CIRCULAR VALUE CREATION ARCHITECTURES: THE CASE OF THE SMARTPHONE INDUSTRY

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ABSTRACT

Closing material loops in a circular economy (CE) calls for additional activities of various market (and sometimes non-market) actors in the value chain, which leads to additional intra-organisational coordination efforts. In this paper, we analyse emerging coordination patterns for circular practices using transaction cost theory (TCT) based on which we propose the concept of value creation architectures (VCAs). We conducted a multiple case study in the smartphone industry covering producers, network providers, and other service providers in the domains of repair and recycling. Our contribution is threefold: First, we identified four different patterns of circular VCAs: : 1) vertically integrated loop operations, 2) network based loop operations, 3) outsourced loop operations, and 4) autonomous loop operations. Thus, focal firms in the value chain are not necessarily the managing authority for CE practices. Second, we developed a comprehensive typology of circular VCAs with regard to their loop activities, their coordination mechanism, and their business case drivers. Third, we find that vertical integration efforts increase for smaller CE-loops and similarly increases the recognition of circular business cases. Therefore, we propose hybrid coordination forms between focal actors and loop operators to reach a sophisticated CE. Additionally we suggest that circular product and service design can act as a lever for decreased coordination efforts and thus overall costs of a CE.

1 INTRODUCTION

To contribute to sustainable development, it is often necessary to widen the perspective from a single organisation or single product to a system level. The concept of the circular economy (CE) takes such an approach and aims at maintaining long-life products, building usage cascades, and closing material loops over long timeframes by spanning diverse actors, organisations, and life-cycle stages (Stahel 1984; EMF 2012; Geissdoerfer et al. 2017).

The goal of this study is to explore patterns of emerging value creation architectures (VCAs) (Dietl et al. 2009) for circular economy practices on an inter-organizational level. Of particular interest are the relationships between focal firms (e.g. manufacturers) and newly emerging loop operators (e.g. repair shops, recycling firms). These make-or-buy decisions are analysed through a classic theoretical perspective of transaction cost theory (TCT) (Coase 1937; Picot 1991; Klein 2005).

We selected the smartphone industry due to the significant sustainability challenges related to production, use, and disposal of smartphones, which have raised interest in academic research and public debate (OECD 2012; Baldé et al. 2015; Dießenbacher & Reller 2016). At the same time, both established industry actors and newly emerging firms engage in more sustainable practices regarding material sourcing, maintenance services, or take-back schemes.

In this paper we present results from a comparative multiple case study (Yin 2009) in the smartphone industry. We followed an engaged scholarship approach (van de Ven 2007) in which we have built close relationships with practitioners as a basis for empirical investigation. Accordingly, the case studies were selected from an innovation network at the authors' institute, which includes practitioners from all stages of the smartphones value chain. Data was collected from various sources including personal interviews, participant observations and secondary publicly available data. A structured content analysis was performed to analyse the collected material.

Our first result is the identification of four different patterns of VCAs for circular economy practices. From these patterns, we developed a typology of circular VCAs with regard to their loop activities, their vertical loop integration and their business case recognition. Further, we find that vertical integration efforts increase for smaller CE-loops and similarly increases the recognition of circular business cases. Additionally we find that a disregard of circular activities by focal actors leads to autonomous loop operations.

The paper is structured as follows: Chapter 2 reviews the literature on the CE concept, introduces TCT and, presents research at the interface of both. It concludes with the preliminary conceptual framework. The research method is introduced in Chapter 3 and an overview of conducted case studies is given. Chapter 4 analyses the four circular VCAs. A deeper analysis of the framework is given in the discussion in Chapter 5. Chapter 6 concludes the paper.

2 LITERATURE REVIEW

2.1 Circular Economy

Current linear economic systems – particularly in the business-to-consumer markets – often focus on streamlined and cost-efficient production processes, rapid introduction of new product versions, and quick product obsolescence and related replenishment. However, they focus only to a limited extend on product quality and longevity (Stahel 1984). Even products with good quality are threatened with quick replacement due to fashion obsolescence (Wieser 2016). In response to the ecological challenges linked to such linear systems, three basic environmental strategies have been differentiated: efficiency, sufficiency, and consistency (Huber 1995). The circular economy (CE) represents a combination of these strategies while prioritising on consistency. The CE can be defined as a

"*regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops*" (Geissdoerfer et al. 2017, 766).

Here, "closing" is about material recycling, "slowing" about product longevity (maintenance, repair, and remanufacture), and "narrowing" about reducing the product's total material and energy use (Bocken et al. 2016).

The CE's overarching metaphor of cyclical processes is derived from concepts such as the performance economy (Stahel 1984; Giarini & Stahel 2000), industrial ecology (Huber 2000; Frosch & Gallopoulos 1989), cradle-to-cradle (Braungart et al. 2007; McDonough & Braungart 2002) and biomimicry (Benyus 2002). More specifically, the CE needs to understand how focal companies and third party actors work together to operate the related cyclical supply chains. Therefore, the CE also borrows from more specific research fields such as closed-loop supply chains (Guide et al. 2003), reverse logistics, and remanufacturing (Lund 1985; Jayaraman et al. 1999). Last but not least products have to be developed which are compatible with the CE framework. From this perspective, the CE represents a further extension of the well-established life-cycle orientation and management in which products are designed, managed, and evaluated covering the whole value chain from resource extraction to end-of-life. Eco and sustainable design (Brezet & van Hemel 1997), sustainable product development (Ny et al. 2006), sustainability-oriented innovation (Hansen et al. 2009), and lately circular design (Bocken et al. 2016) have all contributed to understand product characteristics for the CE. These concepts have also more or less strongly called for a stronger service orientation by highlighting the role of product-service systems and new business models (Bocken et al. 2016).

The CE covers both technical (e.g. remanufactured product) and biological (e.g. compostable products) metabolisms each with entirely different characteristics (McDonough & Braungart 2002; EMF 2012). We focus on technical metabolisms because this represents the current practices in the information and communications technology (ICT) industry. Against this background, the CE adds four generic "loops" to the value chain: 1) reuse, 2) repair/maintenance, 3) reconditioning/remanufacturing, and 4) recycling. The environmental benefits are considered to decrease from the inner loop (i.e. reuse) to the outer loop (i.e. recycling) (Stahel 1984); see also the European Commission (EC)'s 2008 waste management hierarchy (EC 2008, Art. 4). Accordingly, recycling is considered the least preferable strategy both from the perspective of thermodynamics (Jackson 1996, 12; Reuter 2011) and imbedded monetary values (EMF 2012). A detailed overview of CE-loop definitions used in this study is given in Table 1 below.

Table 1: Material loops in a CE as defined by Stahel (1984), Thierry et al. (1995), EMF (2012) and Bocken et al. (2016).

Loop strategy	CE loop	Product recovery	Level / Unit of analysis	Quality requirements	Resulting product
Slowing	Maintenance	Repair / maintain	Product	Restore product to working order	Fixed product, replaced by spares
	Reuse/ redistribute	Reuse	Product	Functioning product	Second, third, ... life
	Refurbish/ remanufacture	Re-furbishing	Module	Inspect all critical modules and upgrade to specific quality level	Some modules repaired/replaced with potential upgrades
		Remanu-facturing	Part	Inspect all modules and parts and upgrade as new quality	Used or new parts combined into new product with potential upgrade
		Cannibali-sation	Part	Functioning parts ready for reuse	Some parts reused; remaining product recycled or disposed
Closing	Recycle	Open loop	Material	Down-cycling	Materials reused in low-grade products
		Closed loop	Material	Virgin-material quality	Materials used as virgin-materials

By transcending the narrow product perspective to the (circular) product-service system, the CE emphasises a system's perspective beyond the single company (Tukker 2015). Closing technical loops in the CE requires additional activities which existing actors – who have so far mostly operated in linear value chains – are not always prone to take care of. This makes the analysis of actor constellations that are necessary to operate the various CE loops an interesting research object particularly regarding the classic economic question of "make-or-buy".

2.2 Transaction Cost Theory

Transaction cost theory (TCT) is the predominant framework for analysing make-or-buy decisions from the perspective of organisational theory. TCT emerged out of the new institutional economics (NIE) research stream and presents a more specific and reliable approach to make-or-buy decisions than traditional management approaches such as cost accounting and business strategy (Picot 1991; Klein 2005), as both of these rely heavily on subjective and short-term decisions within one organisation rather than a systematic economic analysis.

According to Coase (1937) the reason for existence of firms are the costs of markets, as all attempts of coordination between market actors produce transaction costs. Such costs can include research, consultation, negotiation, and quality control expenses (Picot 1991, 344). These considerations result in a continuum of coordination mechanisms with market-based and hierarchical (i.e. organizations) forms as polar types (Williamson 1981). Between these two poles other intermediate or hybrid forms of organisation such as networks and long-term partnerships are plausible (Borys & Jemison 1989; Powell 1990; Williamson 1991).

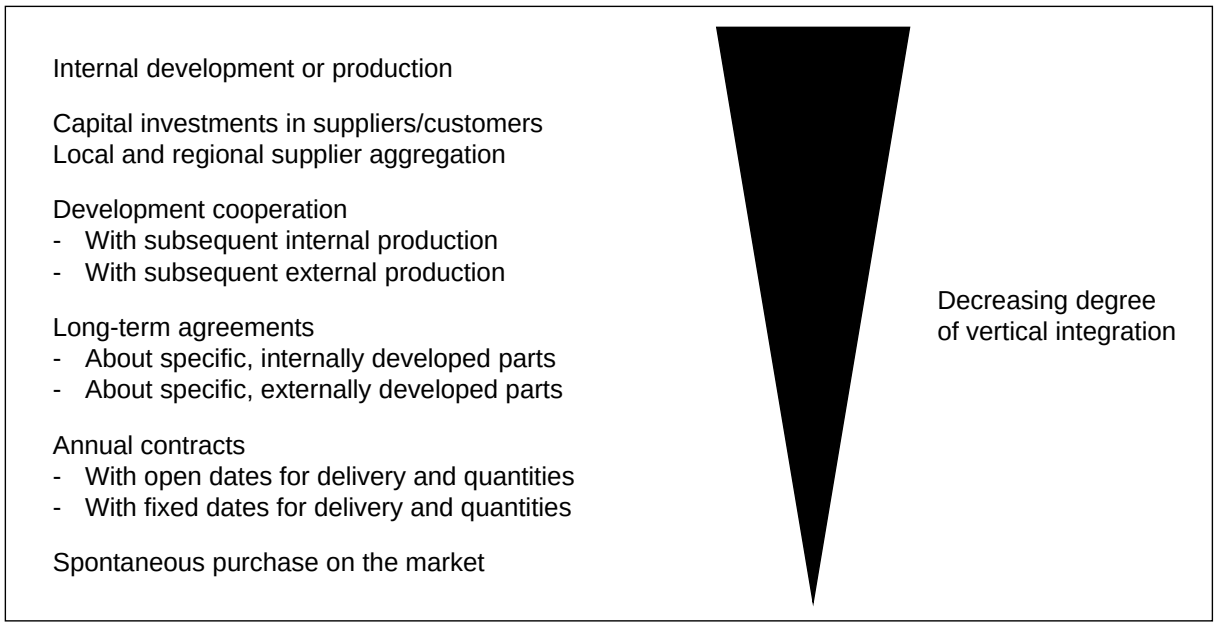

Figure 1: Exemplary forms of coordination along a continuum between markets and hierarchies. Source: Picot (1991, 340) as cited in Picot et al. (1997, 45).

