Business Opportunities for Sustainable Modular Product Designs: Briefing Paper of the 'Innovation Network aiming at Sustainable Smartphones' (INaS)

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Briefing Paper of the 'Innovation Network aiming at Sustainable Smartphones' (INaS)

Centre for Sustainability Management

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Preamble

This CSM working paper is part of a workshop series on business opportunities for sustainable modular product designs in the smartphone industry. Participants received this briefing paper for their preparation to the kick-off workshop. For further information on the INaS workshop series please visit: *https://www.leuphana.de/institute/csm/forschung-projekte/inas.html*

Abstract

The Innovation Network aiming at Sustainable Smartphones (INaS) is an innovation lab at Leuphana University Lüneburg for sustainability pioneers from the smartphone value chain. It was founded in 2015 with the dual purpose of facilitating collaboration in the value chain and researching sustainability transformations. An initial workshop series from 2016-2018 addressed various sustainability challenges to co-create circular product and service innovations. Our second workshop series focuses on business opportunities for sustainable modular product design in the circular economy.

Overview INaS 2.0

In the second INaS, pioneering actors from the smartphone value chain meet in three consecutive workshops to discuss and explore business opportunities for **modular product designs**. The aim is to jointly develop innovative business models based on **sustainable modular product designs** for smartphones – paving the way towards a **circular economy**. Each consecutive one-day workshop focuses on one specific aspect of sustainable modular product design. In addition to the **collaborative workshop settings**, participating actors will be accompanied to work further on their ideas between the workshops to stimulate a **successful transformation in practice**. Figure 1 provides an overview of the planned workshop topics and timeline. This briefing paper aims to facilitate preparation for participants. It includes some background information and a short overview of relevant concepts for INaS 2.0.

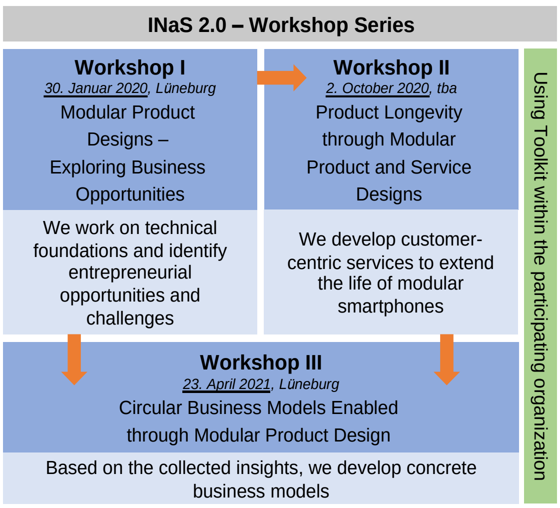

Figure 1: Overview of Workshop Series INaS 2.0

Background and Motivation

The **global smartphone market faces stagnation** due to market saturation (Bitkom 2019). In Germany, the number of sold smartphones has dropped by 1.3% from 2017 to 2018, and a further decrease is predicted for 2019 (Tenzer 2019). However, **total sales in value rose by 11%** from the preceding 2018 record year, due to **increasing averages prices** of smartphones. On the user side, eight out of ten people are using a smartphone in Germany, and every second user claims to buy the newest model every time (Bitkom 2019).

The slowdown of the number of sold smartphones and short initial use-phases go along with an upswing of second-hand products and repair services. In particular, the **global revenues for refurbished and used smartphones is expected to almost double** from 2017 to 2025 to approximately 40 billion dollars – with a compound annual growth rate of 8.9% (Persistence Market Research 2017). This makes the secondary market the **fastest growing** market worldwide (even before India or China) (Counterpoint Research 2018).

The dominant smartphone design and incumbent business model is only partially suitable for consecutive use-phases. Market saturation and sustainability requirements increase the **interest in modular designs and new business models** that allow benefit from the potential of cascading use-phases. Moreover, high growth rates for niche actors such as Fairphone or Shift demonstrate a demand for alternative smartphone designs. Modular product design (MPD) can have the potential to **meet both, sustainability criteria and profitability of circular economy business models**.

