Wang, Burke, and Zhang (2022) did not identify collaboration with upstream suppliers as a challenge for buying firms. They argue that 's*uppliers are traditionally required to engage with firms in product design, ensuring the availability of raw materials and component compatibility*' meaning '*major challenges in circular product design from a supply chain perspective are centred on the management of reverse resource flow by the downstream firms.*' (Wang et al., 2022)

The notion of power dynamics and asymmetric bargaining power is often overlooked or even negated in the context of a circular economy, where the collaborative paradigm is firmly established. Even some of the interviewees, when being confronted with the subject, expressed their surprise or irritation over being asked about power dynamics. Such a 'transactional' topic was seemingly at odds with such a noble quest such as the joint and collaborative journey towards a circular economy.

Within section 3.2, there is a paragraph summarising the varying reasons and motivations for buyer-supplier collaboration. Buyer-supplier collaboration is cast in a mostly positive light, listing benefits like improved circularity, innovation, shorter time-to-market, shorter reaction time and resilience. The findings of this study paint a more nuanced picture, containing evidence of different relationship dynamics and struggles pertaining to adverse power dynamics. While there were examples of buyer-supplier relationships that seem to be well-aligned, the cases also showcase suppliers not being able to unlock their full potential with all their buyers, and buyers struggling to find suitable suppliers or

engaging them beyond a low level of integration. Such examples can be found for example within the type-by-type analysis in section 7.2.2 Type D.

Therefore, it is helpful and necessary to discern the motivations to (not) collaborate or to collaborate at a certain level. Only by making sense of the barrier to fruitful collaboration can it be overcome, which is critical as seen in the previous section: a supernormal outcome on circular design can only be achieved through the full realisation of the dyad's collaborative potential.

It appears that both the rRBV and, partly, the NRBV operate under the implicit assumption of a buyer's market, or at least they do not explicitly consider the case of a power balance so strongly in favour of suppliers. According to Lavie (2006), participation in interorganisational relationships such as buyer-supplier collaborations can either benefit or impair a firm's quest for rent[11]. Therefore, firms need to optimise the configuration of their value network to combine their resources in a competitive way (Barney, 1991; Lavie, 2006). Missing resources need to be obtained from other organisations, resulting in dependencies (Pfeffer & Salancik, 2003). The supplier possesses resources the buyer wants, and the buyer has limited alternatives to obtain the resources (Bourantas, 1989; Pfeffer & Salancik, 2003). The buyer does not have the means to in-source the value chain step in question and produce their own materials, leading to a dependency and limiting the scope of action for the buyer (Freiling, 2013; Nienhüser, 2008; Pfeffer & Salancik, 2003). For instance, case 2 is likely limited in its transition towards type A and the realisation of more circular design principles by the dependence on its suppliers

[11] As outlined in section 3.1.2, relational rents include relationship-specific assets, knowledge exchange routines, the combination of complementary resources and effective governance

Partner scarcity explains how it can be difficult for buyers to find suppliers that are suitable collaboration partners (Dyer & Singh, 1998). As the textile sector exhibits only low levels of circular maturity, suppliers offering materials of the desired qualities are not common, especially since the cases reported differing priorities and interpretations of circular design principles. Mulder et al. (2021), in the context of outlining the process of finding alliance partners, describe how firms deliberate on their own and potential alliance partners' technical and organisational capacities in joining a shared perspective on circularity. On the other hand, the implementation of circular design principles and improving circularity throughout the value network cannot be reduced to problems of supplier screening and selection (Hoejmose & Adrien-Kirby, 2012; Touboulic & Walker, 2015).

According to the relational view, a number of factors influence the willingness of suppliers to engage in higher levels of integration:

- A buyer's lack of **relative resource scope or scale**, meaning not having enough complementary resources decreases their attractiveness as a partner (Lavie, 2006). In an extreme case, the buyer's shared resources are a subset of the supplier's shared resources, limiting the supplier's potential benefit from the collaboration relative to the buyer (Lavie, 2006).
- The **relatively higher bargaining power** of the supplier leads to a situation where a supplier does not need to conform to a buyer's wishes as the buyer, based on spend volume and strategic nature, is not as important to the supplier as the supplier is to the buyer (Hamel, 1991; Lavie, 2006).
- If the supplier were to suspect **opportunistic behaviour** from the buyer, such as the disproportionate extraction of relational rents, it motivates the supplier to limit the

scope of collaboration and knowledge transfer (Dyer & Singh, 1998; Lavie, 2006; Parkhe, 1993).