These different coordination types lead to value chains with various actor constellations, relationships, and responsibilities, which Dietl et al. (2009) refer to as integrated, quasi-integrated, and disintegrated value creation architectures (VCAs). The concept of VCAs "describes the structure and relationships of all the value-adding activities that are carried out by various actors and companies to bring a particular product or service to market" (Dietl et al. 2009, 26). Similarly to the supply chain management literature, the analysis starts from the focal actor, who links the production and distribution side (Dietl et al. 2009; Gemünden et al. 1996; Seuring & Müller 2008). Herein focal actors are defined as "those companies that usually (1) rule or govern the supply chain, (2) provide the direct contact to the customer, and (3) design the product or service offered" (Seuring & Müller 2008, 1699).

Focal actors engage in make-or-buy decisions through which they decide about their desired VCAs. As conceptualised in the organisational failure framework by Williamson (1975, 40), such decisions are subject to diverse influencing factors (Table 2). The most important influencing factors for make-or-buy decisions are the *specificity* of the involved assets and the *strategic relevance* of the activity (Picot 1991). Activities that require specific assets are more efficiently organised in-house, whereas activities that demand standard factors of production or standardized processes can be outsourced, as low transaction costs occur when transferred to third-parties (Picot 1991). Analogously, strategically important activities that contribute to the firm's core competencies (usually these are also of high "specificity" as they are basis for differentiation in the market) are maintained inside the focal firm.

Table 2: Influencing factors on make-or-buy decisions. Based on: Picot (1991), Williamson (1979), Williamson (1975), Geyskens et al. (2006), Fischer (1993), Schneider et al. (1994), Picot et al. (1997).

Drivers	Influencing factors	Explanation
Major drivers	Specificity	Specificity is the critical determinant of TC. It characterizes the immobility of unique assets and can include site, physical, human, time, and procedural specificity. Specificity increases mutual dependencies and thus demands for integral relationships and trust between focal actors and suppliers.
	Strategic relevance	Strategic importance is the activity's contribution to the final product's competitive position and core competencies. At the same time, strategic relevant products or service often demand for highly specific activities and thus foster an integration strategy.
Supporting drivers	Uncertainty	Uncertainty in transactions can be caused by both, opportunistic behaviour of economic actors and global technological, political or economic developments. In addition, missing standards and norms can play a role. Together with specificity and strategic relevance, it fosters an integration strategy.
	Frequency	Economies of scale and learning effects foster the in-house production of highly specific activities. Standardized activities with high occurrence are more efficiently organised outside the organisation. Thus, the frequency of an activity is not an independent criteria.

Uncertainties and *transaction frequency* are supporting cost drivers of transactions (Williamson 1979; Picot 1991; Picot et al. 1997). Uncertainties make frequent adjustments of the agreement or contract necessary and lead to high transactions costs, therefore favouring internal organisation. Frequency of occurrence of the activity can only be understood together with specificity/strategic relevance and drives relative transaction costs: whether activities are pursued internally or externally, more frequent occurrence lead to economies of scale and related efficiencies in both internal and external organisation.

Last but not least, according to the organizational failure framework by Williamson (1975, 40), make-or-buy decisions should always take into account characteristics of actors involved. All actors underlie behavioural assumptions of bounded rationality and opportunism (Williamson 1981, 553). Bounded rationality is based on the assumption that individuals have limited knowledge and information processing capabilities as well as time constraints. This comes into play for uncertain or complex situations. Opportunism implies strategic actions and self-interest of economic entities, thus perusing its own interests. Furthermore the transaction atmosphere (or "spirit") is also of importance (cf. also (Picot et al. 1997). It describes the underlying values and norms of involved actors and relevant social and technological conditions and developments.

2.3 Make-or-Buy Research for Circular Practices

The subject of who or which actor specially engages in circular practices (including remanufacturing) has been a subject of debate in academic literature. Stahel (1984) mentions OEM-independent work units which are locally organized to perform loop activities. In his later work he mentions both independent and OEM remanufacturers in the example of automobile and ICT industries, not further detailing the relationship between them (Stahel 2010).

In the remanufacturing and closed-loop supply chain literature, the topic of outsourced reverse logistics activities has been subject of occasional debate. A number of studies used decision modelling and other mathematical techniques for their analysis (Agrawal et al. 2016; Govindan et al. 2012). The first study

using TCT for the analysis of drivers for make-or-buy decisions for remanufacturing were Martin et al. (2010). From their quantitative and qualitative empirical analysis, they concluded that asset specificity and frequency are primary drivers for make solutions. However, as most studies come from the remanufacturing literature stream they do not consider all four loops of a CE. Further, their analysis is limited to the two poles of internal and external integration.

Lund (1985) was the first to categorize different remanufacturing actors that emerged in practice: 1) the OEM remanufacturer, 2) the independent remanufacturer, and 3) the contract remanufacturer, the latter being a derivative from the first two. He defines an OEM remanufacturer as one that additionally deals with reverse activities; in contrast, an independent remanufacturer is concerned with items produced by others only. However, the independent remanufacturer can also be a franchise from an OEM with access to necessary spare parts and information. A contract remanufacturer performs a service only, but does not own the items or cores. A frequently mentioned issue in remanufacturing and related inter-organizational relationships between OEMs and remanufacturers is the sufficient supply of items or cores (Lind et al. 2014).

2.4 Preliminary Conceptual Framework

Based on the previously introduced concepts of the CE, VCAs, make-or-buy analysis, and TCT, we propose a preliminary conceptual framework as basis for our empirical investigation. It represents a novel research approach that enables an in-depth exploration of inter-organizational relationships that emerge around circular products and services.

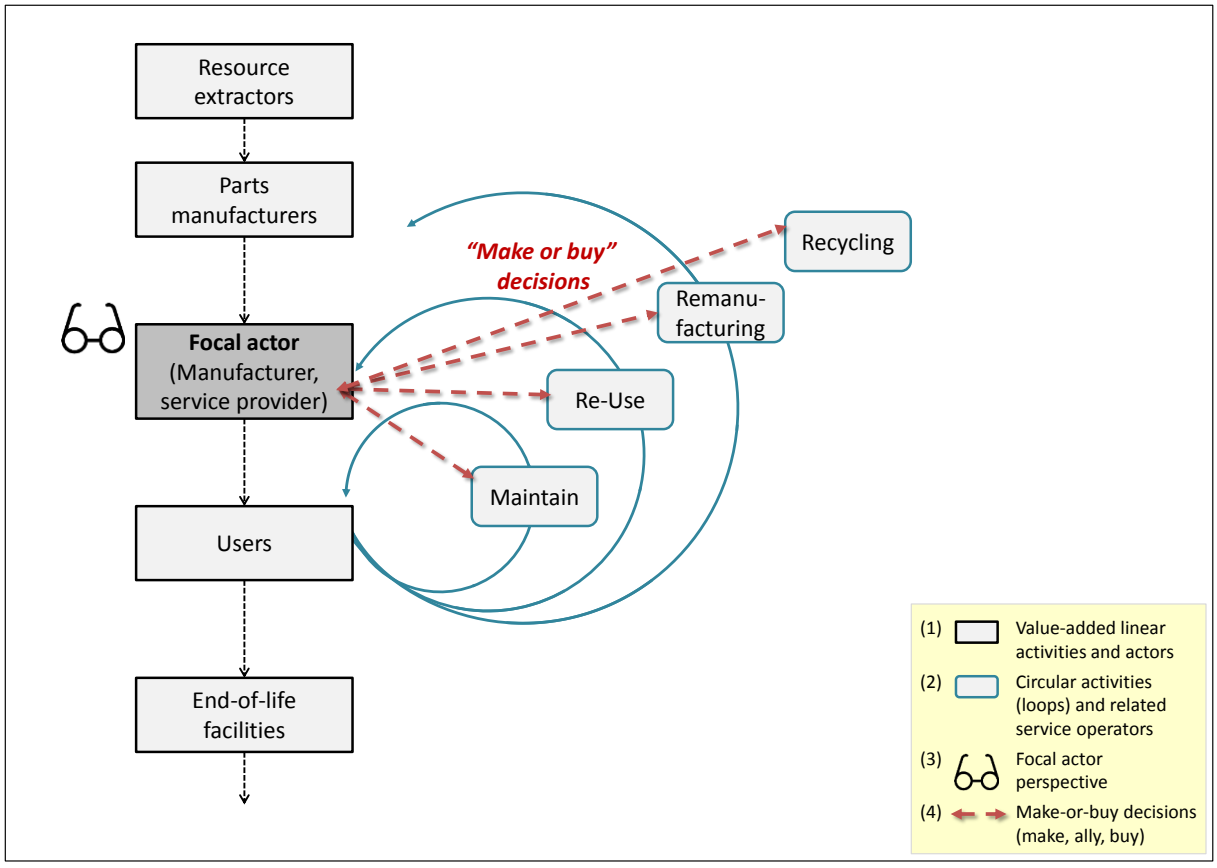

Figure 2: Schematic representation of the preliminary conceptual framework

The preliminary framework has four components:

- The analytical basis is a linear value chain (1) that reaches from resource extraction to collection of used devices.
- A "focal actor" (2) has direct contact to the user, controls the value chain, and can be either a producer, or a service provider (or both).
- A third component covers the circular value added activities (3) that are related to the user or post-user (e.g. collection) phase. We term market (and non-market) actors who offer circular services as "loop operators".
- A fourth component is the make-or-buy decision of the focal actor with regard to each of the loop activities either leading to vertical integration, hybrid coordination or outsourcing to a related loop operator.

3 METHODS

3.1 Research Design

We chose a qualitative research design to cope with the still novel research of inter-organisational practices for closing loops in the CE. In order to analyse the contributions of different VCAs for closing loops in a CE we conducted a comparative multiple case study in line with Yin (2009). We applied a theory building approach by identifying patterns from our case studies in line with Eisenhardt & Graebner (2007).

3.2 Case Sampling

We selected the smartphone industry for our empirical study due to significant sustainability challenges related to production, use, and disposal of smartphones, which have raised interest in circular practices in research and public debate (OECD 2012; Baldé et al. 2015; Dießenbacher & Reller 2016). Also, both established and newly emerging industry actors – though to varying degree – have already engaged in more sustainable practices regarding material sourcing, maintenance services, and take-back schemes.