Modular Product Design in the Context of the Circular Economy

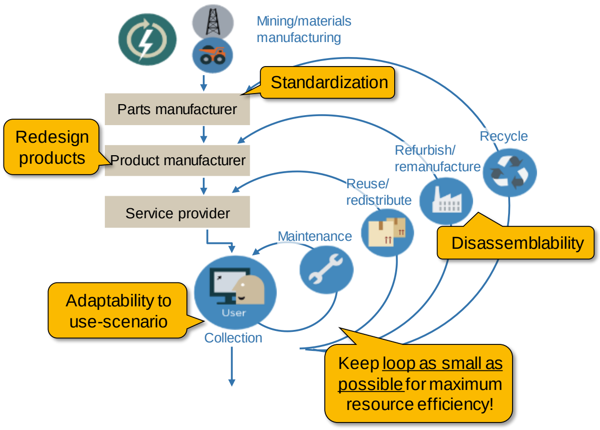

Figure 2: Exemplary Levers of MPD in the Circular Economy (based on EMF 2012, p. 24)

The Circular Economy (CE) concept is an economic paradigm that envisions circular flows for both, **products of consumption** (e.g. biodegradable tire abrasion) and **products of use** (e.g. smartphones) (Braungart et al. 2007). For the latter category, we refer to the concept of product circularity with three basic strategies of **slowing, narrowing and closing resource loops** (Stahel 2010; Bocken et al. 2016). Strategies for *slowing* resource loops include practices like repair, second-hand markets, refurbishing and upgrading that extend total product lifetime. *Narrowing* strategies include eco-efficient product design and reducing material flows, e.g. optimizing resource consumption per device. The third strategy of *closing* loops applies a product's end-of-life through comprehensive material recycling. For most consumer electronics, major environmental impacts are caused in the production phase. Therefore, **product lifetime extension** (i.e. slowing strategies) generally is a valuable approach for sustainability (Cooper & Gutowski 2017).

To reap benefits from CE, a mere redesign of products is insufficient. Circular designer den Hollander (2018) stresses the need to **manage obsolescence** throughout the entire lifecycle by redesigning products and business models. He identified eight **design strategies for product lifetime extension**. First, for *resisting obsolescence*, design can target emotional ("remain wanted") or physical ("functionality") durability over a long period of time. Second, for *postponing obsolescence*, design can target maintenance, repair or upgrading. Last, for *reversing obsolescence*, design can target recontextualizing (reuse in different context), refurbishing (minor repairs before devices are remarketed), or remanufacturing (complete dis- and reassemble to meet "quality as new").

The CE concept has gained momentum on various policy levels, most recently with the **EU Green Deal** that includes an updated **circular economy action plan**. It particularly focuses on circular electronics due to their resource-intensity. Specifically, it outlines that businesses will be encouraged *"to offer, and to allow consumers to choose **reusable, durable and repairable products**"*. In particular, the new CE action plan, highlights the importance of a 'right to repair' and to evade planned obsolescence. The report also emphasizes that *"new business models based on renting and sharing goods and services will play a role as long as they are truly sustainable and affordable"* (European Commission 2019).

Furthermore, although the current **EU Ecodesign Working Plan** (EC 2016) does not yet apply to smartphones, they are on the list of 'soon to be included' products. While the focus of EU's Ecodesign Directive so far laid on improving products´ energy efficiency, the Commission emphasizes that the initial product design largely determines *"the possibility to **repair, remanufacture or recycle** a product and its components and materials"*. Therefore, further product-specific requirements are under review: (1) *"extending product lifetime"*, (2) *"ability to re-use components or recycle materials from products at end-of-life"*, and (3) *"use of re-used components and/or recycled materials in products"* (Ecodesign Working Plan 2016, 8-9).

Technical Modularization Approaches for Smartphones

Modular product design (MPD) is an **established concept** in various contexts and industries (Starr 1965). Initially applied in production to decrease lead-times in the 70s, it enabled mass customization in the 90s, and is now seen as a **design principle to support sustainability** throughout the product lifecycle.

Smartphones are complex technical products with fast development cycles, making MPD for sustainability a less prioritized design goal for most OEMs. Historically, at least the battery and sim card constituted exchangeable modules. Today, product modularity for smartphones can take **various forms**, depending on the OEM's strategic focus. From LEGO style approaches for user access to fully integrated concepts only accessible by OEMs. Schischke et al. (2019) classify nine types of modularity, including "DIY repair modularity" of the Fairphone 2, to "mix and match modularity" of Google's ARA concept. All of these technical modularity approaches have their own **underlying business models**.

MPD in the Value Chain

Based on our literature analysis we identified opportunities and challenges as well as basic technical requirements of sustainable MPD for smartphones throughout the value chain (Figure 5). This represents a preliminary selection without a particular order of priority.

The listed **opportunities** of each value chain stage result from MPD or enhance the extension of a smartphone´s or at least certain modules´ lifetimes as well as material use-time. However, **challenges** result from MPD as well, and limit the device´s lifetime extension. Therefore, **business models need to be implemented together with MPD** to maximize opportunities and minimize challenges *(we will develop supporting business models during the third workshop)*. In addition, **technical requirements** of a modular smartphone influence the interaction between two value chain stages and the success for product lifetime extension. For example, a modular smartphone may be more easily dis- and reassembled to recover a used device for a subsequent use-phase. At the end of a smartphone´s lifetime, still-functioning modules can be reused in other devices, or at least materials can be recycled. This requires careful consideration of the corresponding **circular value creation architecture**.