- Less a matter of willingness but capability is the **relative absorptive capacity** of a supplier. Absorptive capacity measures a firm's ability to identify, evaluate, assimilate and exploit external knowledge (Cohen & Levinthal, 1990). Because firms differ in absorptive capacity the same way resources are distributed unevenly (Lavie, 2006), the supplier might not be able to absorb and exploit all the shared resources at the same pace as the buyer.
- As specialisation and, with that, asset specificity grows, transaction costs rise (Dyer & Singh, 1998; Williamson, 1985, 1991). Relationship-specific assets **do not have market liquidity** and cannot be redeployed once a relationship has ended, resulting in a significant loss (Coggan, van Grieken, Jardi, & Boullier, 2017). When faced with a buyer that has yet to establish themselves in the market, the perceived risk of losing the investment in a relationship-specific asset is higher than the cost of searching and contracting another buyer. This explains why suppliers are open to joint activities to the extent that they are buyer-driven but are cautious to take on a more proactive role and invest in the relationship.

When the examples provided for relative resource scope or scale, relative bargaining power and opportunistic behaviour are turned around; they become drivers of buyer-supplier collaboration. A buyer with a large set of complementary resources is an attractive partner, a buyer with higher bargaining power has influence over the supplier, and the absence of (suspected) opportunistic behaviour becomes the bases for fruitful collaboration.

At the same time, buyers may be willing to push their supplier's performance in terms of quality, reliability, circularity and innovation – requiring financial and personnel resources (Vachon & Klassen, 2007) – if the (perceived) cost of searching for, negotiating with and onboarding a new supplier is too high (Simpson & Power, 2005).

The case studies revealed several examples where more circularity-mature apparel brands have started encouraging, guiding and even funding their suppliers in becoming more circular (Blome, Paulraj, & Schuetz, 2014; Simpson, Power, & Samson, 2007). A sense of responsibility towards the supplier base, in terms of livelihoods and perceiving long-standing key suppliers as an extension of the buyer's organisation and identity, was found to be a further incentive driving supplier development efforts. Moreover, if suppliers view the 'cost of doing nothing', such as a loss of sales needing to be compensated for by a new buyer, as higher than the effort required to engage in development, they will lean towards development (Simpson & Power, 2005).

In turn, suppliers unwilling to evolve towards circularity with their buyers can be in danger of losing significant parts of their business. Therefore, suppliers, in the interest of securing market access and a potentially long-standing, reliable, and commercially attractive relationship, might choose to collaborate with their buyers (Simpson et al., 2007).

The above-described factors show how relational exchanges are complex, and how the establishment of truly collaborative relationships is no easy feat (Touboulic & Walker, 2015). For the buyer, developing a collaborative relationship entails the development of ongoing supplier engagement and buy-in (Alvarez, Pilbeam, & Wilding, 2010) to engage in meaningful resource-sharing and development, co-development activities and joint planning and decision-making, as well as enabling or even convincing the supplier to

take on a more proactive role. Ultimately, apparel brands are reliant on their suppliers, upon which they have differing degrees of influence (Touboulic & Walker, 2015). The relational view frames successful inter-firm collaboration as a competitive asset that is valuable, rare, and not easily imitated or substituted. This perspective underlines once again how much of an asset such buyer-supplier relationships are. The described pain points in supplier engagement related to power dynamics are less surprising in that context, albeit that guidance on how to overcome them is missing. For both interfirm collaboration and circular economy literature it is crucial to not disregard or downplay the effects of relationship and power dynamics or just operate under the implied assumption of a buyers' market. This study has shown that power dynamics can become a major barrier in achieving higher levels of supplier integration and realising circular design principles. This study has provided initial anecdotal evidence, such as cases that brand themselves to a supplier as an opportunity to test material innovations in the market to convince a supplier to invest into a collaborative relationship. Further research is needed to further explore effective strategies, incentives or mechanisms at firm or even policy level to mitigate the unfavourable and limiting effects of such power dynamics on the collaborative potential of buyer-supplier relationships.

Further insights on alliance partner selection for the purpose of circular design collaboration, as well as the structural and procedural governance mechanism of such partnerships may also contribute to mitigating struggles in supplier engagement

8.3.2 The Quest for a Sweet Spot in Supplier Integration

Competitive dynamics like those described in 8.2 serve as clear rationale as to why LOW CDP OUTCOME and MED CDP OUTCOME cases are working towards increasing

their supplier integration, although their motives might vary slightly: Some value network actors attribute their development trajectory towards a moral obligation to the planet and future generations, some sense the competitive opportunity, and others perceive it as a pathway to securing their future license to operate.