Following an engaged scholarship approach (van de Ven 2007), we selected the case studies from participants of an 'innovation lab on sustainable smartphones' at the authors' institute, in which actors from all stages of the smartphones value chain met in a continuous fashion to discuss challenges and develop solutions for the industry. In line with the conceptual research framework, we theoretically sampled (Yin 2009, 91) case organisations with engagement in circular practices matching the three coordination types make, ally, and buy. In addition to these clearly theory-based cases, we selected extreme cases – uncoordinated loop operations – that served to challenge the preliminary conceptual framework as this is expected to produce most valuable insights (Flyvbjerg 2006).

Table 3: Overview of embedded case studies and unit of analysis

Case	Theoretical sampling	Unit of analysis 1: Focal actor	Unit of analysis 2: Loop operator(s)
1	Make	Smartphone manufacturer "SmartMan"	n.a.
2a	Ally	Telecommunication network-provider "Telco-A"	Reverse logistics specialists "Loop operator I-III"
2b	Ally	Telecommunication network-provider "Telco-B"	Reverse logistics specialist "Loop operator IV"
3	Buy	*Telecommunication network-provider "Telco-A"**	Waste/recycling association/agency
4a	Uncoordinated	*n.a.*	Uncoordinated loop operators (battery exchange specialist) "Autonomous loop operator V"
4b	Uncoordinated	*n.a.*	Uncoordinated loop operators (local repair shops) "Autonomous loop operator VI"

** Case is based on historic snapshot of case 2a in which circular practices were limited to outsourced recycling*

3.3 Case Vignettes

Table 4 represents a short summary of each case conducted in the empirical observations.

Table 4: Case study characterization and pattern allocation

Case	CE loops and priority	Coordination of CE activities	Make-or-buy motive of focal actor	Case vignette	Pattern
1	1. Maintain 2. Reuse 3. Re-manufacture 4. (Recycle)	Internal coordination (make)	Highly specific activities combined with strategic relevance (quality-driven)	Sustainable niche manufacturer who stepwise vertically integrates CE- loops (except recycling) as a core competency. Currently no monetarization of CE activities.	1) vertically integrated loops
2a	1. Reuse 2. Recycle 3. (Refurbish)	Hybrid coordination (ally) through capital investments	Increasingly specific activities combined with low strategic relevance (business case)	Large German Telco as focal actor cooperates w/ experienced loop operators. Telco places equity investments in loop operators. Multiple take-back and repair programs developed out of initial public collection and recycling scheme	2) cooperative loop-networks
2b	1. Recycle 2. Reuse 3. (Refurbish)	Hybrid coordination (ally) through long-term contracts	Unspecific activities combined with no strategic relevance (CSR-driven)	Large German Telco as focal actor cooperates w/ experienced loop operators. Long-term contracts and exclusivity agreements. Focus on collection of low-value mobile devices and compliance as main goal.	2) cooperative loop-networks
3	1. Recycle	Market-based coordination (buy) with short-term contracts	Standard activities combined with no strategic relevance (compliance)	Case describes the legal arrangement for take-back of WEEE. Highly regulated collaboration between partners through a joint agency. Recycling on short-term contract basis.	3) outsourcing to loop operators
4a	1. Maintain	Un-coordinated activities Ambivalent relationship	No strategic relevance	Battery exchange specialist for electrical/ electronic devices with high problem solving capabilities. Loop operator actively seeks contact to focal actors, without success.	4) autonomous loop operations
4b	1. Maintain	Un-coordinated activities without focal actor	No strategic relevance	Local repair shop for electronic devices who fills an unobserved niche for repairs. Access to high quality spare parts as unique selling point, but services is limited to basic repairs.	4) autonomous loop operations

3.4 Data Collection and Data Analysis

We collected data from various sources and triangulated them (see Table 5). Primary data was collected from personal interviews with company representatives at a management-level and other industry

experts, focus groups, and extended site visits (Lamnek 2010). Secondary data included publicly available information such as websites, press-releases, company brochures, product flyers, and media reports.

Table 5: Overview of data sources

Data type	# Amount	Total length [h:mm]	Documentation
Formal, semi-structured interviews	10	05:31	Transcripts
Informal, semi-structured and unstructured interviews	5	01:55	Protocols
Site-visits	5	03:30	Field notes, photographs
Focus groups (workshop setting)	3	24:00	Protocols (workshop documentation)
Secondary sources	Approx. 30 documents	-	Websites, electronic documents (e.g. PDFs), and scanned documents

Interviews were usually conducted face-to-face to allow for a more holistic perception and to couple the interviews with a site visit. A semi-structured interview questionnaire was developed building on theory and the preliminary conceptual framework (Flick 2011). Compared to rigid questionnaires, qualitative interviews allow to move from observing to understanding the case and its embeddedness in the system (Hopf 2013). All formal interviews were recorded and transcribed.

A structured content analysis was performed to analyse the collected material. We followed an abductive approach (Dubois & Gadde 2002) with both deductive categories from existing theory and inductive categories emerging from the collected data. The content analysis was carried out with a software for qualitative data analysis. A pattern-matching approach (Eisenhardt & Graebner 2007, 29) was used to group cases and link empirical evidence with theory.

We followed trustworthiness criteria by Guba (1981) in order to increase credibility. Furthermore, we applied "communicative validation" (Mayring 2010, 120) by discussing preliminary results with peer researchers in the project team and at academic conferences – ultimately aiming at increasing transparency and reducing biases. We also conducted member checks with case study representatives by presenting and receiving feedback to intermediate results.

4 RESULTS

4.1 Overview of the four Patterns of Circular VCA

Our case study analysis leads to four generic circular VCA patterns: 1) vertically integrated loop operations, 2) network based loop operations, 3) outsourced loop operations, and 4) autonomous loop operations. These four patterns represent a continuum from internal coordination, via market-based coordination, to uncoordinated loop activities representing a decreasing degree of vertical integration and decreasing recognition of circularity as a business case (Figure 3). Each VCA pattern integrates circular activities in a transaction cost optimizing way, mostly driven by their specificity and strategic relevance. On the left side of the continuum, a high integration of CE activities in the core business can

be observed, thus, leading to a value creation supported by CE activities. In contrast, a neglection of circular activities and thus a value creation mainly based on linear activities, leads to the formation of autonomous loop operators that successfully offer CE activities outside the value chain. In a nutshell, each pattern can be described as follows:

- Pattern 1, *vertically integrated loop operations*, is characterised by maximising internal coordination ("make") of multiple high-value loop operations, including maintenance and reuse activities. Through the direct involvement of a focal actor – a manufacturer or telecommunication service provider – smartphones and spare parts can be returned and reused or remarket in the same value chain. This VCA is driven out of strategic considerations, but is also supported by the high asset specificity of (small) loop operations. The vertical integration of CE activities allows for the development of a business case based on innovation and quality; leading to differentiation in the market (CE as core competency).
- Pattern 2, *network based loop operations*, describes a focal actor with long-term partnerships ("ally") to specialised loop operators. Within these partnerships, focal actors develop circular practices from low-value recycling to high-value reuse loops. As the loop specificity increases towards high-value loops, collaboration between the involved partners increases, too. These VCAs are initially motivated by compliance and public awareness, but increasingly recognise business case drivers such as cost reduction and profit generation.
- Pattern 3, *outsourced loop operations*, describes the standard case for engaging in limited circular activities – usually recycling at a product's end of life – with outsourcing based on short-term contracts via the market ("buy"). The outsourcing decision is driven by the strategic unimportance of these (standardised) loop activities and, with regard to recycling, low asset specificity of operations. The business case is narrowly interpreted as a mere compliance measure.
- Pattern 4, *autonomous loop operations*, describes VCAs in which the focal actors' perceive circular practices as of no strategic relevance, consequently not offering anything beyond legal requirements. As consequence, third party loop operators emerge who operate small loops such as maintenance services without formal relationship to a focal actor ("uncoordinated"). Although focal actors maintain no formal relationship with the autonomous loop operators, they are still tolerated. Thus, this pattern is characterised by the ambivalent relationships between focal actors and autonomous loop operators.

In the following sections, all four patterns are explored with regard to their loop activities, their coordination mechanism, and their business case drivers.

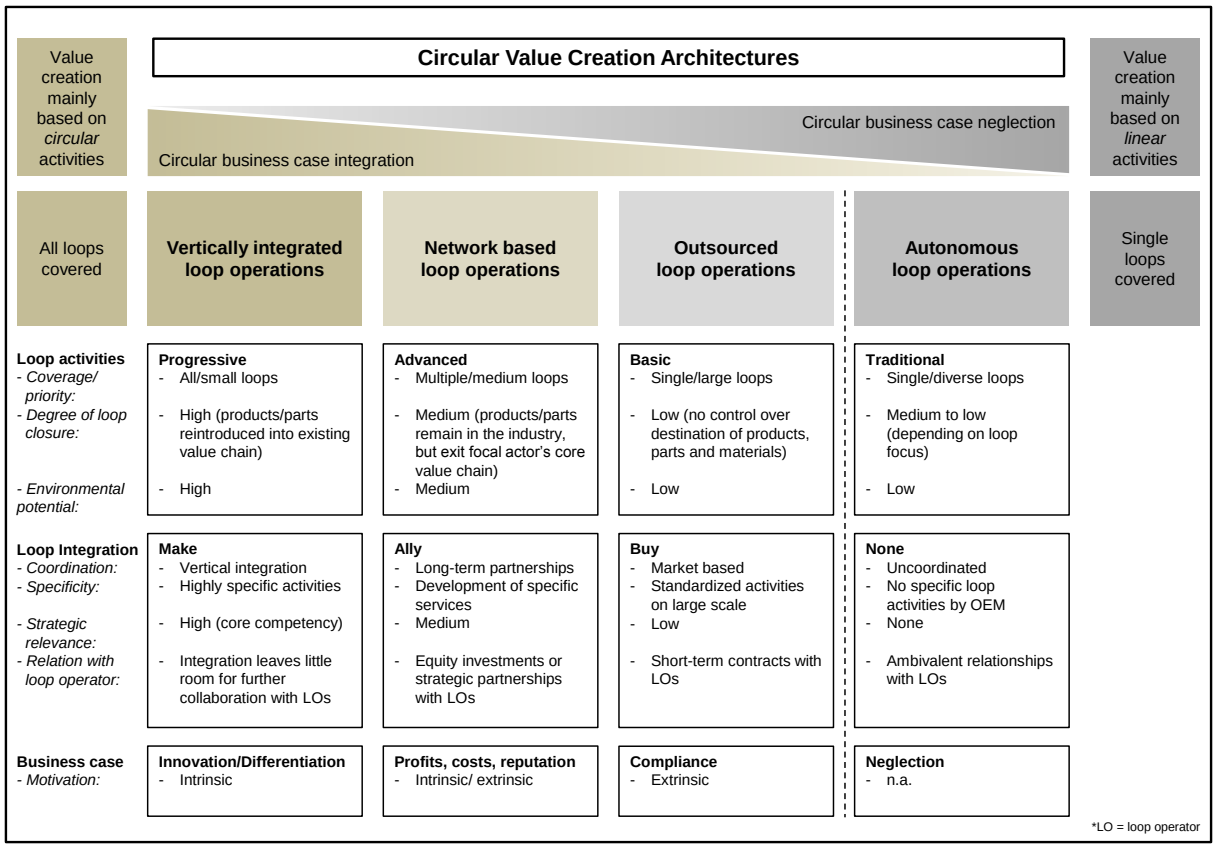

Figure 3: Typology of circular VCAs from a focal actor's perspective

4.2 Vertically Integrated Loops

The first pattern that emerged from the empirical data is based on the analysis of SmartMan (Case 1), a vertically integrated niche smartphone manufacturer. The firm offers a number of circular services and actively integrates these into its business practices. This VCA is thus characterized by intensive engagement of a focal actor in CE activities with a focus on small CE loops.