Our preliminary definition of modular product design for sustainability

Modular product design is an **established design principle** that can enable and facilitate circular product and material flows – but can also lead to rebound effects in the form of unintended negative environmental (side) effects. Therefore, MPD does **not automatically contribute to sustainability**, but needs careful consideration of the entire product lifecycle.

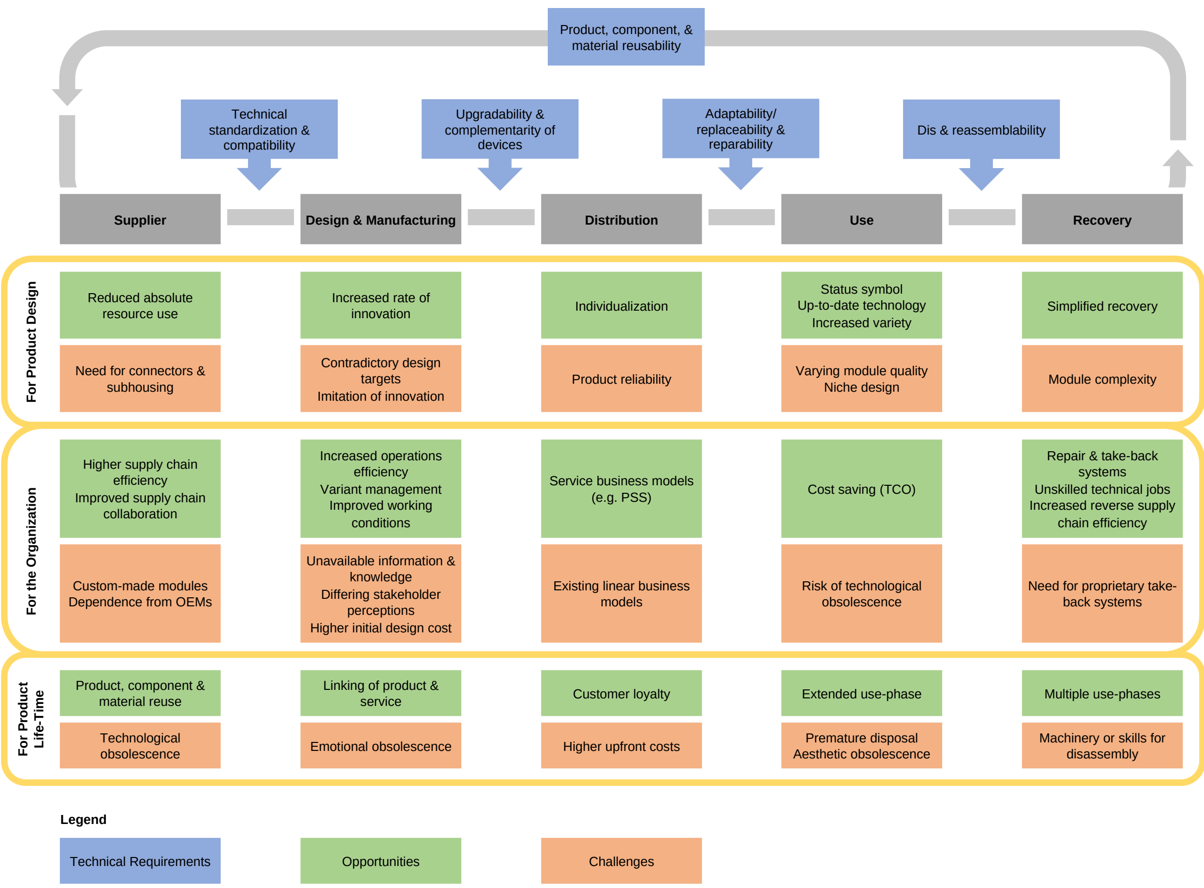

Figure 3: Modular Product Design in the Smartphone Value Chain

Based on existing literature (among others: Gershenson et al. 1999, 2003; Pimmler & Eppinger 1994; den Hollander 2018; Baldwin & Clark 1998; Ma & Kremer 2016), we have developed a preliminary definition of sustainable MPD, which we want to discuss with you at the workshops:

Sustainable modular product design is the grouping and processing of (1) ***interdependent components*** *into (2)* ***independent modules,*** *forming a (3)* ***reversible technical system*** *which facilitates circular service operations for replacements, upgrades, and recovery throughout the entire product lifecycle – together preventing (4)* ***premature product and material obsolescence****.*

1) **Interdependent components** within a module interact more strongly and perform similar functions. They have similar lifecycle expectancies.
2) **Independent modules** perform an umbrella function and utilize standardized interfaces to ensure compatibility between different modules and module generations (as well as software versions).
3) **Reversible technical systems**, which consist of modules linked by reversible spatial-, energy-, information- and/or material interfaces, facilitate circular service operations.
4) **Premature product and material obsolescence** aims at product lifetime extension and material recyclability.