Initially, the theoretical model reflected the notion presented by Petersen et al. (2005) that at a certain level of supplier integration, the supplier can assume a driving role in the relationship and independently execute based on some guardrails set by the buyer. Since no pure or even primary supplier-driven relationships were observed, the model was adapted to distinguish between relationships with and without supplier-driven behaviour. This implicitly raises two interrelated questions to further understand the mechanism of buyer-supplier collaboration in a circular setting:

1) *Is there a type beyond HIGH CDP OUTCOME that was not observed due to a lack of maturity in the industry given that the apparel sector is so fragmented and secretive or does buyer-supplier collaboration play out differently in a circular context?*

The case evidence is inconclusive: A minority of interviewees agreed with what is described by Petersen et al. (2005) that the apparel industry, regarding supplier integration, matures to the point where suppliers assume a driving role to execute independently within a scope of action determined by the buyer. On the other hand, most interviewees perceived the type of close-knit collaboration currently described as HIGH CDP OUTCOME to be the way forward to achieve and further develop circularity. To them, this type of collaboration is closely intertwined with what 'normal' would look like in a circular economy.

2) *Does HIGH CDP OUTCOME reflect the ideal level of buyer-supplier collaboration, meaning that if higher levels of supplier integration were to exist in a circular context, they would not yield a better outcome? Or, conversely, is more intense buyer-supplier integration always beneficial to circularity outcomes?*

In linear relational alliance literature, authors seem to agree that there is an ideal level of supplier integration, beyond which the resource expenditure and risks outweigh the already described benefits (Corsten & Felde, 2005; Das, Narasimhan, & Talluri, 2006; Fawcett & Magnan, 2002; Fine & Whitney, 1996; Singh & Mitchell, 1996). As intensive buyer-supplier interactions are not always effective (Yan & Dooley, 2014), there have been previous efforts to examine factors determining the quality of the collaborative relationships (Hoegl & Wagner, 2005; Hoegl, Weinkauf, & Gemünden, 2004; Marks, Mathieu, & Zaccaro, 2001; Schliephake et al., 2009; Wagner & Hoegl, 2006; Youn et al., 2013). Solely based on the case evidence, there was no example where more intense buyer-supplier collaboration also led to more circular design principles being realised. Of course, this does not completely discount the possibility higher levels of buyer-supplier collaboration beyond type HIGH CDP OUTCOME will limit the realisation of circular design principles. At the same time, where the implementation maturity of the circular economy is this low, even more so in the textile industry, recommending more intense buyer-supplier collaboration represents solid advice – at least regarding the realisation of circular design principles.

In summary, examining pathways beyond the HIGH CDP OUTCOME type represents an important direction for future research. There is a real opportunity for broadening the

context of this study's model and answering the question whether there is an ideal level of supplier integration for the best outcome on circular design.

8.4 Trade-offs in Realising Circular Design Principles

The case evidence points towards a trade-off between product integrity and product cyclability. Den Hollander et al. (2017) point out how the extension of product lifetimes does not always result in an improvement in their environmental footprint. Similarly, Wang et al. (2022) noted how the use of reusable materials decreases the durability of products, calling for the development of new materials that satisfy both criteria. Bakker et al. (2014) argue that successful design for product cyclability entails optimisation of a product's lifespan without compromising the product's economic viability. In this context, the hesitancy of brands that offer high-end outdoor gear to compromise product integrity and performance characteristics for product cyclability is understandable. The case findings are also consistent with Bakker et al.'s (2014) findings in that one of the key challenges of circular design is the highly context-dependent choice of which design strategies to prioritise. The product's characteristics, the anticipated use context and business constraints (including market dynamics and regulatory requirements) influence the suitability of different design strategies (Bakker et al., 2014). None of the reviewed studies offered practical guidance on how to resolve this trade-off, for example by providing decision criteria.

To become circular, a simple prioritisation of product integrity in the name of economic viability is falling short. There were several examples of cases that have found ways to address the trade-off between product integrity and product cyclability.

- Employing **'material first'** (vs. product first) product development approaches, where a material satisfying circularity requirements is taken as a starting point to determine potential garment applications (as seen in cases 5, 2, 20)
- A **circular economy north star**, i.e., a deliberate and strategic decision about whether to follow a biological or technical cycle. Each trajectory has different implications and requirements: Cases 2 and 5 pursue a biological cycle, with the aim that their products will leave no environmental footprints. Cases 1 and 20, to take two examples, follow a technical cycle, with product cyclability efforts focused on the recycling of resources at their highest possible value. The north star helps value networks focus their efforts on their goals.
- **Circular design audits**, as done by case 17, certify that a product adheres to the value network's design principles and highlights any deliberate decisions made in light of trade-offs. Such reports are a helpful tool to create awareness of trade-offs, setting the agenda for new material development or alternative design approaches. Also important is the visibility of assumptions made during product development, making it easier to challenge them in case a better alternative is available. Throughout the value network's circularity journey, the report allows them to track and actively change assumptions whenever circumstances shift, such as the emergence of new materials and technology, end-of-life infrastructure or a change in regulatory paradigms. In an open-source setting, such reports could potentially provide valuable guidance to other value networks on circular design.