Loop Activities

In the case of SmartMan, the organisation focuses on the smallest loops in the CE: maintenance and reuse. They offer related services to their customers and operate them in house:

> *"All of these fields we cover ourselves with [SmartMan] and process them with our small team in-house. We operate a small repair workshop, a second-hand market, and try to reuse most of our parts ourselves". (SmartMan sustainability report 2016, p. 11)*

With their priority on maintenance and repair, unlike other smartphone manufacturers, SmartMan offers a wide range of original spare parts in their online shop, publishes repair manuals (e.g. YouTube instructions), and offers an in-house repair service. To simplify the maintenance of their devices, their newest devices have been designed with a modular architecture:

> *"The uniqueness of our new smartphone model lies not only in its performance, but also in its modularity. This is why it carries an „m" as suffix." (Website, Blog-entry 01.07.2017)*

Their commitment to maintenance and repair also goes beyond the legally or voluntarily offered warranty timeframes. Prolonged life-times are fostered through a close integration of the user in the VCA. Smartphone users develop a more intense relationship to their devices through stylish design and related communication (which the company also calls "lovephone") as well as both professional and

"do-it-yourself" repairs based on modular design. SmartMan has indeed built an active community around its product, with intense exchange via direct communication and social media (e.g. a brand forum).

More recently, SmartMan has also implemented a deposit system for their devices to increase return rates of used smartphones. These used smartphones are then sold by SmartMan to "less demanding" customers:

> *"We have enough customers, who ask for an old phone. They do not demand the newest Android version; mainly they want to write a little bit on WhatsApp." (Owner manager, SmartMan)*

With a focus on high-quality small CE loops, the (large) recycling loop is only a peripheral activity in this VCA as it becomes relevant only in the last stage of the product's life-cycle, which the company tries to delay as much as possible. Nevertheless, over time, the organisation extended their perspective towards larger loops targeting the later phases in the products life-cycle. In the case of SmartMan the owner managers do not only rely on the regulatory compliance scheme (see also pattern 3), but established a collaboration with an NGO for a voluntary take-back mechanism (see also pattern 2).

Regarding the environmental potential of this VCA, a high potential lies in the dedication towards prolonged and multiple product life-times of the devices.

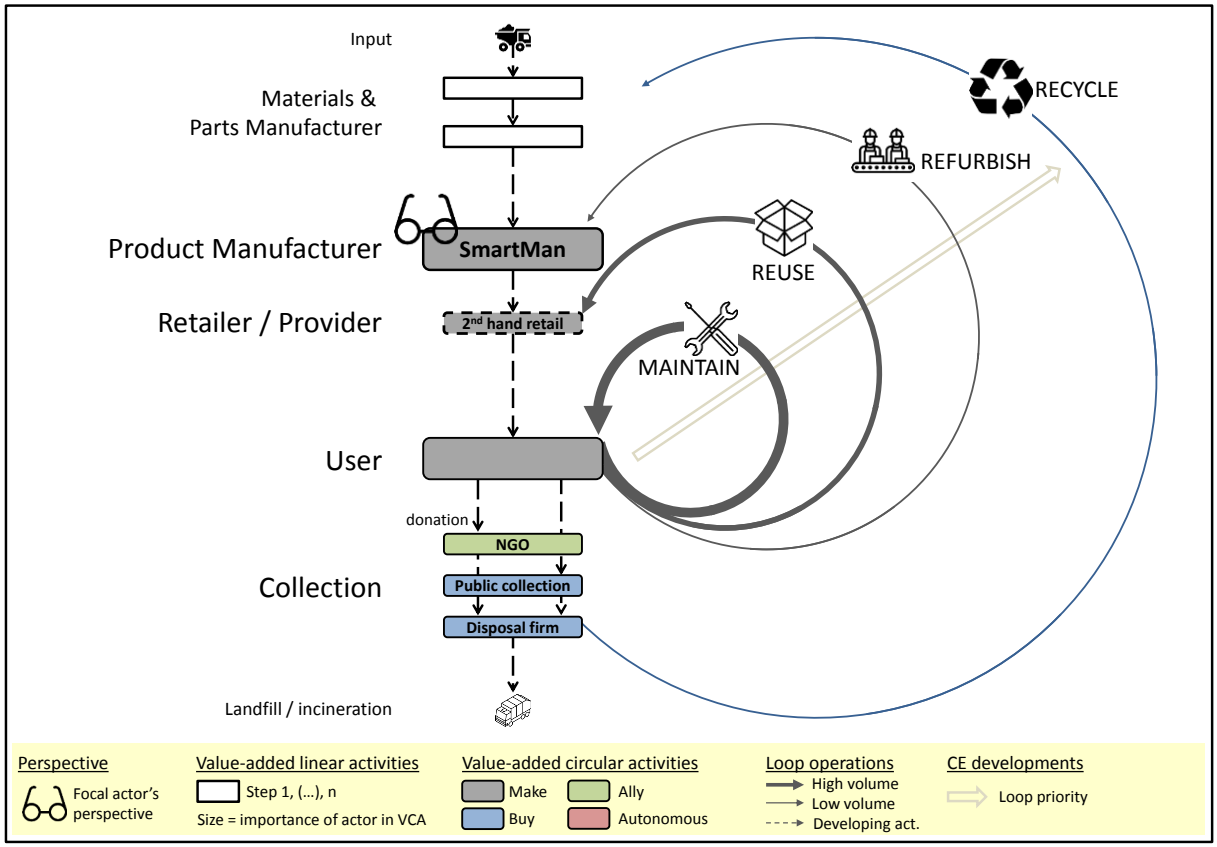

Figure 4: Schematic representation of VCA pattern 1 with a make coordination of key circular activities.

Loop Integration

In the present pattern, organisations predominantly take a "make" decision by vertically integrating as many loops as possible. A mix of strategic relevance and specificity of the loop operations can explain

this decision. From a strategic perspective, the organisation deliberately positions itself in a niche that honours their integrated life-cycle approach. The fair and sustainable smartphones become the organisation's unique selling proposition and with their life-cycle commitments (i.e. loops) they are able to offer a superior quality commitment. Hence, offering loop activities is contributing to their competitive advantage and differentiation strategy. From an ecological perspective, maintenance and take-back services allow for longer life times of its smartphones.

Based on the strategic commitment to deeply engage in CE loops – particularly small loops – the specificity of these loop activities suggest internal coordination. Similar to conventional smartphone OEMs, SmartMan's first product generations have still used non-modular product design architectures (modular components were not available on the market and thus needed own development). Therefore, existing maintenance and refurbishing services require very specific assets such as knowledge and tools. If outsourced to a third party, this would lead to high transaction costs. It would also prevent the organisation to generate inputs from those loop activities to their further product innovation process. The complexity involved in maintenance services, also led the company to change to a modular architecture for new product developments:

> *„We believe that it [full maintenance service] is only possible when we have really modular phones. So that every child can repair them." (Owner Manager, SmartMan)*

As a supporting factor, the transaction frequency can be named. Because volumes of returns with specific requests and related contact to customers is relatively high, economies of scale are possible and it is therefore economically feasible for SmartMan to build up an in-house repair service. Overall, strategic relevance, high asset specificity, and transaction frequency together have favoured internal coordination of repair, reuse, and refurbishing loops. In contrast, the comparatively standardized procedures for smartphone recycling are outsourced because the process is not smartphone specific and it requires higher volumes exceeding those of a single (niche) producer. Specialized recycling operators already existing in the market better meet these characteristics.

Business Case Drivers

In this VCA, we could observe a business case that builds on innovation and a clear differentiation from the mass market through the development of fair devices with a holistic quality understanding of the product over its entire lifetime. This strategy originates from the owners' underlying personal values and norms rooted in fairness:

> *"This theme [fairness] is a personal matter to us – we do not want that anyone has to suffer because of our products." (SmartMan sustainability report 2016, p.3)*

Moreover, they see circularity simply as the way to do it right:

> *"These [CE] loops, we just did them all intuitively. ... because we realized: to do it [the phone and related value creation] well, we have to deal with them." (Owner Manager, SmartMan)*

Although the initial motivation was of intrinsic nature, SmartMan could successfully develop their business in a sustainability niche. They see their business activities not only focused on the sale of devices, but also based on their quality commitment offering circular services to their customers. For example, they create additional value through their spare parts in the online shop, second-hand market, and in-house repair service. Therefore, a recognition of the circular business case that leads to a further development of the initial business model can be assumed.

4.3 Network Based Loop Operations

The second pattern represents VCAs that are coordinated in networks between the focal actor and various affiliated loop operators. The case studies belonging to this pattern involve large telecommunication providers (telco) as focal actors (cases 2 and 3).

Loop Activities

In both cases, the initial engagement in circular practices was based on voluntary collection systems exceeding the legal requirements for e-waste. They operated these loop activities in cooperation with an external reverse logistic provider for ICT. This collection system's main aim was the take-back of low-value mobile devices on a donation basis. To increase credibility, both telcos have cooperated with an environmental NGO. However, the majority of collected devices (up to 90%) ended up in the material recycling loop due to their low use-value.

As, these collection systems were not a self-supporting business model, a further development of circular activities have been pursued:

> *"As part of this [voluntary collection system] the idea was to further develop also a buy-back model for mobile phones. For this, we also cooperated with Telco_A intensively. (Loop Operator, Key-Account Manager)*

Accordingly, reuse and refurbishing loops were developed in one of the cases. The investigated consortium of Telco_A and loop operator have offered an online and offline-based buy-back system for smartphones. After minor cosmetic repairs, these devices are remarketed in batches to professional resellers. In contrast to pattern 1, these smartphones do not re-enter the original value chain of the telcos (their original customers do not get used products offered), but are distributed to other markets both nationally and internationally. Therefore, we speak of a medium *degree of loop closure* in relation to the more established dichotomy of open vs. closed loop recycling. In order to increase the sales volume, refurbishing activities are also pursued and increasingly applied to devices from the voluntary collection scheme (similar to the previous loop, we assume a medium *degree of loop closure*). However, access to original spare parts and repair manuals is limited and represents a shortcoming of these VCAs. Recently, the telco in Case 2 placed a further equity investment in a professional repair shop. Therefore, it is expected that similar to other loop operations, also maintenance activities will be integrated into this VCA.