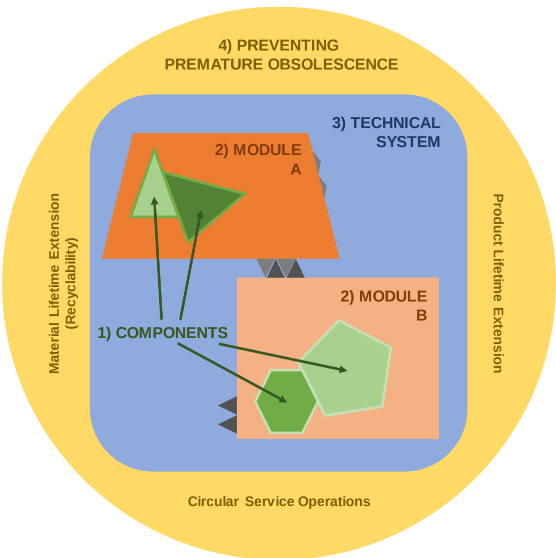

Figure 4: Graphical Representation of Sustainable Modular Product Design

Value Creation in a CE

In a CE **value is created at multiple points in time and for various stakeholders**. This includes for example repair services or second-hand markets. Thus, OEMs and distributors fill new roles as central coordinators orchestrating circular flows of their products and materials over multiple use-cycles. Central coordinators have to answer the **strategic question of make-or-buy** for related circular service operations (e.g. repair services, second-hand markets). Four basic circular value creation architectures (CVCA) are possible, reaching from **vertical integration to a laissez-faire posture** (Figure 3) (Revellio & Hansen 2017).

In *vertically integrated architectures* (1) central coordinators manage comprehensive circular systems themselves. In *network architectures* (2) central coordinators peruse strategic partnerships to extend their circular reach. Less strategic regarding circularity are *outsourcing architectures* (3) that allow for outsourcing of basic circular service operations to external actors. Finally, in *laissez-faire architectures* (4) central coordinators are indifferent to circular service operations, which leaves a vacuum for autonomous third-party actors to develop their own services.

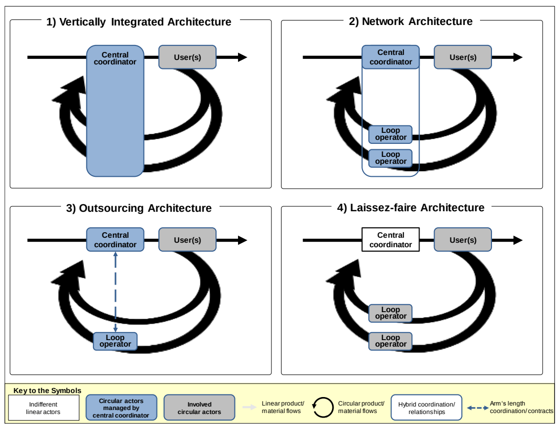

Figure 5: Circular Value Creation Architectures (based on Revellio & Hansen 2017)

New **business models and product designs** directly link to these basic circular value creation architectures. Modular product designs can facilitate circular product and material flows and strategic partnerships with third-party actors, but require a sound mechanism to capture value from it. Autonomous third-party actors capitalizing on other OEMs laissez-faire architectures need to invest considerably in reverse engineering or seek partnerships with OEMs to jointly benefit from circularity.

Conclusion

In the INaS 2.0 workshop series sustainability pioneers from the smartphone value chain and academia **jointly explore business opportunities** for modular product designs. As shown above, modularity constitutes a promising design principle for smartphones **within the circular economy** context. However, it does not guarantee for positive sustainability effects. In this briefing paper, we have developed a preliminary definition of sustainable modular product design that acts as a **boundary object** throughout the INaS 2.0 workshop series. Sustainable MPD is a **lifecycle oriented concept** aiming at product lifetime extension and material recyclability, thus supporting circular business models. These require **new actor constellations**, together forming circular value creation architectures. Therefore, INaS aims to facilitate **co-creation of circular product and service innovations** capturing MPD's business and sustainability opportunities.

Acknowledgments

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