Design principles, in theory, can appear like a simple laundry list of requirements to achieve circularity. As illustrated through this and other studies, the realisation of design principles is a challenging enterprise (de Kwant, Rahi, & Laurenti, 2021; Dumée, 2021;

Farrell et al., 2020; Reuter, van Schaik, Gutzmer, Bartie, & Abadías-Llamas, 2019; Romme & Endenburg, 2006). This study has provided three potential strategies that attempt to mitigate the identified trade-off and work towards unlocking the full potential of circular design principles. Technological advance may produce materials that bridge the trade-off. Still, further work is needed to prepare industry-specific guidance on how to overcome trade-offs between integrity and cyclability. Beyond that, further research is needed to connect the realisation of circular design principles with an organisation's overall circularity performance.

9 Conclusions and Outlook

This chapter, containing the conclusions of the thesis, is divided into three parts: an overview of theoretical and practical contributions, research limitations, and an outlook on future research opportunities.

9.1 Research Contributions

9.2.1 Theoretical Contributions

The dissertation contributes to the **literature on interorganisational relationships** and supplier integration, linking collaborative practices to circularity outcomes. Traditionally, the field has mainly been concerned with the effects of such relationships on financial and competitive outcomes. When venturing into investigating the effect on environmental performance, studies have employed broad and, at times, fuzzy concepts. This study provides a tangible outcome specific to the circular economy. Besides offering a set of specific and collaborative practices relevant to achieving outcomes on circular design and mapping them to the relational rents pertaining to the rRBV, the study also demonstrates how the practices can be mapped to maturity stages. The study demonstrated, that when pursuing outcomes in circular design, it is not sufficient to rely on a single category of relational rent, but that all combined are necessary to achieve a 'supernormal outcome on circular design'.

Furthermore, links between the relational view and the natural resource-based view of the firm were established. Collaboration between buyers and suppliers supports the development of core capabilities that drive sustainable development, namely pollution prevention and product stewardship and can be directly linked as an outcome of the four

relational rents. Furthermore, there is evidence to support the claim that lower levels of supplier integration may lead to some success in product stewardship, but higher levels of product stewardship as well as the pollution prevention capability building are restricted to high levels of supplier integration.

Additionally, the insights on motives, drivers and barriers to buyer-supplier collaboration shed some light on relationship dynamics, considering situations where the supplier has more bargaining power than the buyer. Such insights acknowledge the reality that despite the noble ambitions of circularity, most value chain actors remain economically driven and need a compelling strategic and/or financial case to engage in collaborative practices. This thesis provides a nuanced view of interorganisational relationships, framing buyer-supplier collaboration as a deliberate and business-driven choice to advance ambitions of a circular, strategic, or financial nature.

The study extends and adapts the relational view for the pursuit of a supernormal outcome on circular design and through this extension, connects it to the NRBV. Furthermore, the findings call attention to adverse power dynamics as a key barrier to achieving supernormal outcomes on circular design.

Brown et al. (2021) call for research on specific collaborative practices and processes in the circular economy, describing it as a neglected field. The dissertation's findings contribute to the circular economy literature by empirically validating the importance of collaboration across the value network, offering a dedicated approach for collaboration with suppliers: The model captures key dimensions and practices of buyer-supplier collaboration in a circular context including the intensity of collaboration, i.e., the level of supplier integration, and the hierarchy of the collaborative practices. Furthermore, the collaborative practices were linked to desired, measurable outcomes to assess their

effectiveness in CE operationalisation. The thesis therefore constitutes a valuable addition to circular economy research and a foundation for further research that encompasses other industries or value network actors.

9.2.2 Practical Contributions

On a practical level, this research project provides an understanding of how sourcing is linked to the capability to design circular apparel. It not only offers guidance on buyer-supplier collaboration practices but also provides an analytical lens to organisations and sourcing professionals against which they can assess and benchmark their practices as well as evaluate their suitability to transition towards circularity. The resulting model serves as a navigator, allowing buyers and suppliers to gauge the maturity of their relationship and identify the potential for improvement.

The case evidence can further support progress through the types or stages of the model by providing illustrative examples, potential best practices and learnings from other apparel brands and suppliers.