The environmental potential of this VCA pattern, on the one hand, cannot be realised to the same extent as those of the vertically integrated one, as maintenance and refurbishment loops cannot be conducted on the same technical level. Also, the motivation to develop the more impactful smaller loops is somehow lower than for the vertically integrated organisation. On the other hand, the collaborative VCA has the potential for better economies of scale, because devices from multiple sources and customers are processed. This allows for learning effects, high investments in automation, lower prices, and therefore a more competitive offering of loop services in the market.

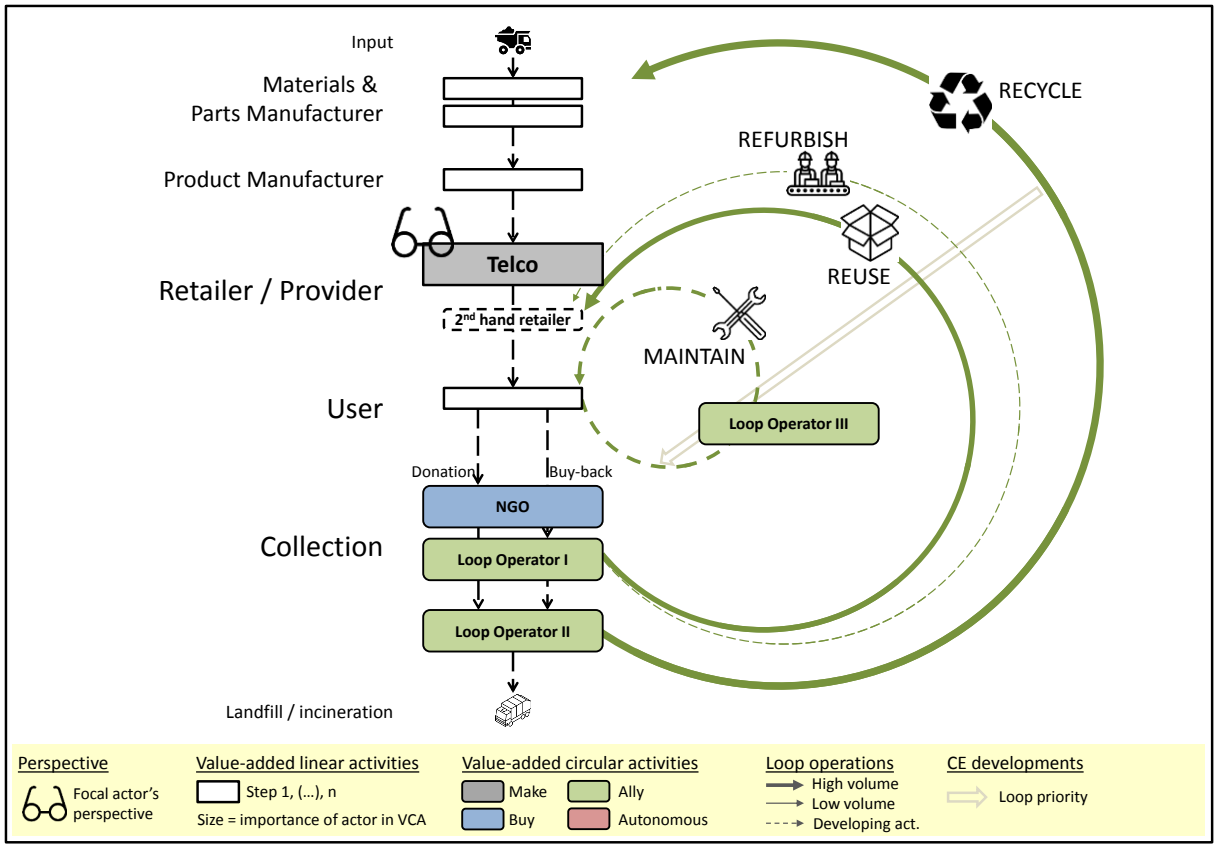

Figure 5: Schematic representation of VCA pattern 2 with an ally coordination of circular activities.

Loop Integration

Our transaction cost analysis shows, again, that the make-or-buy decisions by the focal actors are a mix of strategic relevance and specificity of the loop operations. Initially, they focused on the recycling loop, because they found the smaller loops strategically of low relevance. The low specificity of current recycling loop activities initially led to outsourcing to specialised service providers. Recycling processes for electronic equipment are high volume standardized activities that – in currently established practices – do not depend on a device's model or manufacturer: In a first step, a homogenised material is produced through a shredding process. Second, valuable metals are extracted in highly specialised smelters. This process is only cost-effective on a large scale and thus usually outsourced. However, later, both telco organisations became to understand recycling and the other smaller loops of increasing strategic relevance and established long-term relationships into experienced loop operators and reverse logistics specialists. Telco_A has continuously placed equity investments in various loop operators (from recycling, to reuse, to maintenance). Whereas Telco_B actively developed one main loop operator to further build up their mutual circular practices (from recycling to reuse). The strategic partnership is crucial for reuse and refurbishing loops, because, in comparison to recycling, both types of activities are subject to higher degrees of specificity because they require specific assets such as close customer relationships for securing significant tack-back volumes and market knowledge for remarketing refurbished and repaired products. Vice versa, the loop operators provide specialised knowledge in the logistics and processing the devices:

> *"We help [Telco_A] by providing processes that they could do themselves, but it would be much more expensive and cost intensive if they would do it themselves". (Loop Operator, Key-Account Manager)*

While both telcos have assigned some strategic relevance to the loop operations, they still do not consider them as a core business activity. But, given that the speed in which future technological and regulatory developments occur are uncertain, they have already prepared for further increase in strategic importance. Thus, the decision for a collaborative coordination form is beneficial as it provides flexibility to the focal actor:

> *"A big firm equals to a huge tanker. They have their business and the tanker runs straight ahead and probably is very successful. But you cannot tell this tanker: tomorrow you have to do the opposite and run in a different direction. […] For this they need small dinghies like us." (Loop Operator, Key-Account Manager)*

Through their engagement in cooperative loop networks, focal actors can keep a certain influence in their circular activities while limiting their risks.

Business Case Drivers

From a business case perspective, the initial recycling based activities were mostly reputation-driven and aimed at a publicly visible commitment to environmental issues regarding the production and consumption of smartphones. For this reasons, and to increase legitimacy from a users' perspective, environmental NGOs are part of these VCAs. However, as both case studies show, a sole focus on recycling activities – under the current market framework – still results in costs, without increasing profits:

> *"But we have to say clearly that we do not earn money with the voluntary collection of mobile devices." (Telco_A, Sustainability Manager)*
> *"We observe a development […] from recycling, which was central in the last years, towards reuse. […] This is a topic I am going to deal with in the near future. "(Telco_A, Sustainability Manager)*

This is why, over time, both telcos show a business case recognition with a focus on costs reduction on the one hand, and potential increase in profits, on the other. Both of which were reached through an engagement in smaller loops. According to one of the loop operators, the main motivation for Telco_A to implement a buy-back scheme was to increase their market share (vouchers from the buy-back scheme as incentive for new and existing customers) and cross-finance the voluntary collection scheme.

> *"For Telco_A we now do both, fulfil legal compliances and boost business". (Loop Operator, Key-Account Manager)*

4.4 Outsourced Loop Operations

The third VCA pattern is based on cases in which circularity is framed rather reactively as a response to legal requirements. These include particularly take-back schemes necessary to deal with e-waste. In the context of these case studies, which were conducted in Germany, the legal basis can be found in the national electronic waste law (ElektroG §16, Sec. 1) – enacted based on European law. It regulates the take-back of waste electrical and electronic equipment (WEEE) through a joint agency called 'national register for waste electric equipment'[1] (EAR), in which focal actors are members, similar to an industry association. We specifically looked at basic compliance mechanisms conducted by large telecom operators.

[1] Elektro-Altgeräte Register

Loop Activities

This pattern focuses on recycling loop activities. Through the legal regulation described above, smartphone users have the possibility to discard their unused devices at publicly operated collection centres. These local collection centres report full WEEE containers to the joint agency EAR, which then assigns each full container to one of the focal actors (i.e. a telecom provider or manufacturer) based on their market share. Each focal actor then individually commissions a disposal specialist for the pick-up of the assigned container.

Nearly all smartphones collected through this take-back scheme end up in the material recycling loop. This is because, smartphones handed over to public waste disposal authorities are considered legally as waste due to the user's disposal intention (KrWG §3). Thereafter, a reuse of disposed devices is normally not possible and legally complex. One industry expert from the innovation lab summarises the disposal process as follows:

> *"At this point, when it comes from public collection, then nothing is going into reuse or remarketing. Everything is going into recycling". (Industry expert)*

As in other VCA patterns, the recycling activities are open loop, because material quality degrades and is then predominantly used for purposes other than smartphone production. Thus, it corresponds to a low *degree of loop closure*. Because of the sole focus on recycling activities and their open loop nature, we assume a low environmental potential for this pattern.

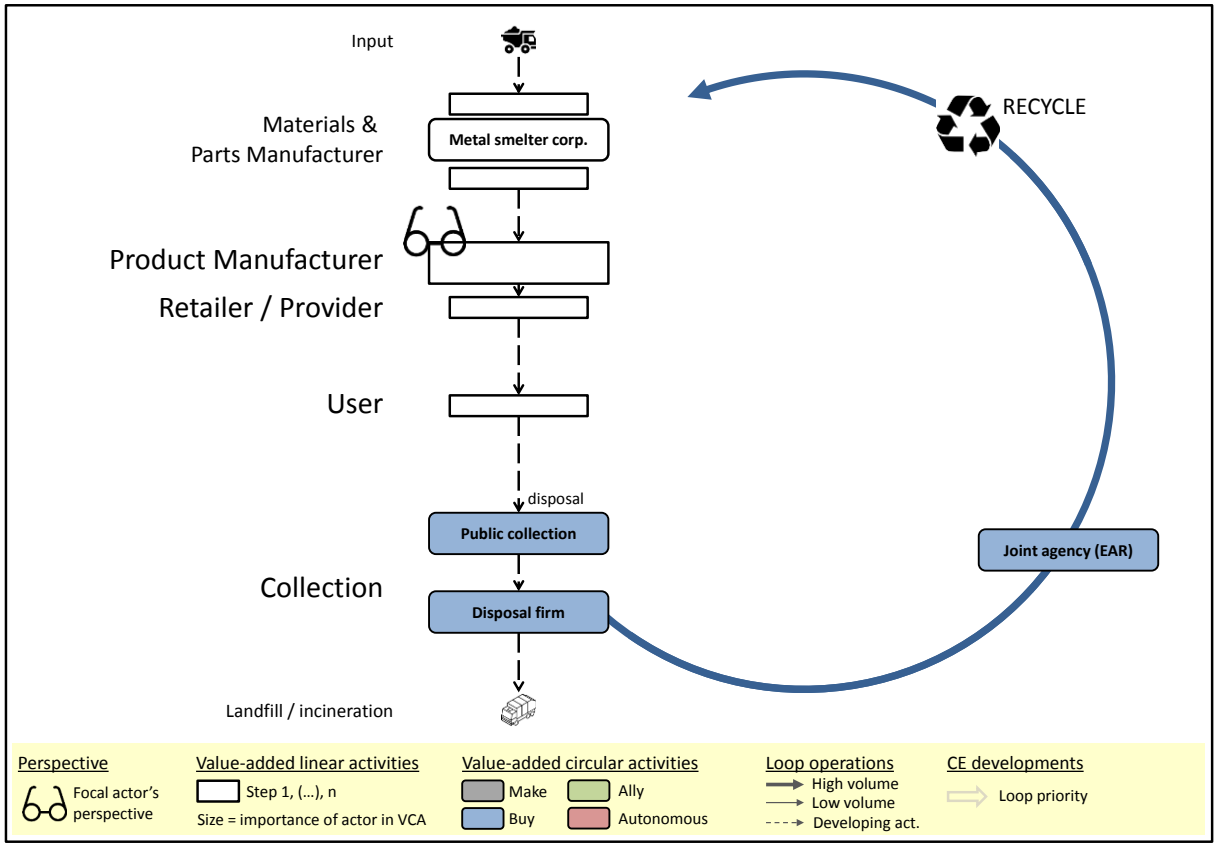

Figure 6: Schematic representation of VCA pattern 3 with a buy coordination of circular activities.

Loop Integration

Given that the joint agency EAR – which was founded as an industry association to anticipate a strict regulation by the government – coordinates the take-back process in cooperation with public waste disposal authorities, this could be considered a cooperative form of organisation as in the previous pattern. However, the focal company's memberships are obligatory and for the actual operational process of disposal, each individual focal company burdens the commissioning of full containers and the entire disposal costs. These activities are usually outsourced to specialised disposal service providers and are coordinated on a short-term basis by the focal actor. Overall, the whole procedure is very similar to a conventional market-based outsourcing.

Due to this highly regulated collection scheme with clear responsibilities and duties for focal actors, little uncertainties are involved. Furthermore, due to the coverage of all producers, high collection volumes are achieved, making large scale standardized recycling activities possible.

As described in the previous VCA, the asset specificity of recycling activities is considered low due to their standardized and large-scale nature (recycling activities are not device-specific). Thus, allowing for an outsourcing of recycling activities through the above described process. Other factors for the make-or-buy decision, such as strategic considerations, are of limited relevance due to the compliance situation in this pattern.

Business Case Drivers

In this VCA the focal actors do not recognize circular practices as a potential business case. In contrary, the presented VCA is based on the legal obligation to take back e-waste. The focal actors in the value chain thus experience the take-back activities as a compliance measure and therefore a sole cost driver. However, as described in the *network based loop operations* pattern, some focal actors decided to engage in voluntary take-back schemes with carefully selected partners, in order to gain reputational effects and develop their business case in a more proactive way.

4.5 Autonomous Loop Operations

The fourth VCA pattern focuses on autonomous loop operators working completely independent – and without contractual or otherwise formal relationship – to focal actors in the value chain. Rather, the connection to the focal actors' value chains is established only through those users that decide to start a direct service relationship with the autonomous actor. As with other loop operators, the autonomous actor can be both for-profit and non-profit (e.g. repair café) service organisations.

Loop Activities

The key actors in these VCAs are specialized repair shops for smartphones and other electronic devices operating locally in the form of small businesses or nationally using an Internet sales organisation. They are specialised in a single loop activity (mostly maintenance) and have usually developed their skills and supply chain through "learning-by-doing". Nevertheless, they operate cost-covering or profitable businesses, depending on their legal form. Comparably to retailers of new goods, they are legally obliged to offer a one-year warranty to their customers. Their value offer aims at smartphone users with 1) damages not covered by OEM's guarantee, 2) repairs not offered by OEM's repair services, or 3) price-sensitive customers preferring the low cost and/or quick services from an autonomous service provider over the official OEM's services.

As autonomous actors lack formal relationships with focal actors, they experience difficulty in gaining access to official spare parts supply. Hence, they sometimes use in-house cannibalisation techniques for products ultimately taken out of the market, in order to supply themselves with (used) original spare parts. Others are dependent on rare and sometimes dubious intermediaries, who offer spare parts with varying quality levels:

> *"Here we are of course fully self-sufficient, this means offside from manufacturers. […] For example, we do not have any access to [original] spare parts. This means we are dependent to solve these things in the small loop". (Owner Manager, Autonomous loop operator I)*

All interviewees from autonomous loop operators in this pattern report a general openness from their side towards potential collaboration with focal actors, however, received rejections in their attempts to do so. If they were not disregarded in the first place, the focal actor's reasoning included arguments such as product safety or customers' convenience.

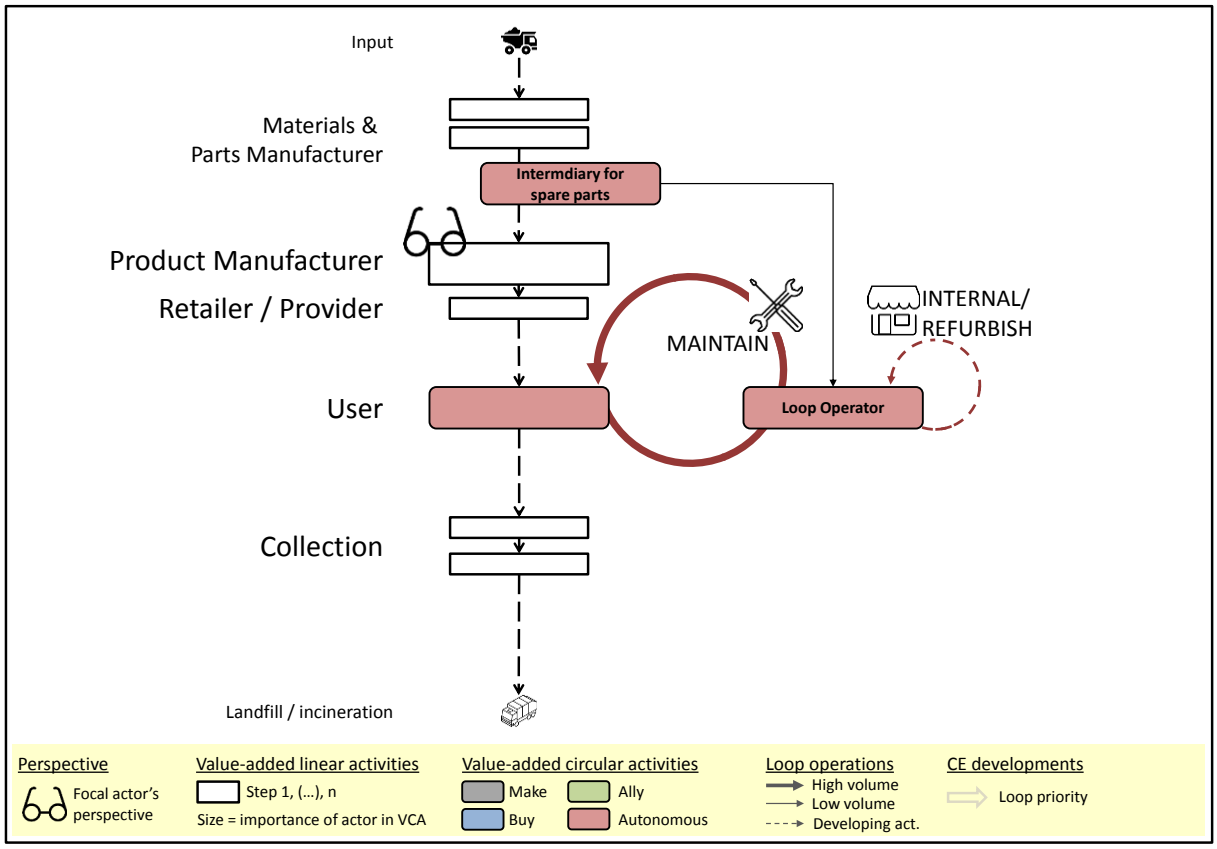

Figure 7: Schematic representation of VCA pattern 4 with a buy coordination of circular activities.

Loop Integration

Our data suggests that the perceived low strategic relevance of circular practices and related decisions from focal actors are the main reason for the emergence of autonomous loop operators. Typical smartphone manufacturers or telecommunication providers with conventional business models have optimised their business processes for the sales of new devices. Either they do not want to change their organisational routines, or they have a disinterest in offering prolonged lifetime services as delivered through repair and related loops, because margins for selling new devices are considerably higher (i.e. some form of planned or at least conscious product obsolescence). One of the owner managers of a repair service operator named himself a *"lone warrior"*, because he receives no support from established

actors in the value chain. Further, strong information asymmetries exist with respect to the availability of knowledge about the devices architecture and their value chains. This hampers their work.

A disregard of circular opportunities, such as repair services, then leads to the formation of autonomous loop operators (or even vertically integrated manufacturers as in pattern 1). Although the emergence of autonomous actors is not necessarily linked directly to a focal actor's behaviour, it is at least indirectly. At the same time, we observed ambiguity in focal actors' behaviour. In fact, autonomous actors are sometimes indirectly supported, or at least tolerated. For example, some manufacturers consciously provide access to original spare parts, even they officially neglect:

> *"I see it like this: manufacturers are absolutely aware of their position. They could say rigorously […] that these spare parts ONLY go through us [manufacturers] and […] that they do not appear on the open market. But they [manufacturers] obviously let this happen". (Owner manager, Autonomous loop operator I)*

Autonomous loop operators in some way contribute to the satisfaction of the users, as they enable working devices on a low-level basis without restrictions. Without these unofficial repair options, customers may would turn away from certain brands or models. Another autonomous repair shop owner concludes that the autonomous activities were in fact "unofficially desired" by the manufacturers:

> *„Officially we are unwanted, unofficially we are the basis of their success". (Owner manager, Autonomous loop operator II)*

Overall, the relationship between independent loop operators and focal actors along the value chain can be described as ambivalent, as they receive no official support but are at the same time tolerated or even desired.

Business Case Drivers

From the perspective of a focal actor, a neglection of the circular business case can be assumed and is therefore not further explored.

5 DISCUSSION

This paper explores inter-organizational relationships that develop based on newly emerging circular practices of market and non-market actors in the smartphone value chain. In our case studies, we found four circular VCA patterns by which circular practices are offered to smartphone users. Based on these patterns, we will discuss the relationship between the loops addressed (small vs. large) and the degree of vertical integration, the business case recognition, the influence on open and closed loops, the special role of the autonomous loop operator, and the potential of product design changes.

Vertical Integration Increase for Smaller CE Loops

While existing literature generally suggests increased collaboration efforts for the implementation of a circular economy (e.g. EMF 2016, 13 and Roy & Whelan (1992)), our study puts forward that coordination levels particularly increase for smaller CE loops (e.g. maintenance or reuse). We could trace this effect back to increased specificity levels for smaller CE-loops based on smartphone model specific repair manuals and spare parts. In line with TCT, these increased specificity levels lead to the observed higher vertical integration levels for smaller CE-loops (Williamson 1979; Picot et al. 1997).

Martin et al. (2010) could also identify specificity as a main driver in the case of the integration of remanufacturing operations in the automotive industry. In addition, over time, we could observe a development towards smaller CE-loops within individual VCAs that was accompanied by an increased attentiveness towards self-supporting business cases.

The Potential for Generating Circular Business Cases Increases with the Level of Vertical Integration

While our "buy" pattern is rather compliance oriented and leads only to additional costs to the focal firm, higher levels of vertical integration show that companies – if they make the necessary changes to their business model – can potentially benefit from business case drivers. Observed drivers include decreased costs, increased reputation, innovation/differentiation, and even increase in profits (Schaltegger et al. 2012). In the extreme, a vertically integrated company can offer a holistic quality commitment including maintenance and repair – a business model strategy referred to as "extending product value" (Bocken et al. (2016, 313) – as the basis for entirely new (sustainable) product offerings in the market. However, success is not guaranteed: One important factor is the coupling of the circular loop services with the product marketing as means of differentiation, also by directly targeting niche markets interested in sustainable product offerings. Close customer relationships or even a community approach needs to be developed to engage the target groups. Additionally, financial incentives (e.g. deposit) help to successfully operate take-back processes for used devices. Access- and performance-based business models could also help to develop such businesses (Stahel & Reday-Mulvey 1976; McDonough & Braungart 2002; Hansen et al. 2009; Bocken et al. 2016), however, we could not observe them in practice in the smartphone industry (probably due to importance of data privacy linked to smartphones).

Higher Vertical Integration Levels Allow for a Higher Degree of Loop Closure

The CE should be improved by a transition from open to closed-loops, as Haupt et al. (2017) stress from a recycling perspective. Additionally, supply chain literature suggests that vertical integration enables more strongly closed loops (Guide & van Wassenhove 2009; Jayaraman et al. 1999). Together this shows a general relationship between the *degree of loop closure* and the degree of vertical integration. Based on our findings, we can extend the open vs. closed loop understanding to a continuum of closure that applies to all main loops of the technical cycle. We find that a vertical integration of circular practices leads to more strongly closed loops with respect to returns to the original value chain, not only in recycling, but across all loops. For example, SmartMan remarkets their own second-hand smartphones – either as-is or after repair or refurbishment – in their online shop next to any other new products and also returns used parts to the own production site. Further, the close cooperation of Telco-B with their loop operators enables the remarketing of smartphones at least in the similar markets in the national context (though not necessarily to existing customer base). In contrast, in the buy pattern – using independent service providers – materials or components are treated in an aggregated way across producers, leading to low collection rates (OECD 2011) and usually leading to the lowest possible achievements in circularity. For example general recycling across devices returns many quality-degraded materials which are usually marketed in an "open loop recycling" (EMF 2016) approach in totally different value chains and industries. Thus, no closed-loop recycling is reached through this low integration in the value chain.

Disregard of Circular Activities by Focal Actors leads to Autonomous Loop Operations

We found that circular services do not necessarily have to be initiated by the focal actor in a value chain. In absence of the focal actor, they can also be initiated and successfully operated by autonomous loop operators. This is contrary to the extant literature in two ways. First, from a TCT perspective, because Williamsons continuum does not include autonomous coordination mechanisms. Second, from a CE perspective, as extant literature (including the branch of closed-loop supply chain and remanufacturing) does not explicitly recognize *uncoordinated* loop operations. Stahel (2010, p.218) and Lind et al. (2014) recognise independent actors, without differentiating between coordinated and uncoordinated activities. They suggests that loop operators need to be coordinated through focal actors in order to utilized their potential regarding (Guide & van Wassenhove 2009). In contrast, we make a further distinction between *independent* loop operators (who have a contractual relationship to the focal actor) and *autonomous* loop operators (who have no formal relationship to focal actors).

We should mention that we are aware of partly existing official repair offers from OEMs existing beyond the timeframe of product warranties and that most large OEMs outsource these to service providers. However, most OEMs' circular practices such as repair or take-back solutions are only offered for a limited time-period after initial release, to a limited scope (display and battery), and with unattractive pricing models. Thus, OEMs do not necessarily disregard circular services, but may also disincentivise them.

Circular Product Design as a Lever for Decreased Coordination Efforts

A holistic approach to design, which would include circular design practices such as design for disassembly and design for repairability, could decrease coordination efforts. Our empirical evidence shows that modularity is seen as a solution to decrease coordination efforts with customers due to standardization effects and reduced uncertainties. In other cases, simplified access to spare parts and repair manuals would similarly decrease coordination efforts considerably. Both approaches are also suggested in TCT literature as it is often argued that with increased complexity of operations an internalization is favoured (Schneider et al. 1994, 69; Williamson 1991, 291). Modular design and simplified access to spare parts, however, must begin on a supplier's level and thus become an industry wide standard. As of today only a few examples for circular designed smartphones exist and all use custom-made parts (e.g. Fairphone 2 (Schischke et al. 2016)). The EMF estimates that costs related to remanufacturing processes of mobile phones could be reduced by 50% through circular design techniques (EMF 2012, 8). Case companies in this study named the automobile industry as a positive example for such a system.

5.1 Limitations

The present paper is limited in various ways. First, for reasons of access, some of our investigated studies included the focal actor perspective from the outside only. However, the conceptual research framework used in this work allows for an outside-in approach, which means that VCAs are partly analysed indirectly, i.e. through statements by loop operators. This is not an ideal situation for performing a make-or-buy analysis, which generally produces statements from a focal actor perspective. Thus, to validate the results, future research should integrate the original perspective of large smartphone OEMs.

A second limitation is conceptually: while we are confident that the resulting typology including coordinated and uncoordinated patterns will be an important contribution to the emerging literature on the CE, we admit that the uncoordinated type of autonomous loop operators is not fully consistent with the established theory framing of the make-or-buy concept (Williamson 1979; Picot et al. 1997). Still, given our findings on the deliberate ignorance of such autonomous activity, we theorize that focal actors do indeed consciously decide (though do not communicate about it) to leave loop activities to such autonomous actors. Further research should apply and test the proposed framework in other industries.

6 CONCLUSION

The objective of this paper was to investigate how emerging circular VCAs contribute to closing material loops in a CE. We combined approaches from the CE concept with classical TCT to investigate emerging VCAs in the smartphone industry. Based on our empirical investigations we have developed five main contributions: We first contribute to CE literature by identifying four different patterns of VCAs for circular practices: 1) vertically integrated loop operations, 2) network based loop operations, 3) outsourced loop operations, and 4) autonomous loop operations. Second, we find that loop specificity for circular practices increases for higher order CE-loops such as maintenance or reuse. Therefore, vertical integration of CE practices or partnerships between focal actors and loop operators are beneficial strategies to reach a sophisticated CE. Third, we find that the higher the degree of vertical integration, the easier it is for an organisation to integrated circular practices strategically into their core business. Fourth, the most sophisticated VCA pattern – the vertical integrated firm – is best able to translate experiences from circular activities into a revised circular design of products. This in turn is the basis for reducing necessary transaction costs and thus overall costs of a circular economy in the long term. Fifth, this work provides evidence that focal firms in the value chain are not necessarily the managing authority for CE practices, but that circular economy activities are also initiated and operated by specialised loop operators or even autonomous actors such as repair shops. This finding also extends the coordination continuum (Williamson 1991; Picot et al. 1997) of transaction cost theory by suggesting the relevance of uncoordinated activities in specific industry settings and (upstream) value chain sections beyond product sales.

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REFERENCES

Agrawal, S.; Singh, R. K. & Murtaza, Q. (2016): Outsourcing decisions in reverse logistics. Sustainable balanced scorecard and graph theoretic approach, Resources, Conservation and Recycling, Vol. 108, 41–53.

Baldé, C. P.; Wang, F.; Kuehr, R. & Huisman, J. (2015): The Global E-Waste Monitor 2014. Quantities, Flows and Resources. United Nations University. Bonn, Germany, URL: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf (accessed November 15, 2016).

Benyus, J. M. (2002): Biomimicry. Innovation inspired by nature. New York, N.Y.: Harper Perennial.

Bocken, N. M. P.; Pauw, I. de; Bakker, C. & van der Grinten, B. (2016): Product Design and Business Model Strategies for a Circular Economy, Journal of Industrial and Production Engineering, Vol. 33, No. 5, 308–320.

Borys, B. & Jemison, D. B. (1989): Hybrid Arrangements as Strategic Alliances. Theoretical Issues in Organizational Combinations, Academy of Management Review, Vol. 14, No. 2, 234–249.

Braungart, M.; McDonough, W. & Bollinger, A. (2007): Cradle-to-Cradle Design. Creating Healthy Emissions – A Strategy for Eco-Effective Product and System Design, Journal of Cleaner Production, Vol. 15, 13-14, 1337–1348.

Brezet, J. C. & van Hemel, C. G. (1997): Ecodesign. A Promising Approach to Sustainable Production and Consumption. Paris, France: United Nations Environment Programme, UNEP.

Coase, R. H. (1937): The Nature of the Firm, Economica, Vol. 4, No. 16, 386–405.

Dießenbacher, J. & Reller, A. (2016): „Das 'Fairphone' – ein Impuls in Richtung nachhaltige Elektronik?“, in: Exner, A.; Held, M. & Kümmerer, K. (Eds.): Kritische Metalle in der Großen Transformation. Berlin, Heidelberg: Springer Spektrum, 269–294.

Dietl, H.; Royer, S. & Stratmann, U. (2009): Value Creation Architectures and Competitive Advantage. Lessons from the European Automobile Industry, California Management Review, Vol. 51, No. 3, 24–48.

Dubois, A. & Gadde, L.-E. (2002): Systematic Combining. An Abductive Approach to Case Research, Journal of Business Research, Vol. 55, No. 7, 553–560.

Eisenhardt, K. M. & Graebner, M. E. (2007): Theory Building from Cases. Opportunities and Challenges, Academy of Management Journal, Vol. 50, No. 1, 25–32.

EMF (2012): Towards the Circular Economy 1. Economic and Business Rationale for an Accelerated Transition. Ellen MacArthur Foundation. (1) (accessed June 6, 2016).

EMF (2016): Waste not, Want not. Capturing the Value of the Circular Economy Through Reverse Logistics. Ellen MacArthur Foundation. (CE 100), URL: https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/Reverse-Logistics.pdf (accessed August 29, 2016).

European Commission (EC) (2008): EC-Directive 2008/98 of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives, in: EUR-Lex, URL: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098 (accessed November 8, 2016).

Fischer, M. (1993): Make-or-Buy-Entscheidungen im Marketing. Neue Institutionenlehre und Distributionspolitik. Wiesbaden: Gabler.

Flick, U. (2011): Qualitative Sozialforschung. Eine Einführung. Reinbek bei Hamburg: Rowohlt Taschenbuch Verlag.

Flyvbjerg, B. (2006): Five Misunderstandings about Case-Study Research, Qualitative Inquiry, Vol. 12, No. 2, 219–245.

Frosch, R. A. & Gallopoulos, N. E. (1989): Strategies for Manufacturing, Scientific American, Vol. 261, No. 3.

Geissdoerfer, M.; Savaget, P.; Bocken, N. M.P. & Hultink, E. J. (2017): The Circular Economy – A new Sustainability Paradigm?, Journal of Cleaner Production, Vol. 143, 757–768.

Gemünden, H. G.; Ritter, T. & Heydebreck, P. (1996): Network Configuration and Innovation Success. An Empirical Analysis in German high-tech Industries, International Journal of Research in Marketing, Vol. 13, No. 5, 449–462.

Geyskens, I.; Steenkamp, J.-B. E. M. & Kumar, N. (2006): Make, Buy, or Ally: A Transaction Cost Theory Meta-Analysis, Academy of Management Journal, Vol. 49, No. 3, 519–543.

Giarini, O. & Stahel, W. R. (2000): Die Performance-Gesellschaft. Chancen und Risiken beim Übergang zur Service Economy. Marburg: Metropolis-Verl.

Govindan, K.; Palaniappan, M.; Zhu, Q. & Kannan, D. (2012): Analysis of third party reverse logistics provider using interpretive structural modeling, International Journal of Production Economics, Vol. 140, No. 1, 204–211.

Guba, E. G. (1981): Criteria for assessing the trustworthiness of naturalistic inquiries, Educational Communication & Technology Journal, Vol. 29, No. 2, 75–91.

Guide, V. D. R.; Harrison, T. P. & van Wassenhove, L. N. (2003): The Challenge of Closed-Loop Supply Chains, Interfaces, Vol. 33, No. 6, 3–6.

Guide, V. D. R. & van Wassenhove, L. N. (2009): The Evolution of Closed-Loop Supply Chain Research, Operations Research, Vol. 57, No. 1, 10–18.

Hansen, E. G.; Grosse-Dunker, F. & Reichwald, R. (2009): Sustainability Innovation Cube - A Framework to Evaluate Sustainability-Oriented Innovations, International Journal of Innovation Management, Vol. 13, No. 04, 683–713.

Haupt, M.; Vadenbo, C. & Hellweg, S. (2017): Do We Have the Right Performance Indicators for the Circular Economy? Insight into the Swiss Waste Management System, Journal of Industrial Ecology, Vol. 21, No. 3, 615–627.

Hopf, C. (2013): „Qualitative Interviews. Ein Überblick“, in: Flick, U.; Kardorff, E. v. & Steinke, I. (Eds.): Qualitative Forschung. Ein Handbuch. Reinbek bei Hamburg: Rowohlt Taschenbuch (Rowohlts Enzyklopädie), 349–360.

Huber, J. (1995): Nachhaltige Entwicklung. Strategien für eine ökologische und soziale Erdpolitik. Berlin: Ed. Sigma.

Huber, J. (2000): „Industrielle Ökologie. Konsistenz, Effizienz und Suffizienz in zyklusanalytischer Betrachtung“, in: Kreibich, R. & Simonis, U. E. (Eds.): Global Change. Causal Structures and Indicative Solutions = Globaler Wandel. Berlin: Berlin-Verl. Spitz (Wissenschaft in der Verantwortung), 109–126.

Jackson, T. (1996): Material Concerns. Pollution, Profit, and Quality of Life. London, New York: SEI, Stockholm Environment Institute; Routledge.

Jayaraman, V.; Guide, V. D. R. & Srivastava, R. (1999): A closed-loop logistics model for remanufacturing, Journal of the Operational Research Society, Vol. 50, No. 5, 497–508.

Klein, P. G. (2005): „The Make-or-Buy Decisions: Lessons from Empirical Studies“, in: Ménard, C. & Shirley, M. M. (Eds.): Handbook of New Institutional Economics. Berlin: Springer, 435–464.

Lamnek, S. (2010): Qualitative Sozialforschung. Lehrbuch. Weinheim, Basel: Beltz, 5., überarb. Aufl.

Lind, S.; Olsson, D. & Sundin, E. (2014): Exploring inter-organizational relationships in automotive component remanufacturing, Journal of Remanufacturing, Vol. 4, No. 1, 5.

Lund, R. T. (1985): Remanufacturing. The experience of the United States and implications for developing countries. (The World Bank, WTP31), URL: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP//.

Martin, P.; Guide Jr., V. D. R. & Craighead, C. W. (2010): Supply Chain Sourcing in Remanufacturing Operations. An Empirical Investigation of Remake Versus Buy, Decision Sciences, Vol. 41, No. 2, 301–324.

Mayring, P. (2010): Qualitative Inhaltsanalyse. Grundlagen und Techniken. Weinheim, Bergstr: Beltz, J, 11., vollständig überarbeitete und aktualisierte Aufl.

McDonough, W. & Braungart, M. (2002): Cradle to Cradle. Remaking the Way We Make Things: Farrar, Straus and Giroux.

Ny, H.; MacDonald, J. P.; Broman, G.; Yamamoto, R. & Robért, K.-H. (2006): Sustainability Constraints as System Boundaries. An Approach to Making Life-Cycle Management Strategic, Journal of Industrial Ecology, Vol. 10, 1-2, 61–77.

OECD (2011): A Sustainable Materials Management Case Study. Critical Metals and Mobile Devices. Organisation for Economic Cooperation and Development, URL: http://www.oecd.org/env/waste/49805008.pdf (accessed July 26, 2016).

OECD (2012): Case Study on Critical Metals in Mobile Phones. Final Report. Organisation for Economic Cooperation and Development, URL: http://www.oecd.org/env/waste/Case%20Study%20on%20Critical%20Metals%20in%20Mobile%20Phones.pdf (accessed July 26, 2016).

Picot, A. (1991): Ein neuer Ansatz zur Gestaltung der Leistungstiefe, Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung (ZfbF), Vol. 43, No. 4, 336–357.

Picot, A.; Reichwald, R. & Wigand, R. (1997): Information, Organization and Management. Expanding markets and corporate boundaries. Chichester [u.a.]: Wiley.

Powell, W. W. (1990): Neither Market nor Hierarchy. Network Forms of Organization, Research in Organizational Behavior, Vol. 12, 295–336.

Reuter, M. A. (2011): Limits of Design for Recycling and "Sustainability". A Review, Waste and Biomass Valorization, Vol. 2, No. 2, 183–208.

Revellio, F. (2017): Closing Loops in the Circular Economy. A Make or Buy Analysis for the Smartphone Industry, Master's Thesis. Leuphana Universität Lüneburg, URL: http://opus.uni-lueneburg.de/opus/volltexte/2017/14446/pdf/Revellio_2017_Thesis_Circular_Economy.pdf (accessed July 18, 2017).

Roy, R. & Whelan, R. C. (1992): Successful Recycling Through Value-chain Collaboration, Long Range Planning, Vol. 25, No. 4, 62–71.

Schaltegger, S.; Freund, F. L. & Hansen, E. G. (2012): Business Cases for Sustainability. The Role of Business Model Innovation for Corporate Sustainability, International Journal of Innovation and Sustainable Development, Vol. 6, No. 2, 95.

Schischke, K.; Proske, M.; Sommer, P. & Trinks, T. (2016): „Wie nachhaltig ist das Fairphone 2?". Ergebnisse einer Expertenbefragung. Fraunhofer IZM; Deutsche Umwelthilfe. Berlin, URL: http://www.duh.de/uploads/media/160701_Fraunhofer_DUH_Nachhaltigkeit_des_Fairphone2_Endbericht.pdf (accessed July 27, 2016).

Schneider, D.; Baur, C. & Hopfmann, S. (1994): Re-Design von Wertkette durch Make or Buy. Konzepte und Fallstudien: Gabler Verlag.

Seuring, S. & Müller, M. (2008): From a Literature Review to a Conceptual Framework for Sustainable Supply Chain Management, Journal of Cleaner Production, Vol. 16, No. 15, 1699–1710.

Stahel, W. R. (1984): „The Product Life Factor", in: Orr, S. G. (Ed.): An Inquiry into the Nature of Sustainable Societies: The Role of the Private Sector, 72–104.

Stahel, W. R. (2010): The Performance Economy. Basingstoke, England, New York: Palgrave Macmillan, 2nd ed.

Stahel, W. R. & Reday-Mulvey, G. (1976): Jobs for Tomorrow. The Potential for Substituting Manpower for Energy. Brussels, New York: Vantage Press.

Thierry, M.; Salomon, M.; van Nunen, J. & van Wassenhove, L. (1995): Strategie Issues in Product Recovery Management, California Management Review, Vol. 37, No. 2, 114–135.

Tukker, A. (2015): Product Services for a Resource-efficient and Circular Economy. A Review, Journal of Cleaner Production, Vol. 97, 76–91.

van de Ven, A. H. (2007): Engaged Scholarship. A Guide for Organizational and Social Research. Oxford u.a.: Oxford Univ. Press, 1. publ.

Wieser, H. (2016): Beyond Planned Obsolescence. Product Lifespans and the Challenges to a Circular Economy, GAIA - Ecological Perspectives for Science and Society, Vol. 25, No. 3, 156–160.

Williamson, O. E. (1975): Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economies of Internal Organization. New York: Free Press.

Williamson, O. E. (1979): Transaction-Cost Economics: The Governance of Contractual Relations, Journal of Law & Economics, Vol. 22, 233.

Williamson, O. E. (1981): The Economics of Organization. The Transaction Cost Approach, American Journal of Sociology, Vol. 87, No. 3, 548–577.

Williamson, O. E. (1991): Comparative Economic Organization. The Analysis of Discrete Structural Alternatives, Administrative Science Quarterly, Vol. 36, No. 2, 269–296.

Yin, R. K. (2009): Case Study Research. Design and Methods. Los Angeles, Calif.: Sage Publications, 4th ed.