Considerations for apparel brands

For buyers, the model can serve as a basis to argue for the adoption of more collaborative supplier management practices to senior management. The findings can help empower Sourcing & Procurement (S&P), an organisational function that is traditionally driven by cost and efficiency considerations, to contribute towards a sustainable future on a strategic level. Because S&P operates at the interface to suppliers and the entire upstream value network, this represents a considerable development opportunity: First, S&P can provide supply market insights, including on the emergence of new circular technologies, materials and suppliers to the organisation. Second, the developed model can guide S&P

in building a collaborative relationship with suppliers as the model contains a development trajectory describing the different collaborative dimensions. Working on resource sharing, joint planning & decision making, and co-development will only take a dyad so far (a MED CDP OUTCOME type at best). The model makes clear that the highest outcome on circular design principles is only achieved when the buyer-supplier relationship also features supplier-driven activities. Knowing how adverse power dynamics can make it difficult to engage suppliers at the targeted level, buying companies should think carefully how they can mitigate these dynamics. The findings on motives, drivers and barriers may be helpful in devising strategies to engage suppliers at the desired level.

Besides, the thesis contains a wide range of empirical examples and proven practices on how to collaborate effectively with suppliers. Therefore, S&P can take on the role of actively and deliberately integrating the upstream value network as well as its interfaces into other organisational functions, supporting the firm in sourcing and developing circular materials.

Finally, the study might inspire apparel brands to rethink their sourcing strategy and approach to supplier management on a more general level. Engaging in collaborative practices was shown to have benefits beyond circularity: from innovation, resilience, and shorter reaction times to personally enriching relationships.

Considerations for material suppliers

For suppliers, the model is useful to understand the potential challenges that apparel brands face as buyers to tailor their go-to-market approach accordingly. The shared examples of successful buyer-supplier collaboration might even alleviate fears around

sharing information freely. None of the buyers interviewed was interested in backwards integration; they simply aimed for transparency in their value network and wanted to further their own learning.

Analogous to the buyer's side, the model can support suppliers in configuring the buyer relationship model. It can serve as a starting point to think about how to best leverage resources in cooperation with other value network actors, potentially applying the findings to engage with their own suppliers.

Broader practical contributions

Ideally, the learnings gained from studying the apparel industry can serve as a basis for guiding collaboration in other industries or with other stakeholders. At least, the thesis can serve as an impetus to re-evaluate relationships with stakeholders throughout the value network and within the organisation, representing an opportunity to identify potentials that can be realised through collaborative practices.

Generally, this study seeks to contribute to the transition to a circular economy by clarifying another key component– sourcing and supplier collaboration in relation to product design. The concept of circular economy is approached from a sourcing and procurement perspective, a perspective that was underrepresented in previous research.

Hopefully, the described benefits of buyer-supplier collaboration can convince more organisations to undertake the journey towards a circular economy.

9.3 Research Limitations

This section discusses the limitations of the study, including its methodology, case selection and context.

Methodological limitations

A weakness of typological theories is that a researcher cannot infer from case findings how frequently each type of causal pattern appears in the universe of cases of that phenomenon. Beyond that, the social world has not necessarily produced cases of all types of a phenomenon that are socially possible, and the researcher can, therefore, not be certain whether a type of case cannot occur or merely has not occurred yet. The study findings gave some indications as to which types may be more common than others, but for a robust analysis, further research is required.

As typical for case study methods, the study is difficult to replicate and more susceptible to researcher bias. To address the latter, the questionnaire and initial model were validated with experts to ensure that the direction taken was relevant and did not overly rely on unconscious assumptions. The typological theory provided structure to the analysis, and beyond that, findings were discussed with fellow researchers, industry experts and sourcing professionals.

Limitations due to the case selection

Relationships, even on an interorganisational level, are not free from cultural particularities. The study did include examples of brands working with suppliers across the globe, but the buyers were all headquartered in Europe, potentially limiting the applicability of findings to other cultural contexts.

Since in most cases only the brand's perspective was included in the study, it renders an analysis of the dyad, including the supplier's cross-validation of the described buyer-supplier relationship, impossible, constituting a key limitation.

The industry focus was deliberate to achieve comparability across cases and generate multifaceted learnings on how common industry challenges are addressed by different brands. Besides, the design principles were tailored to the industry context. Even though the findings may be useful to other industry contexts, adaptations to the design principles may be required.

Further Limitations

The benefit of basing the dependent variable on design principles is the tangible nature of the concept and the ability to determine how collaborative efforts supported their realisation. The downside, as hinted at earlier, is that the design principles realised form part of the equation of circularity. Just because a garment is designed to be recyclable does not prevent it from becoming landfill. Design principles are an important factor in circularity but should not gloss over the need to make efforts in areas related to retail, consumers, infrastructure, policymaking, and more.

9.4 Future Research Opportunities

One of the outcomes of this study is the opportunities for future research. The created model represents a starting point that can be tested quantitatively, across different industries and geographies and potentially be adapted to different stages of the value network. For instance, more evidence to explore differences of MED CDP OUTCOME types 1, 2 and 3 would help create a more nuanced view of the subtypes and their relationship to the outcome of the DV.

Moreover, the characteristics of public procurement justify a separate investigation into how to support the realisation of circular design principles, including potential alternatives to the collaborative practices highlighted in this study.

Besides, the link between buyer-supplier collaboration and specific design principles could benefit from further investigation, deepening the understanding of how circularity (closing, slowing, or narrowing resource loops) is best supported through stakeholder collaboration or specific collaborative practices. In particular, the previously illustrated trade-offs as well as the pursuit of regenerative efforts are potential new frontiers that warrant further research.

Furthermore, investigating collaboration throughout a value chain beyond a dyadic perspective from a network analysis point of view can provide more clarity on the dynamics of entire value networks and their effects on the realisation of circular design principles or achieving circularity.

Another potential direction is further investigation of adjacent phases of buyer-supplier collaboration. A subject touched upon in the study and mentioned by Brown, Bocken, and Balkenende (2020) was the selection of collaboration partners for the purpose of achieving circularity ambitions. This process can either be examined on a dyadic level or by employing social network theories that can shed light on the evolution and configuration of alliance networks (e.g., see Ebers, 2015).

Lavie (2006) examined how relational rents are distributed among and appropriated by alliance partners. Another research trajectory is the investigation of that mechanism when it comes to (jointly) developing circular capabilities.

9.5 Closing Remarks

Collaboration within value networks is often initially perceived as an antonym to competitiveness or at least a trade-off. Porter (1985) created the still highly popular Five Forces framework, where bargaining power is the ultimate yardstick. The notion of

competition remains deeply rooted in academia, practice, and society as a whole, its appeal undeniable.

John Green said: '*We are at once far too powerful and not nearly powerful enough. We are powerful enough to radically reshape Earth's climate and biodiversity, but not powerful enough to choose how we reshape them*.' Being confronted with the interconnectedness and vulnerability of global supply networks through occurrences like the pandemic, extreme climate events or political crises has created an awareness among businesses and society that no single entity can address such challenges successfully on its own. Shifting away from a 'lone wolf' narrative with a winner-takes-it-all mentality requires exploring the potential of collaborative approaches.

The apparel sector is a behemoth of an industry riddled with both environmental and social challenges. The industry is the epitome of a take-make-waste pattern within the ever-accelerating trend of overconsumption. Therefore, it is inspiring to see the amount of effort some of the studied cases have put into improving their businesses, their value networks, and the entire industry, together with their value network counterparts. It sparks hope to observe how becoming circular is becoming a criterion for competitiveness and not just a matter of ethics and morality. A competitive rationale speaks to a wide range of stakeholders and, thus, has the potential to trigger a fundamental change in the industry.

Meanwhile, the clock is ticking. The latest IPCC report revealed how climate change is occurring faster than scientists originally thought and could surpass the ability of many communities to adapt (IPCC, 2021). Finding a way to operate within planetary boundaries is not just a matter of moral conviction or competitive advantage – it is a

question of survival. All the competitiveness in the world is useless on a planet that becomes unsuitable for human survival. Or, in the words of Lily Tomlin, *the trouble with the rat race is that even if you win, you're still a rat.*

Even a moderately attentive reader will notice that the consumer perspective has not been addressed within this thesis. Yet, as emphasised many times over, the circular transition requires each stakeholder to do its part. Realising circular design principles is like laying the foundation of a house. Brands and suppliers work on creating products that are durable, versatile, perform their duties well, are easy to repair and care for, and in some cases, are even recyclable. These efforts are in vain if we, as consumers, do not start to treat garments for what they are: precious resources requiring large amounts of human and material input. The recommendation is clear: invest in fewer but higher-quality pieces that do justice to the circumstances they are needed for, using, and taking care of them until they wear out. If possible, select materials that can be recycled – and then take responsibility to recycle them.

This paragraph is not meant as an exercise to assign blame to a single actor, casting the consumer as the sole villain. It is a reminder of how many of us are privileged enough to have the opportunity to make more conscious decisions and change our relationship with textiles for the better.

The path to a sustainable world is not yet entirely clear, and we, as a society, surely struggle to follow it. This dissertation attempts to support us in finding this path by shedding light on new findings and ways to make use of them. Hopefully, the findings can offer researchers and practitioners valuable insight and further inspire the transition to a circular economy.

Appendix

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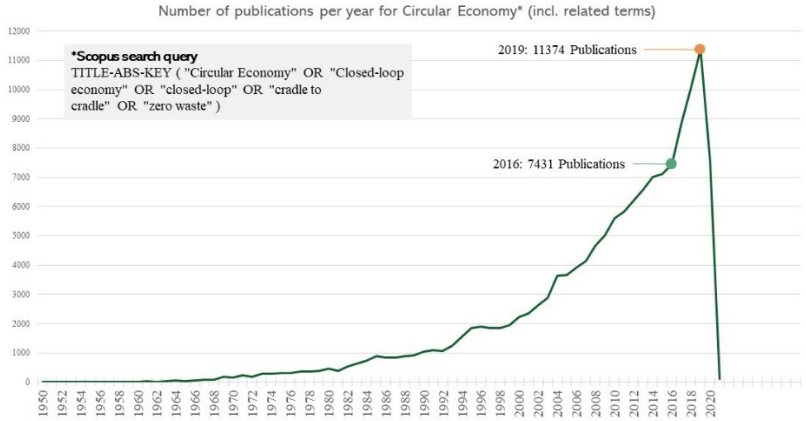
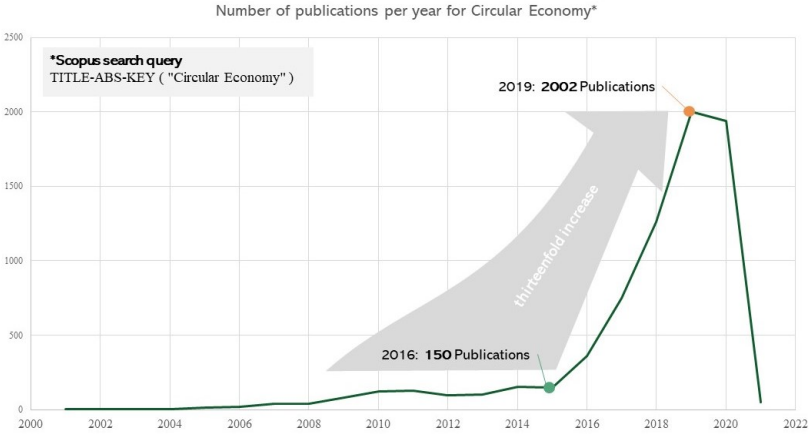
Appendix A: Publication stats on Circular Economy





Appendix B: Interview Acquisition Materials

Recruitment Text

Dear [Addressee],

Request for an Interview | Research on Procurement in a Circular Economy

My name is Nina Schmid and I am a PhD student at the University of St.Gallen, working on my thesis on how supplier management practices can support the design of more circular apparel. I hope that after providing you with some information you will allow me to interview you for the study.

I am seeking to interview procurement and design executives – and ideally supplier representatives – from clothing companies dedicated to sustainability and the circular economy. The main goal is to better understand the role sourcing plays in a clothing company's transition from a linear to a circular economy. More specifically, I would like to analyse how collaborative supplier management practices can support a company's capability to realise circular design principles.

I have attached to this email a leaflet with some more detailed information as well as a consent form for the study. The latter guarantees that you and any organization with which you are affiliated and any information you provide will be treated with complete confidentiality.
If you have any questions, please do not hesitate to ask. To ensure our ethics requirements are met, we will ask you to verbally confirm that you consent to the interview before we start.

[Addressee], I believe that you would add a great deal of value to my study, and I look forward to hearing back. In return for your participation, we would be happy to provide you with a copy of my thesis once it is submitted.

Kindest regards,

Nina T. Schmid

PowerPoint Teaser

University of St.Gallen

Request for an Interview | Input to a PhD thesis

Sourcing in a Circular Economy: How Supplier Management Practices Can Drive a Clothing Labels Capability to Design Circular Apparel

"From insight to impact"

Universität St.Gallen

Thesis Topic: Sourcing in a Circular Economy – a Textile Industry Perspective

How can supplier management practices support or enable a clothing company's capability to design more circular garments?

- Realising circular design principles (i.e., design for durability or repair) is dependent on the ability to source corresponding materials
- Transitioning to a circular economy is assumed to require a more collaborative approach on an intra-organisational (design, manufacturing) as well as inter-organisational level
- Aim of collecting cases of companies that are aiming to become (more) circular to gain insights into the supplier management practices they apply and how it affects their capability to design circular apparel

Relevance:

- The concept of Circular Economy has gained considerable traction in academia and practice, but little is known on the role of sourcing and procurement
- The textile industry is the 3rd biggest industry globally and responsible for extracting large volumes of non-renewable, virgin materials as well as considerable GHG emissions

2

Universität St.Gallen

How You Can Support: Take 60min of Your Time

I am curious to understand…
… the approach your organisation takes to supplier management,
… how aspects of Circular Economy are integrated into sourcing materials and designing products
… any best practices you might have developed or applied in this regard

The Interview:

- Duration: 60 Minutes
- Zoom/Teams Call – unless preferred and permitted otherwise
- You and your organisation are anonymised in the thesis, your data is kept confidential
- Recordings made for transcription only (facilitates analysis) and deleted after; transcripts will not be published as a whole (see *consent form* for more information and options)

While I cannot offer direct compensation, I am happy to share a copy of my PhD thesis once it is submitted.

3

Universität St.Gallen

About Me: PhD Student at the University of St.Gallen

Nina T. Schmid
+41 78 911 76 66
nina.schmid@student.unisg.ch

- PhD student in the University's Management programme
- Supply Chain Consultant at Deloitte Switzerland
- Double master's degree in Business Innovation & CEMS International Management
- Passionate about sustainable garments, being outdoors and DIY projects of all kinds

Thesis Supervision: Prof. Dr. Judith Walls, Institute for the Economy and the Environment (main supervisor)

4

Appendix C: Interview Guide

Interview Guide

Note: *The understanding of Circular Economy used for the purpose of this thesis is briefly explained to create a common understanding of the concept.*

If time permits, sourcing staff might also get asked the design questions.

➔ Consent & Ethics: Confirm that the interviewee agrees to being interviewed and consents to recording the interview (if applicable).

General Questions: Organisational Context
First, I would like to better understand the organisational context.

- Would you say your organisation as a whole actively pursues the transition to a Circular Economy?
- Does the topic of Circular Economy receive (top) management attention and resources?
    - If yes, how much? Do you think it is sufficient?
    - If no, why do you think that is?
- Is CE (or aspects of if) formally integrated into the overall business strategy? How?
- Is CE (or aspects of if) part of day-to-day decision making? How?
- How closely do sourcing and design staff collaborate to achieve more circular products? How do these interactions look like?

Questions for Sourcing Staff: Sourcing & Procurement for a Circular Economy
Strategy & Policies

- Is CE integrated into sourcing strategy & policies?
- Regarding CE, is there a fit between the business strategy & sourcing strategy?

General Supply Chain Context:

- How would you assess your position/ bargaining power in the supply chain vs. your suppliers?

Supplier Management Practices

- (How) do you assess and monitor suppliers? Do you rely on any labels?
- Do you engage in collaboration with suppliers to improve the sustainability/circularity?
    - Can you tell me a bit about how the collaboration works and how it came about?
    - What are outcomes of the collaboration – is it beneficial?
    - How did/do you decide to collaborate with a specific supplier – is there a segmentation in place?
    - Do you share a common vision with supplier you collaborate with? Or is it an association of purpose?
- Do you support your suppliers' development regarding their maturity in Circular Economy?
- Do you actively try to reduce risk for your suppliers through practices like long-term contracts?

Questions for Design Staff: Capability for Circular Textile Design
When products are designed, how is sustainability considered? *If specific design principles are mentioned, inquire more. Otherwise ask about specific design principles.*

- Product Integrity (y/n), if yes, how?
    - Do you design products with the goal to reduce the use of materials, energy and/or reduce the amount of by-product and/or waste?
    - Can you describe any efforts to make apparel more durable? What is the outcome of these efforts?

    - Do you consider the ease of maintenance and care when designing products? Do you offer any support to customers in this regard (care instructions)?
        - *If applicable to garment/product range:* Are there was in which the product can be meaningfully upgraded?
- Product Cyclability
    - Design for Repair:
        - Are products designed with the ease of repair in mind?
        - Do you know which parts tend to break and how is this addressed when designing a product? (Self-repair vs. professional repair)
    - Design for recycling
        - What might make recycling your products difficult? How is this addressed in the design phase?
        - What can products be recycled into? *(same or lower-level applications)*
- Any other design principles/ practices not mentioned?

Questions for Supplier Representatives: Client Relationship and Collaboration

- Would you say your organisation as a whole actively pursues the transition to a Circular Economy?
- Does the topic of Circular Economy receive (top) management attention and resources?
    - If yes, how much? Do you think it is sufficient?
    - If no, why do you think that is?
- Is CE (or aspects of if) formally integrated into the overall business strategy? How?
- How would you assess your position/ bargaining power in the supply chain vs. your buyers?
- How close is the relationship/ collaboration with the buying company?
    - Can you tell me a bit about how it started and how it works?
    - What are outcomes of the collaboration – is it beneficial?
    - How did/do you decide to collaborate with a specific buying company – is there a segmentation in place?
    - Do you share a common vision with supplier you collaborate with? Or is it an association of purpose?
- Regarding incentivising targets on Circularity/ Sustainability, what do you think is more powerful: being monitored and assessed by a buying company or entering into a collaborative relationship? Can you elaborate on your point?

Appendix D: Declaration of originality

Erklärung

Ich erkläre hiermit,

- dass ich die vorliegende Arbeit ohne unerlaubte Hilfe und ohne Verwendung anderer als der angegebenen Hilfsmittel verfasst und bei keiner anderen Universität eingereicht habe,
- dass ich sämtliche verwendete Quellen erwähnt und gemäss den gängigen wissenschaftlichen Regeln korrekt zitiert habe.

Ort und Datum: Bern, 6. Juni 2022

Unterschrift: