THE FALLACY OF "TRICKLE-DOWN" PRODUCT SUSTAINABILITY: TRANSLATING STRATEGIC SUSTAINABILITY TARGETS INTO PRODUCT DEVELOPMENT EFFORTS

ABSTRACT

Purpose: The current manuscript explores how big-picture sustainability strategies are translated into tangible product development efforts. We assert that most sustainable products currently remain confined to niche markets and do not permeate the mainstream. We propose that there is a missing link between strategic sustainability goals and operational product development initiatives. We establish a path to bridging this gap.

Design/methodology/approach: The manuscript is based on a qualitative research design with a sample of 32 companies. Data was collected from semi-structured interviews with product developers as well as secondary data analysis.

Findings: We delineate three empirically derived approaches firms from our sample pursue to develop sustainable products. We identify a phenomenon that we call the *fallacy of trickle-down product sustainability*. We find that only one of the three approaches – *codification* – is equipped to successfully turn strategic sustainability targets into authentic sustainable products.

Practical implications: This study provides an actionable guide to executives and product developers with respect to bridging the gap between often elusive sustainability aspirations and tangible product improvements via the process of rigorous codification.

Originality/value: This study provides a novel and unique perspective into strategy, sustainability, and product development. We synthesize the extant literature on sustainable product development, juxtapose the emergent structure with primary interview data, and elaborate the Resource-Based-View (RBV) to provide theoretical and practical implications. We establish *scalability* as the missing RBV capability of many attempts towards mass-market-compatibility of more sustainable products.

INTRODUCTION

Corporate sustainability, a much-hyped concept just over a decade ago, has entered its maturation phase (Brockhaus et al., 2017; Waller et al., 2015). Despite this, many firms' efforts continuously pursue high-level sustainability targets. For example, Amazon promotes to their shoppers that "*Amazon's sustainability efforts span our company, our products, and our geographies*" (Amazon, 2019). Nestlé reassures they "*can shape sustainable consumption and steward resources for future generations*" (Nestlé, 2019). We propose that it remains dubious for most companies how these goals inform day-to-day decision-making and translate into tangible sustainability improvements (Wright and Nyberg, 2017). Apparently, many companies assumed that their vision for sustainability would somehow "trickle down" into the fabric of their organization and permeate their supply chain.

We propose that *sustainable products* should be the true manifestation of corporate sustainability. Further, we suggest that many companies neglected proactively engraining sustainability into their New Product Development (NPD) processes. We view NPD as a key supply chain management process (Rogers et al., 2004). While it has been argued compellingly that corporate sustainability should become a strategic organizational and supply chain goal (Porter and Kramer, 2006; Reuter et al., 2010), we suggest that the confinement of the notion to the "C-Suite" emerges as a key impediment to its manifestation in companies' product portfolios. Work by Claudy et al. (2016) and Alblas et al. (2014) highlights the missing link between sustainability strategy and NPD. The authors emphasize a lack of research in this realm – especially with respect to understanding the perspective of product developers.

The challenge of developing new products or redesigning products to enhance their sustainability is closely linked to building development capabilities in the company to progress towards more environmentally and socially responsible products. Specifically, firms need to ramp up their NPD to bring more sustainable products to market (Kammerl et al., 2017). Only if a company can ensure the effective incorporation of economic, environmental, and social aspects (Triple Bottom Line – TBL) into their NPD process, can it be successful in achieving this goal (Dyllick and Rost, 2017; Petersen, 2019). Therefore, this paper is *timely* as it attempts to provide a reality check for the achievements of sustainability in NPD. We take a closer look at the challenges companies face when pursuing this integration. Specifically, we provide insights

into the research question: "*How can companies effectively make sustainability considerations an integral part of their NPD process?*". This research question is *relevant* because it is only via making sustainability a fundamental part of NPD that firms can master the challenge of significantly increasing product sustainability acceptance in the mass market. For many companies, product sustainability has in the past not been part of their core philosophy or corporate DNA but rather an add-on to existing portfolios (Petersen, 2019). In many cases, this resulted in "quick-fixes" as opposed to fundamental product redesigns.

This paper focuses on the challenge of aligning a company's strategic sustainability approach with its integration into the NPD process. We identify different types of firms concerning their understanding and integration of the notion of product sustainability in their business processes. We explore different avenues that emerge for these firms to more effectively operationalize the strategic focus on sustainability in their NPD efforts. We employ the Resource-Based-View (RBV) of the firm (Barney, 2001, 1991) as the theoretical lens for our analysis. Specifically, we apply the theory's tenets to companies from our sample and propose an addition to the RBV as it relates to the context of product sustainability. The paper makes three distinct contributions:

1. We characterize three different approaches companies from our sample pursue towards translating sustainability strategy into their supply chain operations – specifically NPD.
2. We explore the role of product sustainability and the underlying development process as a source of competitive advantage based on the RBV and propose an extension of its theoretical tenets.
3. Based on our empirical data and their juxtaposition with theory, we establish the proposition that only one of the three identified approaches to operationalizing product sustainability is well-equipped to enhance the pursuit of sustainability-oriented products for the mainstream market. Specifically, we propose that these development efforts stand out due to a quality we have termed *Scalability*. We establish why the notion of scalability emerges as a crucial differentiator with respect to the competitive potential of NPD efforts around product sustainability and discuss the resulting implications for supply chain managers and product developers.

REVIEW OF THE LITERATURE: DEVELOPING SUSTAINABLE PRODUCTS

NPD is a cross-functional process covering all necessary engineering activities but also extending to functions like marketing and operations. Thus, it should be considered a core supply chain process (Rogers et al., 2004). An extensive body of literature deals with integrating different aspects of sustainability into product development processes – a challenging and long-term-oriented task (Dangelico et al., 2013; Gmelin and Seuring, 2014a). Thomé et al. (2016) identify over 1,500 relevant peer-reviewed publications. This strong interest can be explained by the eclectic aspects of sustainability in the NPD context, ranging from simply omitting toxic materials to designing inclusive products that are universally accessible. Further, the multidisciplinary nature of NPD makes the field appealing to researchers from diverse domains.

To provide an introductory overview of the large literature body, we adopt a structure by Alblas et al. (2014). It distinguishes NPD as the target system, general management as its controlling organ, and the external context. General management is specified concerning (1) its strategy, vision, and targets and (2) the cross-functional coordination of necessary resources. NPD is specified through (a) existent sustainable design expertise, (b) support through processes, tools, and methods, and (c) sustainability-related scopes and targets. Figure 1 provides an overview of the structure. Please note that the overview is not meant to be exhaustive but to introduce the academic context our study is situated in.

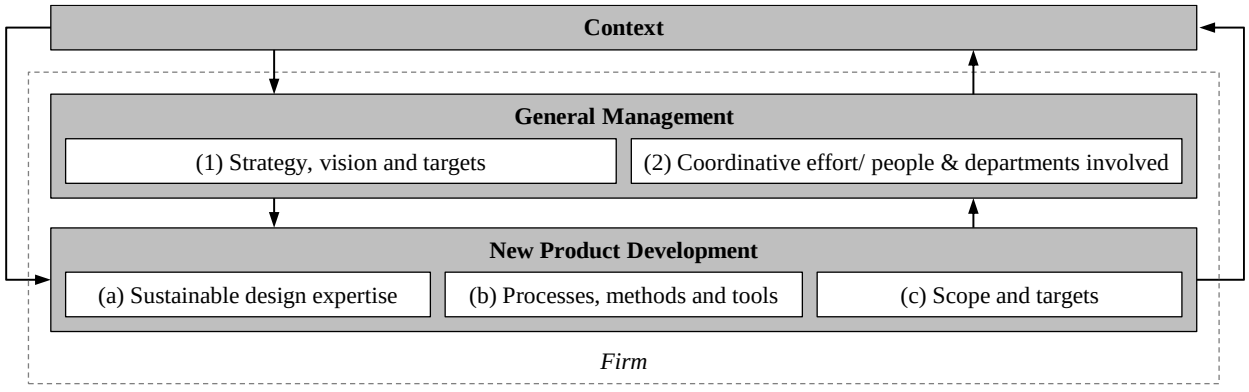

Figure 1

Context

There is a consensus that sustainability efforts are not only internally driven but also result from a range of external factors like regulation, customers, and competitors (Gmelin and Seuring,

2014b). A considerable part of the literature is dedicated to investigating such external factors. Dangelico (2016) finds current and expected regulations and policies to be the predominantly mentioned factor, followed by market demand and stakeholder pressure. However, other factors like external technological developments, the political environment, media attention, cross-industry networking activities, and rival products are also found to be part of the context which NPD is embedded in. Some authors further look into specific factors. For example, Lion et al. (2016) investigate the role of suppliers' sustainability activities.

General Management

Strategy, vision, and targets: Most companies integrate sustainability into their corporate strategy or vision (Lozano, 2015). Thus, a lot of research is devoted to investigating sustainability at the corporate level. For example, Baumgartner and Ebner (2010) identify different profiles and maturity levels of corporate sustainability. Related to this, Dyllick and Muff (2016) differentiate three levels of corporate effort to embrace sustainability. Further, literature looks into the management of conflicting sustainability targets at the strategic level (e.g., Hahn et al., 2010)

Coordinative effort: Other authors investigate the coordination of resources, people, and departments on a company or supply chain level – a task that is acknowledged to be of critical importance for the implementation of sustainability principles. Gerstlberger et al. (2014) look into the link between sustainable NPD strategies and efforts to improve energy efficiency in production. Their findings underline that aligning process and product innovation is a complex coordination activity. Ford & Despeisse (2016) also investigate the interplay of process and product, demonstrating how additive manufacturing technologies might enhance the leverage of product developers to improve product sustainability. From a supply chain perspective, several papers investigate whether a company's willingness to collaborate with suppliers and customers has an effect on product sustainability (e.g., Dangelico et al., 2013).

Product Development

Sustainable design expertise: A range of papers illuminate aspects of sustainable design expertise in NPD (e.g., internal knowledge management or knowledge acquisition from external sources). Aschehough & Boks (2013) argue that the availability of sustainability information is a

prerequisite for building sustainability expertise. They develop a framework for synthesizing a wide variety of relevant information categories. Strömberg et al. (2015) analyze which opportunities exist for product developers to induce sustainable product uses through their design. A specific subset of the literature looks into the importance of human factors in the development process. Verhulst & Boks (2012), for example, investigate the role of individual resistance against sustainability improvements.

Processes, methods, and tools: The largest part of the literature pertains to developing and advancing processes, methods, and tools for the development of sustainable products. A recent review by Petersen (2017) revealed that around 60% of the papers are such conceptual contributions. They range from simple checklists to more sophisticated expert systems. For example, Johansson (2008) proposes a checklist of product properties for efficient disassembly. Schöggl et al. (2017) develop a comprehensive qualitative assessment based on a set of 50 questions and an iterative improvement process. In fact, the variety of methods and tools is so large that reviews and even tools for selecting methods have become their own field of research (Buchert et al., 2017). Literature also reports that only a few of these methods are deployed in companies (Held et al., 2018). Many of them require vast amounts of input data and are too complex for everyday use (Alblas et al., 2014; Hopkins, 2010) or are not otherwise adaptable to specific company needs (Clancy et al., 2013).

Scope and targets: Another prerequisite for a purposeful application of any decision-supporting method in practice is the existence of a clear project scope and quantifiable sustainability targets (Hallstedt et al., 2013). They define the design space, thereby allowing projects to be steered and managed effectively (Alblas et al., 2014) – targets are essential for every successful development project (Kammerl et al., 2017). Kono et al. (2018) identify more than 500 sustainability indicators from a literature review. Clancy et al. (2013) develop an approach to select case-specific sustainability indicators. However, selecting them is only half the battle, as indicators have to be operationalized through clear targets. Empirical studies show that companies face huge difficulties breaking down high-level sustainability commitments into operational targets (e.g., Alblas et al., 2014; Schulte and Hallstedt, 2017). Since sustainability is a multidimensional concept, it could only be approximated by a range of individual indicators and targets. In addition, these targets often provoke inherent trade-offs with other product

aspects like functionality, quality, appearance, and costs (Driessen et al., 2013; Gmelin and Seuring, 2014a).

Our literature overview highlights that a consistent integration of strategic sustainability targets with NPD efforts remains elusive. Without clear sustainability targets at hand, product developers have a hard time prioritizing their available resources (Kammerl et al., 2017) or justifying further investments into sustainability initiatives (Alblas et al., 2014). Thus, providing NPD with a clear sustainability scope and set of targets is a crucial success factor for improving product sustainability (Dangelico, 2016; Hallstedt et al., 2013). Despite the vast body of conceptual research, avenues to connect high-level sustainability targets with quantifiable and measurable product innovation and development goals remain underdeveloped (Schulte and Hallstedt, 2017).

THEORETICAL BACKGROUND: SUSTAINABLE NPD AS A RESOURCE

The Resource-Based-View (RBV) of the firm has been suggested as a suitable theoretical background for sustainability research (e.g., Connelly et al., 2011) and has been successfully employed to provide an explanatory framework for sustainability-related phenomena.

The RBV views the firm to be comprised of different kinds of resources that are put to use to achieve success for the company (Barney, 2001, 1991). These resources have to be *valuable*, *rare*, *inimitable,* and *non-substitutable* (VRIN) so as to build a competitive advantage (Barney, 2001). The RBV is a key perspective used to explore sources for firms to differentiate themselves from competitors and build a sustainable advantage in the marketplace (Wernerfelt, 1984). Resources can include everything the firm has at its disposal such as capital, assets, skills/knowledge, processes, supply chain relationships, etc. Product development capabilities and processes are specifically recognized as a resource in the understanding of the RBV because these skills can be very hard to replicate by competitors, especially in a timely fashion (Verona, 1999).

Conceptually, all possible resources can be evaluated with respect to the VRIN principles to determine if they have the potential to drive company success. Thus, the RBV lends itself well as a theoretical lens to research efforts that aim to assess the strategic competitive potential of a firm's resources in the present and further down the road (e.g., Finney et al., 2008). As such, said

resources should not only have the potential to facilitate immediate company success but also to ignite and sustain firm growth and proliferation in the marketplace (e.g., Oliver, 1997; Pettus, 2001). Hence, while not explicitly detailed as part of the VRIN principles, the RBV perspective can be employed for analyses that consider the longevity and adaptability of resources in a changing environment (e.g., McDowell et al., 2016). These considerations are especially pertinent in the context of innovation and product development (Taneja et al., 2014).

Hart (1995) proposed the Natural-Resource-Based-View in an effort to establish environmental considerations as part of the spectrum of resources that firms can leverage to build a competitive advantage. Along the same lines, other extensions to the RBV such as the Stakeholder-Resource-Based-View (Sodhi, 2015) that focus on social concerns have been proposed too. Both environmental and social concerns have become commonplace on a strategic level in the corporate realm (e.g., Dyllick and Muff, 2016; Hart and Dowell, 2011) and the key focus of this paper is to explore their translation into tangible NPD efforts. Thus, we suggest that a broad RBV perspective which treats all components of the TBL as potential resources is best suited as our theoretical lens without the need for an additional qualifier.

Companies need to build capabilities which they can leverage to be able to integrate sustainability into their NPD. For example, if a firm explores new materials such as bioplastics to enhance product sustainability, they have to learn to adapt their process technology to different material behavior and specifications. Developing new materials and manufacturing processes can be a promising way of improving product sustainability, but it requires new skills, knowledge, and technologies – in short: resources in the sense of the RBV.

METHODOLOGY

This research builds on a grounded theory (GT) approach. GT allows to record, interpret, and abstract subjective experiences into theoretical statements about the phenomenon under study (Fendt and Sachs, 2008). It links well to practice and has been successfully employed for exploring operations and supply chain phenomena (e.g., Binder and Edwards, 2010; Wowak et al., 2016). We follow the GT guidelines put forward by Corbin and Strauss (2008) as we consider them more pragmatic and well-suited for our research question. Overall, we adopted a "total research quality management" process as introduced by Caniato et al. (2018).

Sampling and Data Collection

We composed the sample with the goal of gaining diverse insights into how manufacturing companies from the consumer goods industry strive to integrate sustainability into their NPD efforts. Since we employed theoretical sampling, we selected suitable case companies with the aim of adding novel perspectives (Corbin and Strauss, 2008). Thus, after each round of data collection and analysis, we evaluated which additional data was needed to refine our findings. For example, after learning about the specifics of consumer electronics (#25), we interviewed two participants working on power tools (#26 and #27). This allowed us to compare the challenges of considering sustainability across different categories of electronically-powered products. Most interviewees bear responsibility for the entire development process – starting with idea generation and only ending with introducing the product into the market. Thus, they have an interdisciplinary view on the topic as they interface with other internal functions like logistics or marketing but also with external supply chain partners. Figure 2 shows the study's participants.

#	Consumer Goods Category	Position of Interviewee
1	Household Commodities	(1) General Manager and (2) Marketing Manager
2	Apparel	Procurement and Sustainability Manager
3	Household Commodities	Head of Product Development
4	Leisure and Sports Equipment	Head of Product Development
5	Medical and Therapeutic Products	Head of Product Development
6	Household Commodities	Vice President Product Management
7	Domestic Appliances	(1) Head of Product Development and (2) Designer
8	Household Articles	Head of Product Development
9	Domestic Appliances	Head of Research & Development
10	Household Articles	Product Manager
11	Furniture and Lighting	Director of Product & Sourcing
12	Household Commodities	Head of Product Development
13	Stationery	Director Research & Development
14	Personal Items	Head of Design
15	Stationery	Head of Research & Development
16	Personal Items	Chief Executive Officer
17	Toys	Senior Manager Product Development
18	Home and Garden Commodities	Head of Product Development
19	Leisure and Sports Equipment	Head of Product Development
20	Stationery	Head of Product Development
21	Body Care Products	Team Leader Product Development
22	Domestic Appliances	Head of Product Development
23	Federal Authority	Expert for Sustainable Consumption
24	Body Care Products	Manager Basic Research
25	Consumer Electronics	Director of Product Development
26	Home and Garden Tools	Head of Product Development
27	Home and Garden Tools	Head of Research & Development
28	Home and Garden Commodities	Head of Product Development
29	Consulting	Consultant for Sustainable Products
30	Consumer Electronics	Head of Product Design
31	Leisure and Sports Equipment	Manager Product Development
32	Body Care Products	Manager Research & Development

Figure 2

Beyond the consumer goods category, we strived to consider different perspectives towards the inclusion of sustainability ideas during development projects. For example, companies with different degrees of vertical integration, different competitive strategies, and different types of ownership are represented in the sample. Almost half of our interviewees represent small and medium-sized companies (SME) as defined by the European Commission (2015). This coincides with the factual demographics of the consumer goods industry in our sample country (Germany) (Kern, 2010). Of note, this does not mean that the current sample and research approach were designed to provide a statistically representative sample. All case companies are either German

companies or (in two cases) German subsidiaries of international companies. All companies do business across the European Union, and a majority of the sample distributes their products globally. Further demographic information about the sampled firms is also included in Figure 3.

We conducted in-depth semi-structured interviews for data collection. An interview protocol allowed for both structuring the discussion and facilitating the exploration of emerging themes (Charmaz, 2014; Corbin and Strauss, 2008). The questions were open-ended and concerned with (1) the development process characteristics, (2) the role of sustainability and relevant drivers on the strategic company level, and (3) the consideration of sustainability through various NPD aspects. The interview protocol is provided in Table 1. However, we were careful to follow where the interviewees led us. Thus, we adapted the questions depending on the progression of the interview and the characteristics of the case companies (Charmaz, 2014).

Table 1: Interview Protocol

Section	**Questions**
Introduction	Please provide a brief overview of your company and your responsibilities within the company.
Organization of Product Development Process	How do you structure your product development process?
	How do you make fundamental development decisions? How is the decision-making authority distributed among product development members?
	How do you integrate supply chain partners into your product development process? What challenges do you face?
Sustainability	How do you define “sustainability” within your company?
	Why and how is your company getting involved with sustainability? How are activities related to sustainability institutionalized within your company?
	Who can be seen as a major driving force for sustainability activities within your company?
Development of Sustainable Products	How do you define “sustainable products”? What makes a product sustainable?
	Can you share an example of a sustainable product your company has brought to market?
	How do you integrate sustainability into your product development process? How do include supply chain partners in joint development efforts? What challenges and barriers do you face in the collaborative development of sustainable products?
	How do you identify trade-offs with respect to sustainable products? How do you manage these tradeoffs?

In total, we conducted 32 interviews which varied in duration from 25 to 140 minutes (median of 68 minutes). Such an interview sample is comparable to similar studies from the supply chain

context (e.g., Binder and Edwards, 2010; Wowak et al., 2016). The interviews took place at the companies' sites whenever possible. We assured the anonymity of the interviewees to encourage open information sharing and create an informal atmosphere (Gioia et al., 2012). With the approval of the interviewees, we recorded and transcribed all but two interviews. To further inform the analysis, we collected supplementary data on companies' efforts to consider sustainability during NPD. This included extensive publicly available data like sustainability reports or test reports in magazines. Also, several interviewees provided us with documentation on specific sustainability issues or development aspects (e.g., material analyses or development guidelines) and offered supplemental site visits. Taken together, our secondary data provided a comprehensive context for the experiences the interviewees shared with us.

Data Analysis

Sampling, data collection, and data analysis were part of an iterative process (Corbin and Strauss, 2008). First, we analyzed each interview individually so as to gain insights into the companies' takes on product sustainability. Then, we employed a cross-case analysis to identify and match patterns across the sample. Following the inductive research process, we traveled back and forth between the data and the theoretical arguments in pursuit of a more robust and comprehensive theoretical picture (Charmaz, 2014). To improve validity, data analysis was carried out individually by multiple researchers (Corbin and Strauss, 2008).

The analysis followed the guidelines and recommendations established by Charmaz (2014), Corbin and Strauss (2008), and Gioia et al. (2012). It consisted of three steps. First, we established *first-order codes* by breaking down the transcripts into small and manageable fragments. We then identified statements regarding the interviewees' views on the role and relevance of sustainability within their organizations and their organization's approach to managing sustainability on the product level. After this, we categorized and distilled common ideas into first-order concepts. Second, we used *axial coding* to create second-order themes: As proposed by Charmaz (2014), we clustered the first-order concepts according to underlying themes which marked larger common ideas among them. To identify meaningful themes, we analyzed all text segments from the interviews that were coded into each of the first-order concepts. Third, during *theoretical coding* we juxtaposed the themes for the axial coding process with the RBV to derive implications from and for theory in an iterative process.

FINDINGS

From the axial coding process, three distinct approaches firms take towards making sustainability part of their NPD efforts emerged: Specifically, we identified (1) firms that approach sustainability as a novel and "hot" topic and attempt to integrate the notion into their NPD for separate, special product lines – "The Dabblers", (2) companies that have the notion of sustainability ingrained as part of their corporate DNA and therefore integrate the issue naturally into their NPD – "The DIY-Ecopreneurs" (DYI = Do It Yourself), and (3) companies that strive to integrate sustainability into their general NPD processes through rigorous codification and measurement systems – "The Codifiers".

Figure 3 provides a summary of the proposed classification and shows the distribution of the three identified approaches across the sample. As the figure shows, the majority of the companies in our sample fit the Dabblers approach. With respect to size and ownership structure, Dabblers are a diverse group of companies with no clear patterns. Three companies from our sample fit the DIY-Ecopreneurs category. While this is the smallest number of firms from our sample, this meets the minimum threshold for the current qualitative case analysis (Eisenhardt, 1989). Again, we find different sizes of firms and a mixed ownership structure. Finally, six firms from our sample led us to establish the Codifier approach. While all six firms in the group are large, privately held companies, we propose that this approach to developing more sustainable products is not systematically limited to firms from that demographic. For this study, we specifically interviewed product developers from the sampled firms with a strong focus on their understanding and operationalization of sustainability and their company's efforts to include product sustainability in the development process (see Table 1 for interview guide). The three emerging categories thus specifically pertain to the firm's approach towards integrating sustainability in the product development process and are not to be misunderstood to represent a broader "type" of company on a larger scale.

The three approaches towards developing more sustainable products emerged from the interviews with product developers. While the study by design is not statistically representative, we propose that the emergent classification is strongly informed and driven by the data analysis. Of note, a plethora of demographic and other factors beyond size and ownership structure (e.g., industry, company history, leadership style, product life-cycles, etc.) likely indirectly influence

which approach towards developing more sustainable products a firm's product developers gravitate to (or if sustainability matters at all) and the specific permutation of that approach for each individual firm. However, given the qualitative research design and the subsequently not-statistically-representative sampling, we are naturally unable to systematically "control" for these kinds of factors. We will further discuss this in our limitations section and establish suggestions for future research that can potentially address these factors.

		The Dabblers	The DIY-Ecopreneurs	The Codifiers
Strategic ↕ *Operational*	**Motivation to Pursue Sustainability**	Fear of missing out	Sustainability as a calling (engrained in company DNA)	Opportunity to build a competitive advantage
	General Approach to Sustainable Innovation	Not conceptualized, awaiting trickle down; no trade-offs for profits	Sustainability imperative; willing to sacrifice profits and scale	Structured rollout, continuous improvement; economic imperative but accepting trade-offs
	Operationali-sation in Product Development Process	Serendipitous, unstructured, awaiting trickle down; no management mandate	Exploring all opportunities, comprehensive but only loosely structured; implicit management mandate	Proactive and fully structured via codification, systematic impact analysis and focus on key levers with clear improvement targets; explicit management mandate
	Resulting Sustainable Product Offering	Marginal improvements, confined to Test Balloons, no scale across portfolio	Best possible sustainability performance, focus on radical design changes, very limited portfolio, often single-product-companies	Both incremental and radical innovations, selection driven by impact, scaled across portfolio if possible
Sample	**Number**	21	3	6
	Size	8 SME / 13 large	2 SME / 1 large	6 large
	Ownership	16 private / 5 public	2 private / 1 public	6 private

The Dabblers

The Dabblers pursue an opportunistic approach to sustainability: The trend is apparent -> Opportunities in the marketplace exist -> We need something to show on the sustainability front: *"I believe sustainability is an emerging trend. And if you miss jumping on this trend, in five years you might stand there with the egg on your face if you are not on top of the game by then."* **(#30, Consumer electronics)**. While these firms often approach the topic with urgency, they distinctly lack an operationalized philosophy and an institutionalized process: *"Sustainability is rather something on a gut level, and it also depends on the product manager or the person in charge of*

development." **(#31, Leisure and sports equipment)**. For these firms, sustainability is not an integral part of their development guidelines: *"Well… we consider sustainability in our minds. (…) Yes, I think it's really more of a notional thing until now. Sustainability is not yet backed up methodologically in our development process."* **(#21, Body care products)**. Rather than grounding their efforts in a holistic framework or strategy that informs their entire product portfolio and the corresponding development processes, the Dabblers mostly operate in an opportunistic fashion: *"We got these questions from our customer base what we are doing in sustainability. (…) We needed to do something and quick. So we went with recycling because it came to mind first. It gives us something to share, you know?"* **(#1, Household commodities)**. The impression that many Dabblers are focused on having a story to tell was also shared by one participant who observes the market from a sustainability-oriented governmental agency: *"They just pick one little issue out of the buffet of options to enhance sustainability and implement it as a quick win for a new product line because they really lack the commitment to systematically overhaul their entire production."* **(#23, Federal authority)**.

However, companies that follow this avenue don't necessarily take the topic lightly, let alone approach it in a cynical manner. While there might be voices in the organization which are truly committed to pursuing the notion, many product developers struggle with the freedom and time to deeply engage with sustainability: *"We always have to develop new products quickly. That is why we often build on existing products and adapt them. If you truly want to make a product more sustainable, you have to pursue this with more time on your hands and with another approach."* **(#17, Toys)**. Therefore, firms following the Dabblers' approach often isolate the issue to a specific product line that complements rather than replaces their standard products: *"It is still a small share of the collection that actually is made from organic cotton. But at least we are doing something, right?"* **(#2, Apparel)**. As this quote exemplifies, Dabblers mostly rely on exchanging raw materials (e.g., cotton) to improve product sustainability as opposed to actually altering product designs. They further clearly articulate that they do not expect their firms to roll out the changes to improve product sustainability to the entire portfolio but rather confine these design decisions to the "eco" line with a luxury appeal and the corresponding price tag: *"For this particular line, we chose raw materials costing more than 100 Euros per kilogram. That is something we would never do elsewhere because normally you have prices ranging from two to*

ten Euros." **(#3, Household commodities)**. Due to the limitation of sustainability to specific and more expensive product lines, these firms are not necessarily deeply committed to the issue and in several instances reported terminating their efforts in lieu of immediate customer demand: *"In the end, the consumers did not embrace it as we hoped they would. That is why we said: OK, either we are not ready yet, or the consumers do not look for these kinds of products with our brand. And then we pulled the project for now."* **(#17, Toys)**. Dabblers usually do not have an inherent motivation or personal conviction of making sustainability a feature of their products. Their efforts are driven by putative consumer demand and are potentially abandoned if such hopes fail to materialize quickly.

This rather opportunistic approach to sustainability is also reflected in the NPD process. For these firms, the notion of sustainability is not formalized as a design target in the process and is often not measured systematically: *"In our product development process, sustainability is not very high on the agenda. I mean, it is not that we ever established certain criteria to ensure that we are especially environmentally friendly or something."* **(#4, Leisure and sports equipment)**.

In summary, all of this leads to a lack of commitment to sustainability as part of the product development-, company-, and supply chain strategy. The decision to separate the notion of sustainability to specific product lines that mostly complement the existing portfolio rather than consequently replacing less sustainable products is symptomatic of a lack of grounding sustainability in the fabric of the organization.

The DIY-Ecopreneurs

The DIY-Ecopreneurs are a unique organizational demographic. These companies are not only focused on sustainability; they have the very concept as their founding philosophy. One interviewee summarized this "Do-It-Yourself" attitude pointedly: *"We have been eco-freaks from the start, we never really thought about it. We have no plan. We just do it because it is our conviction."* **(#8, Household articles)**. These firms have never made a specific effort to ingrain sustainability into their NPD because it simply comes naturally to them: *"Sustainability is something anchored deeply inside the company and not something driven by some trend or greenwashing activity."* **(#32, Body care products)**.

Often, the founders of such companies strived to provide a sustainable alternative for a certain product category close to their heart: *"Our products are designed for babies, and I just got involved in manufacturing in this area because I couldn't find anything I thought safe enough for my own kids. I was working in retail for these products, so I knew what is out there – and there was nothing with a convincing sustainability record."* **(#16, Personal items)**. Importantly, these companies did not originally pursue sustainability because of market demand or with a potential competitive advantage in mind; they simply began to create sustainable product alternatives which they themselves were missing as consumers. Naturally, these firms are for the most part small organizations with strong and conviction-oriented founder personalities. Often, these firms started out as design workshops with a specific – sustainable – product in mind and evolved into companies, more by necessity than by design. This avenue to making sustainability part of NPD can be highly successful and is often driven by an uncompromising conviction to resist economic imperatives: *"I consider it a luxury to say: 'This material is more expensive, but since it is more environmentally friendly we take it anyway.'* **(#8, Household articles)**. However, this "luxury" naturally comes at a price: This approach is very challenging to scale beyond a niche market, and can only survive if vigorously protected by the leadership of the firm: *"Maybe the fact that we put responsibility before growth and profit maximization distinguishes us from other firms. But I wouldn't have it any other way. Sure, we could have been laughing all the way to the bank or grown significantly larger, but that's not what I am about. For us, sustainability always beats profit and sales."* **(#8, Household articles)**.

Therefore, we propose that the avenue of "ecopreneurialism" is unattainable for existing firms unless sustainability is their founding philosophy. Ecopreneurialism may not be retrofitted to alter the Gestalt of the firm. Furthermore, DIY-Ecopreneurs from our sample hinted at the limitations of their own approach to sustainability and business: *"We have been eco-freaks for years, and now suddenly this topic is hot. And now, large enterprises start their planned campaigns. And sometimes I get the feeling that they will pass us on the left and the right because they do it systematically. It always felt natural for us, and it has always been this way. And therefore, we struggle to leverage it."* **(#8, Household articles)**.

The Codifiers

Despite not having sustainability ingrained into their founding philosophy, Codifiers see the issue percolating up rather than trickling down: *"For our brand, we set up green and social development guidelines to define and cement this holistic sustainable development. It is like a constitution that we are writing for our brand. Thus, there are rules and standards that the products have to comply with. We are continuously working on codifying sustainability in the DNA of the brand."* **(#12, Household commodities)**. As suggested by this participant, Codifiers are empowering their NPD teams with tools and guidelines to make sustainability opportunities an integral part of their NPD process. It is the very notion of systematically addressing the issue as part of their NPD through rigorous measurement and sustainability goals which sets these firms apart from the other two company categories.

In contrast to the DIY-Ecopreneurs, Codifiers have not experienced a natural presence of sustainability in their organization but have embraced the issue as an impetus to set evolution in motion. These firms often have a long tradition and leverage their experience and organizational prowess to use sustainability as a catalyst for change: *"Being an old dinosaur, we have to change. For us, sustainable development is actually a continuous process because you cannot tear everything down in an instant. Of course, we have to take your consumers along."* **(#12, Household Commodities)**. Codifiers are committed to reacting to consumer demand, yet they are not necessarily waiting for a majority of their customer base to push for sustainability: *"We continuously work on getting better and better regarding sustainability. (…) Even though some improvements might only be relevant for one percent of our consumers. We are not waiting for our customers to push us, but we want to take them by the hand and lead the way."* **(#12, Household commodities)**.

In stark contrast to the Dabblers, Codifiers are committed to making sustainability part of their entire product portfolio as opposed to just an additional product line: *"We consider sustainability for every single product. Otherwise, we would be asked: why don't you do that for the other products as well?"* **(#6, Household commodities)**. They are determined to roll out experiences from individual development projects to their full product portfolio. To facilitate the capability-building-process, Codifiers are willing to make investments. This concerns budgets for exploring new development options as well as knowingly accepting hits on the profit margin: *"We would go for the more sustainable option even if this implied having 10 percent or*

20 percent lower margins on our products. We would put up with that; this is a clear directive from our management." **(#15, Stationery)**. As implied by the previous participant, the decision to put sustainability investments over short-term profits is by no means a decision product developers have to make "midair" – they are still acting with a clear mandate from executives. Additionally, Codifiers have ingrained sustainability into the organizational structure across the board, rather than isolating the notion in a designated functional unit: *"There is no need for a staff function urging people to please consider sustainability. Sustainability is a core value for our company."* **(#22, Domestic appliances)**. Intuitively, these companies know that making sustainability just the responsibility of a function would undermine the commitment of the rest of the organization. They know that trickle-down-sustainability is an elusive concept: *"Our executive director says that sustainability must not be assigned to a staff function. Then everyone in the company would say: 'Let them take care of it.' For him, it is clear that it starts from the top – with him. And it will only flourish if it grows out of the base of the organization."* **(#12, Household commodities)**. Please note that while these developers acknowledge the need to trigger sustainability at the top, they point out that this can only be the start. Developers are painfully aware of the need to engrain the notion into the Gestalt of the company and as a metric to assess performance.

DISCUSSION AND JUXTAPOSITION TO THEORY

We find that all firms from our sample view product sustainability as an opportunity to engage with their customer base and evaluate possibilities to derive competitive advantage. However, we propose that only two of the three approaches are well-equipped to build capabilities that qualify as VRIN resources in the sense of the RBV: *DIY-Ecopreneurialism* and *Codification*. Further, driven by our iterative data analysis process, we suggest that the VRIN principles of the RBV should be augmented as they relate to product sustainability. In the following, we will first establish why and how we have refined our theoretical lens and, in a second step, discuss our resulting perspective and insights.

Augmenting our Theoretical Lens: Introducing Scalability to the RBV

As we detailed in our theoretical background, the RBV lens can take into account the longevity, adaptability, and growth potential when assessing the value of resources. However, we propose

that this perspective is not explicitly captured by the VRIN principles. During our data analysis, the question if the development approach was capable of delivering more sustainable product solutions that can drive company growth emerged as a major theme. Specifically, developers from our sample questioned how they could create more sustainable design solutions that can attract a broader target audience, have the potential to be employed across a larger portfolio instead of just one specific product and can be continuously refined to remain valuable for the firm as it matures through its lifecycle. As a result of axial coding, it emerged that these questions trace back to a fundamental property of the product development approach itself. Namely, whether the development approach is designed as a system that can dynamically adapt in size, scope, and rigor as efforts mature. During theoretical coding, we found that this property mirrors a concept that the academic literature refers to as the *scalability* of a system. Scalability is discussed in academia across different contexts. Stampfl et al. (2013) conducted a systematic literature analysis around the term and found that more than 80% of the studies were in information technology, 9% in the business literature, and 8% in various other fields.

In the information technology context, scalability connotes the capability of a system to accommodate a growing number of objects or an increasing workload (Bondi, 2000). For example, regarding mobile data networks (e.g., 5G) scalability connotes the ability of the system to dynamically allocate the number of network resources based on demand forecasts (Alawe et al., 2018). Thus, the fundamental idea of scalability in information systems is that the size of the system, as well as its scope, can be dynamically adjusted over time and according to emerging needs (Ross et al., 2008).

Another stream of literature discusses scalability at the cross-section of information technology and business strategy. For example, Hallowell (2001) establishes the scalability of e-commerce systems as their ability to accommodate growing customer and order numbers as well as handle an increase in services and functions effectively and efficiently. Other authors such as Rappa (2004), Bouwman & MacInnes (2006), and Stampfl et al. (2013) build on the notion of the scalability of e-commerce systems and connect it to the scalability of the underlying business model. Beyond just the technical scalability of the IT system, these authors emphasize the economic scalability where the system has to be able to grow revenue generation faster than

cost. Further, they caution that a business model is only truly scalable if it can grow without hurting its value proposition or abandoning its strategic principles.

Scalability is also discussed outside of IT or e-commerce. For example, Wang & Koren (2012) explore the role of scalability for reconfigurable manufacturing systems. They emphasize the importance of cost as well as quality considerations during the dynamic capacity allocation process. In another field, Dyer and Ericksen (2005) promote "human resource scalability" – namely the capacity of an organization to design and implement a management system for their human resources that can efficiently deliver the right people to the right place throughout the firm's lifecycle and can grow or contract along with changing company size. They emphasize that the system is only truly scalable if it can remain true to its core values regarding a fair treatment of its stakeholders.

For our conceptualization of scalability in the current context of development approaches for more sustainable products, we lift the following principles from the reviewed literature: Fundamentally, the system must be able to dynamically adapt in size and scope based on evolving needs and outside influences. Further, this adaptation must be economically viable. Lastly, the system must be able to remain committed to the underlying value proposition and principles of the firm. To operationalize this concept for the following analysis, we define the scalability of the product development approach as the ability to (1) be cost-effectively leveraged across a firm's product portfolio (scope), (2) have the potential to economically grow the firm beyond niche existence (size), and (3) maintain the commitment to core sustainability values over time and company growth (principles).

Based on this definition, we propose to add Scalability as the fifth principle to the RBV lens for this analysis, resulting in the VRINS principles. We will evaluate all three identified product development approaches with respect to the *VRINS* perspective and mirror them with the literature around product sustainability. While the three distinct approaches to pursuing sustainability during the product development process are grounded in an analysis of the full sample of 32 companies, we will discuss one exemplar for each approach in detail to provide a more tangible discussion.

The Dabblers: Waiting for Sustainability to Trickle Down

While Dabblers may be able to capture serendipitous rents from adding a more sustainable product line to their portfolio (making them potentially *valuable* in the sense of VRINS), our data clearly show that a lack of commitment and willingness to fundamentally rethink their products leads to a mere flash in the pan on sustainability performance and does not build lasting capabilities. Dabblers often make rather cosmetic changes to their products so as to enhance sustainability with respect to a narrow consideration such as replacing a single ingredient or making the packaging more recyclable. Going back to several quotes in the findings section on Dabblers, these product developers clearly point to a lack of systematic measurement of sustainability performance and acknowledged that meaningful changes would require larger-scale efforts. To put their efforts in perspective to the reviewed literature, Dabblers only pursue efforts on the level of employing simple tools and design tweaks without embedding them in any kind of systematic approach (e.g., Schöggl et al., 2017). Design decisions are also not grounded in any kind of analysis with respect to the impact on the sustainability performance (e.g., Alblas et al., 2014; Hopkins, 2010). Thus, based on their own evaluations, none of the Dabblers from our sample could even roughly gauge by how much or even if their changes had improved sustainability performance. This leads to a distinct lack of connection of their one-off tweaks to the company's sustainability strategy (if one was actually recognizable). Thus, Dabblers' efforts are confined to a single area of the target system on an operational level (Figure 1). Furthermore, most of the Dabblers' sustainability-oriented NPD efforts are based on the skills of supply chain partners. As such, Dabblers generally do not establish any significant design expertise (which would be a resource in the sense of the RBV).

Finally, Dabblers' incremental improvements are exclusive to designated "eco" product lines which complement the existing portfolio as opposed to replacing less-sustainable products or rolling them out across the full spectrum. Inherently, these efforts do not lead to the building of capabilities within the firm. Rather than actually changing product designs or processes internally to achieve improved product sustainability, several Dabblers from our sample simply switched out suppliers for individual raw materials. Because they rely on suppliers' resources, they can easily be sourced by the competition. Thus, they are neither *rare* nor *inimitable*. Due to the fact that they are incremental in nature and remain confined to boutique product lines, they

are often interchangeable with other tweaks to the products. Thus, they are *substitutable*. The lack of embeddedness of any sustainability criteria in the NPD effort does not result in any institutional learning that can be scaled beyond the specific issue at hand. Revisiting our definition of scalability, we conclude that Dabblers neither leverage sustainability across their full product portfolio, nor build capabilities to foster growth, nor show any efforts to engrain core values in their development processes to maintain consistency over time. In consequence, product sustainability efforts by Dabblers at best meet one of the five VRINS criteria and, therefore, cannot be considered resources in the sense of the RBV.

One typical exemplar of the Dabblers' approach from our sample is a manufacturer of plastic household products. Several years ago, this company launched an eco-line made from 100% recycled plastics. The designs are virtually identical to their regular products, making the employed material the only change. The eco-line products are of equal quality and performance compared to products made from primary materials, and only a handful of designs are offered under the eco-line label - complementing the original portfolio rather than replacing conventional products. Thus, eco-line products remain isolated special offers designed to be included in the sustainability efforts of retail outlets. Hence, they are test-balloons that help gauge customer reaction without any risk of cannibalizing the conventional offerings. The company entirely relies on raw materials and know-how of a single supplier specialized in recycled plastics with established and patented technology around closed-loop economics. Therefore, the company does not build internal resources around product sustainability: neither with respect to design nor manufacturing technology. Consequently, VRINS capabilities are not established. Any competitor could get into the game tomorrow.

Dabblers don't necessarily care about the longevity of their sustainability efforts or developing novel capabilities. Importantly, while some Dabblers may find commercial success with their efforts, they do not build capabilities in the sense of the RBV. Both management as well the product developers of Dabblers are essentially waiting for sustainability to trickle down through the fabric of the organization. Our findings, mirrored with the RBV and the literature on product sustainability, suggest that this trickle-down effect remains elusive.

DIY-Ecopreneurs: Authentic, Successful, but Not Scalable

From a VRIN perspective, DIY-Ecopreneurs have pulled off the remarkable feat of making sustainability a *core competency* as opposed to simply a *best practice* (Snyder and Ebeling, 1992), i.e., they derive their competitive advantage from their sustainability efforts. Rather than viewing sustainability as an impediment to business success, these – predominantly niche – companies have thrived by embracing the notion (Gast et al., 2017). Further, DIY-Ecopreneurs often fill a void in the marketplace for a sustainable alternative to a conventional line of products. As a result, they are not originally driven by market demand (as it would be the case for the Dabblers) but rather by a mission to create a sustainable solution to a personal need (Fauchart and Gruber, 2011). Consider the following exemplar from our sample:

The company started out as a small retailer for baby equipment. Its CEO grew increasingly frustrated with what his supply chain partners had to offer: both the production processes as well as the employed materials did not meet his sustainability requirements. Worst of all, manufacturers relied on a plethora of chemical agents that were not only environmentally hazardous but left a nauseating stench after unboxing a shipment. Eventually, then an expecting father himself, the CEO had to come to terms with the moral dilemma that he was selling products he considered to be unsuitable for his own child. In lieu of satisfactory alternatives in the marketplace, he summoned his DIY skills and designed his own prototype made from 0% harmful chemicals and 100% sustainable materials. As he lacked manufacturing capabilities on any scale, he searched for a contract manufacturer that would satisfy his rigorous sustainability requirements. When he eventually found a group of willing and capable suppliers, the final product noticeably outpriced most conventional alternative he was selling in his own store. He decided to go all-in, shutting down his retail operation and turning into a manufacturer himself. He carefully selected distribution partners who shared his values and today sells 20 times the volume he had originally pegged the market at – making him a tiny niche player among conventional competitors. Albeit frequently exploring possibilities to expand his portfolio to include other types of baby equipment to grow the company, he has refrained from pursuing any other options because he found them to be incompatible with his sustainability standards. Thus, he has settled on his niche existence.

This exemplar illustrates the key aspect that characterizes a DIY-Ecopreneur: an uncompromising commitment to superior sustainability standards, driven by a strong intrinsic motivation that is both independent of and unadulterated by consumer sentiment, where the sustainability vision naturally transcends the boundaries between strategy and operations. In an important difference to the Dabblers, the strategy to provide more sustainable product alternatives for DIY-Ecopreneurs directly informs their product development goals and process. Hence, we propose that DIY-Ecopreneurs short-circuit the sequence from context to management to NPD established by the literature (Figure 1). Firstly, they reverse the context that is usually driven by outside influences (e.g., Dangelico, 2016; Gmelin and Seuring, 2014b) as they create market demand via their internal innovations. This sets them apart from the other two approaches which are initially driven by outside demand. Secondly, their powerful sustainability imperative essentially dissolves any gap between management and NPD by making the sustainable product the vision itself. The conduit that enables this transcendence is the founder personality of the company for all DIY-Ecopreneurs from our sample. Additionally, it is crucial to note that while our DIY-Ecopreneurs naturally prioritized sustainability and elaborate on the social and environmental superiority of their products in detail, they did not pursue any form of systematic impact analysis (e.g., Schöggl et al., 2017; Sihvonen and Partanen, 2016), nor did they follow or establish structured development guidelines (e.g., Alblas et al., 2014; Schulte and Hallstedt, 2017).

From a VRINS perspective, we therefore conclude that DIY-Ecopreneurs satisfy four out of five criteria:

- Their innovations are *valuable* to a selected target market. Indeed, customers are willing to pay a potentially significant price premium over less sustainable alternatives.
- Their unique designs make their solutions *rare*. DIY Ecopreneurs usually occupy market niches with none or few competitors that can deliver comparable sustainability performance.
- DIY-Ecopreneurs achieve superior product sustainability by “rethinking” the design fundamentally and basing every design decision from raw materials to manufacturing processes around maximizing sustainability performance. In this process, they often create new production methods and innovative material solutions. Further, they

reconsider issues such as packaging, delivery methods, and serviceability of their products. In sum, this comprehensive approach gives them a unique authenticity that is *inimitable* in short to medium term.

- Their niche targeting designed to provide a sustainable alternative to one specific product leaves them without *substitutes*.

Yet, while they may well deliver on the VRIN principles, they distinctly and crucially lack *scalability*. Going back to our definition of scalability:

1. DIY-Ecopreneurs usually remain focused on one single product and forgo opportunities to leverage their sustainability capabilities across a broader product portfolio. It is important to note that this is not necessarily by choice but because their unstructured, yet absolutist approach to developing sustainable products is not easily replicable for new product lines. The DIY-Ecopreneurs from our sample openly acknowledged this limitation and expressed concerns that companies with a systematic approach and more resources could enter their markets any time.
2. They remain niche players because their products are not commercially viable (i.e., too pricy) for the mass market. Their sustainability efforts raise costs on both materials and processes. Thus, the "no-compromises"-approach to product sustainability all DIY-Ecopreneurs our sample pursued led their products to a price point that was not competitive on a large scale – fatally inhibiting growth beyond a niche. In fact, all companies from our sample in the DIY-Ecopreneurs category account for less than one percent market share in their respective category. DIY-Ecopreneurs from our sample are aware of this issue. Yet, lowering the price point without losing ground on sustainability commitments emerges as the squaring of the circle for these companies. Importantly, from a resources perspective, this leads to a vicious cycle: The uncompromising sustainability requirements lead to a high price point – which in turn leads to constraints on growth beyond a niche market share – which in turn leads to a lack of economies of scale that would help bring costs down.
3. DIY-Ecopreneur's commitment to sustainability isn't institutionalized but remains confined to individuals, thus making it vulnerable to erosion over time. In an important contrast to Codifiers (as will be discussed below), DIY-Ecopreneurs do not uncouple their

more-sustainable-product-development efforts from individuals via institutions, systems, manuals, and procedures. Rather the VRIN capability lies embedded in the persona of the product developer itself.

To reiterate, from a scalability perspective, DIY-Ecopreneurs' key advantage to transcending the divide between strategy and operations emerges as their biggest weakness. Specifically, their competitive advantage relies on their uncompromising, often puritanical commitment to absolute sustainability standards, which gives them their unique authenticity (Debeljak et al., 2011). However, these high standards often come at a price premium, significantly constraining the possible product portfolio. In addition, beyond these operational limits, their absolutist approach to product sustainability often strategically "boxes them in" as they may forgo product alternatives with incremental improvements if a perfect solution is unattainable. While two of the three DIY-Ecopreneurs from our sample had more than a single product in their portfolio, none of the companies in question had leveraged their sustainability-oriented development capabilities in a systematic way beyond simple variations of one design/category. While not every DIY-Ecopreneur may actively pursue such an expansion, it is important to note that their DIY-Ecopreneur approach to product sustainability is not equipped to facilitate ambitions in this direction. Specifically, the DIY-Ecopreneur approach does not foster a firm's ability to translate the learnings beyond one product idea/category due to the lack of systematic measurement and tools or an institutionalization via codified development guidelines.

Finally, DIY-Ecopreneurs are structurally constrained by their reliance on key individuals as opposed to institutions. For all DIY-Ecopreneurs from our sample, the expertise and commitment regarding the development of more sustainable products were directly tied to a specific product developer who acted as a champion of product sustainability. Therefore, the way DIY-Ecopreneurs pursue product sustainability is hardly translatable to larger corporations because reliance on single individuals to bridge the strategy-operations-gap via personally controlling every aspect of the firm is unfeasible.

In summary, DIY-Ecopreneurs from our sample emerge as authentic and successful companies (with respect to all three dimensions of the TBL), yet they lack scalability and therefore remain confined to their niche. Thus, while they excel with respect to the sustainability performance of their products and often deliver the cutting-edge solution in their category, they do not

noticeably penetrate, let alone alter the mainstream market. Therefore, they fail to deliver on the larger goal that drives both research as well as societal interest in more sustainable products – delivering sustainable product alternatives that replace conventional products on a larger scale and contribute toward shifting consumption patterns which measurably alleviate social and environmental concerns from a macroeconomic perspective.

Codifiers: Bridging the Gap to Scalable Success

Codification emerges as the most systematic approach to developing more sustainable products. Based on our data, these firms neither have product sustainability at their core self-conception (like DIY-Ecopreneurs) nor do they serendipitously launch one-off test-balloons such as the Dabblers. In short, Codifiers embrace product sustainability via institutionalizing targeted environmental and social improvements in their NPD guidelines. Yet, their efforts go far beyond simply adding auxiliary sustainability goals for their products: First, they institute product sustainability as a NPD target equal to "traditional" targets (price, quality, etc.). Consequently, they establish a comprehensive system that systematically aligns vision and strategy with operational decisions, engrains sustainability in all management processes, and rigorously measures performance. Naturally, this requires managerial prowess. Consider the following exemplar from our sample:

This well-established manufacturer of household necessities offers a broad product portfolio under a brand name that is recognized worldwide. While the company had casually monitored the energy consumption of some of its products for several years, leadership eventually made a strategic push for a comprehensive product sustainability program. Aware of the scope and magnitude of the challenge and determined to avoid a fad, the program was grounded in the company's established continuous improvement efforts (e.g., Alänge et al., 2016; Dangelico et al., 2013). To determine the context (see Figure 1), the firm analyzed the market environment, existing regulation, and customer preferences. Next, they established a sustainability vision (e.g., Lozano, 2015) for the whole company which is built on achieving a long-term balance between the three foundations of the TBL – environmental, social, and economic responsibility – augmented by a fourth meta-dimension that specifically codifies the responsibility of all employees for achieving said balance. Importantly, they strategically engrained the vision across their entire management hierarchy (e.g., Dyllick and Muff, 2016) by inviting participation,

assigning clear responsibilities, and explicitly mandating that any effort could only count towards successful implementation if progress can be demonstrated with clear metrics.

Addressing the NPD portion of the structure in Figure 1, the company took to translating the strategic approach into operational principles and NPD guidelines. To maintain a structured process and avoid chasing quick fixes, the first step was the development of a comprehensive target measurement system with a status-quo baseline. With the external expertise to guarantee objectivity, a team of product developers, manufacturing engineers, and supply chain managers started by thoroughly analyzing their latest product generation in terms of relevant product sustainability aspects across all life-cycle phases. For every identified aspect, at least one clearly measurable metric was established. Then, the results were aggregated with the traditional performance metrics to maintain institutional consistency and ensure that sustainability was embedded into the process as opposed to just being latched on retroactively. The result was a NPD scorecard which included several dozen sustainability metrics for the products' complete life-cycle. In keeping with previous scorecards and to facilitate easy applicability, they implemented a straight-forward points-based scoring system and set their current product generation as the benchmark. This ensured a forward-looking atmosphere to avoid possible frustration of the development team by the added complexity while smothering any temptations to low-ball future targets based on watered-down baselines. Finally, in alignment with the established vision, a cross-functional team put forth an explicit number of points across the scorecard total that each new product generation must at least lead its predecessor by. This elaborated approach achieves the following goals: (1) Transparent targets for product sustainability guide the development process (e.g., Kammerl et al., 2017), (2) the mandatory absolute score improvements between each product generation institute a continuous improvement process with automatically increasing rigor after the low-hanging fruits are picked, and (3) the integrated scorecard makes trade-offs between development targets visible and allows developers to establish a constructive rationale for their decisions. From this operational approach, a feedback loop to context and strategy was established via an aggregated scorecard that informs internal and external communication for reporting and marketing.

To summarize: True codification of sustainability in NPD requires a product development process that makes product sustainability an integral and equal part of product design goals. As such, it

must begin with a vision which informs a comprehensive strategy, supported by a genuine leadership mandate. Rather than short-circuiting the translation of said strategy into operations via single individuals (DIY-Ecopreneurs) or awaiting a "trickle-down" (Dabblers), Codifiers leverage their institutions to bridge this gap. Rigorous codification thus maintains the momentum of the effort as well as abstracting the program from individual employees. They codify a continuous improvement process and empower their developers to pursue both incremental as well as radical design changes to increase product sustainability – even if they have to compromise traditional performance metrics to do so.

From an RBV perspective, sustainability programs by Codifiers meet all facets of the VRINS principles: Because their efforts are grounded in a market analysis, they are *valuable* to customers; due to the elaborate underlying process and the fact that resources are built in-house, the resulting capabilities are *rare* and hard to *imitate*; the lack of comparable products for the mainstream market make them *non-substitutable*. In contrast to both the Dabblers as well as the DIY-Ecopreneurs, Codifiers also achieve *scalability* – making them the only type to build VRINS resources. Their approach is scalable on all three levels: (1) their codification process ensures that improvements for one product automatically become part of the development guidelines for the portfolio at large, (2) their continuous improvement process gradually raises the bar on sustainability requirements while maintaining scorecard balance with respect to price and quality to ensure mass-market viability, and (3) the rigorous institutionalization of sustainability untangles those values from individuals and engrains the issue in the DNA of organization – maintaining core values over time and growth.

Of note: Related research from the operations domain demonstrates that there likely is a large overlap between companies with a successful implementation of sustainable operations practices and firms that exhibit best practices in managing their operations in a larger sense (Longoni et al., 2019; Pagell et al., 2014; Pagell and Wu, 2009). In other words, companies that excel at managing their operations can leverage those capabilities to also include sustainability. Importantly, this suggests that the reverse also holds true: Successful operations management is a prerequisite to successful *sustainable* operations management. A similar dynamic likely exists in the context of the current analysis: A rigorous and structured approach to including sustainability in the NPD process (i.e., codification) naturally requires that such a systematic

process is in place to begin with. Thus, firms that have a tradition of systematically codifying development guidelines and employing tools and methods to assess the impact of design decisions with respect to issues such as costs and quality will be much more likely to also extend this behavior to sustainability considerations. However, our analysis strongly suggests that the sheer existence of a structured NPD process does by no means guarantee a systematic codification of sustainability. In fact, many of the Dabblers in our sample did pursue a formally developed NPD process but did not include sustainability in a systematic way. This is precisely where Dabblers relied on the elusive "trickle-down" effect while Codifiers set themselves apart by pursuing pro-active integration.

THEORETICAL AND PRACTICAL CONTRIBUTIONS

Theoretical Contributions

Based on our analysis, we propose an extension to the RBV. While the established VRIN principles adequately capture the differences in resource-building around product sustainability between Dabblers and DIY-Ecopreneurs, to distinguish the unique nature of the resources established by Codifiers, *scalability* is required as an additional principle.

In keeping with best practice in theory-building research, all three identified approaches to developing sustainable products emerged from data analysis during axial coding without a predetermined theoretical lens. Only after completion of axial coding did we begin iteration between data, literature, and possible theories to guide our understanding. We found the three-level structure by Alblas et al. (2014) to be well-equipped to ground the role of NPD in a managerial/strategic as well as a broader external context – corresponding to the themes that emerged from our data. We subsequently found that the RBV provided us with a theoretical lens that allowed us to identify and differentiate the nature of the NPD resources established by each company archetype according to the VRIN principles. Yet upon further iteration, we found that *scalability* was the key quality that set apart the Codifiers' approach to sustainable products – an aspect not specifically covered by the traditional RBV. Thus, we propose an augmented RBV, guided by the VRINS principles for the current analysis. While the *scalability* extension to the RBV is a proposition that resulted from this specific effort to empirically-grounded theory-building around product sustainability, we suggest that it has merit for a larger context.

Frequently, companies develop resources that meet the VRIN criteria but are not translatable beyond a specific product, are challenging to scale to mass-production, or are tied to certain individuals and lack institutionalization.

Practical Contributions

We propose that our classification of companies' approaches to developing sustainable products and its juxtaposition with the VRINS principles is highly relevant to product developers. We suggest that the classification can be used by product developers to reflect on their own organization's strategic positioning. For practitioners, our findings clearly suggest that codification is the most effective approach to translating strategic sustainability goals into tangible products beyond a niche market. If product developers aspiring to leverage product sustainability – after reviewing their firm's approach – find closer resemblance to the *Dabblers*, they may consider the following best practices that emerged from our data analysis: (1) Ensure top-management support for more sustainable products is genuine and includes willingness to invest, (2) redesign the NPD scorecard to include sustainability targets with clear and actionable metrics, (3) institute continuous improvement program that includes sustainability metrics, (4) empower product developers to take risks and explore trade-offs between dimensions of the revised scorecard.

In case managers find their company to be a better resemblance to a DIY-Ecopreneur, they specifically need to ponder scalability. If their firm has the desire to grow beyond their niche, they should also engage in codification via a scorecard and continuous improvement processes in an effort to institutionalize and channel the commitment to sustainability inherent in their firm.

LIMITATIONS AND FURTHER RESEARCH

Naturally, this study comes with *limitations* that lead to *further research* opportunities. First, we employed a qualitative methodology with limited sample size. We attempt to build and elaborate theory rather than testing. As we point out in our findings section, we classified the companies from our sample into three distinct approaches towards integrating sustainability considerations into their product development process. As such, we do not suggest that these three approaches represent a company "type" beyond that narrow perspective. It is likely that

an abundance of variables (such as industry, firm size, supply chain structure, etc.) have an influence on which approach a company pursues and how it manifests itself in day-to-day operations. However, our current sample is not equipped or designed to provide reliable conclusions in this regard. Thus, we invite researchers to subject our findings to further qualitative studies to build testable hypotheses around these outside factors and subsequently subject them to empirical verification via quantitatively oriented inquiry (surveys, secondary data analysis, experiments, etc.). We further invite researchers to explore how scalability can complement the RBV in other contexts.

Second, the current sample is limited to German consumer goods companies. While we strongly believe that the tenets of our findings hold true for other developed economies, nuances for different regions/industries surely make a difference. Studies that can shed light on the impact of culture, market structure, regulatory influence, and other factors with respect to sustainable NPD capabilities can further inform the academic discourse.

CONCLUSIONS

We set out to explore how companies are engaging with the notion of product sustainability. Initially, we raised the question, how sustainability is translated from strategy into operations, specifically how it can be integrated into the NPD process. Based on our empirical data, we identify three approaches: The *Dabblers*, the *DIY-Ecopreneurs*, and the *Codifiers*.

We find that a majority of firms from our sample (the *Dabblers*) do not actively manage the transition from strategy to NPD. Rather, *Dabblers* seem to await a trickle-down effect from vision to operations that remains elusive. From our extended RBV perspective, *Dabblers* do not develop VRINS resources and thus fail to leverage product sustainability for competitive advantages. Extrapolating from our sample – with respect to the identified characteristics, publicly observable company behavior, and the distinct lack of convincing and widely available sustainable products – we propose that a vast majority of the global consumer goods companies can currently be described as *Dabblers*. Given the qualitative nature of our sample, we are fully aware of the audacity of this proposition. However, given the marginal progress around making more sustainable products mainstream to date, we believe that the underlying disconnect between strategy and NPD may emerge as an insightful explanation for this lack of momentum.

We explicitly invite fellow researchers to empirically and conceptually scrutinize this proposition and engage in constructive discourse – both within the academic community as well as with practitioners and stakeholders at large.

From our sample, we further identified two company types that actively and successfully manage the translation of sustainability strategy into NPD. One unique firm demographic – the *DIY-Ecopreneurs* – essentially short-circuit any translation process via the authentic and uncompromising commitment of their leadership to product sustainability in combination with the fact that the very same individuals also drive and fully control the NPD process. This approach results in products with a radically superior sustainability performance for a boutique market. While our data suggest that this leads to the development of VRIN capabilities, this approach is naturally only feasible for niche, start-up companies, and crucially lacks scalability. This is a caveat which *DIY-Ecopreneurs* are not only fully cognizant of – they consciously sacrifice scale and expansion to protect their idealistic sustainability principles and avoid the hassle of establishing the institutions necessary to abstract said principles from themselves personally.

The final type that emerged from our sample (the *Codifiers*) is the only identified avenue towards bridging the gap between sustainability vision, strategy, and operations that satisfies all criteria of the expanded VRINS principle. They specifically leverage their institutions to embrace product sustainability as a challenging, trade-off-ridden, and long-term undertaking. As detailed in our discussion of an exemplar from our sample, effectively codifying product sustainability for NPD requires fundamentally engraining the notion across the entire firm while rigorously and transparently measuring performance in all dimensions of the TBL. Crucially, codification thus abstracts the burden of increasing product sustainability from the individual and ties it to the institutions, institutionalizing both the accountability as well as the explicit mandate to make decisions that come with inherent trade-offs. Put bluntly, from our classification, only *Codifiers* treat product sustainability as a "normal" business opportunity. We propose that only via this normalization can product sustainability finally become mainstream.

REFERENCES

Alänge, S., Clancy, G., Marmgren, M., 2016. Naturalizing Sustainability in Product Development. Journal of Cleaner Production 135, 1009–1022.

Alawe, I., Ksentini, A., Hadjadj-Aoul, Y., Bertin, P., 2018. Improving Traffic Forecasting for 5G Core Network Scalability: A Machine Learning Approach. IEEE Network 32, 42–49.

Alblas, A., Peters, K., Wortmann, H., 2014. Fuzzy Sustainability Incentives in New Product Development - An Empirical Exploration of Sustainability Challenges in Manufacturing Companies. International Journal of Operations & Production Management 34, 513–545.

Amazon, 2019. Sustainability: Amazon Products, Business and Initiatives.

Aschehoug, S.H., Boks, C., 2013. Towards a Framework for Sustainability Information in Product Development. International Journal of Sustainable Engineering 6, 94–108.

Barney, J., 1991. Firm Resources and Sustained Competitive Advantage. Journal of Management 17, 99–120.

Barney, J., 2001. Resource-Based Theories of Competitive Advantage: A Ten-Year Retrospective on the Resource-Based View. Journal of Management 27, 643–650.

Baumgartner, R.J., Ebner, D., 2010. Corporate Sustainability Strategies: Sustainability Profiles and Maturity Levels. Sustainable Development 18, 76–89.

Binder, M., Edwards, J.S., 2010. Using grounded theory method for theory building in operations management research: A study on inter-firm relationship governance. International Journal of Operations & Production Management 30, 232–259.

Bondi, A.B., 2000. Characteristics of Scalability and Their Impact on Performance. In: Proceedings of the 2Nd International Workshop on Software and Performance, WOSP '00. ACM, New York, NY, USA, pp. 195–203.

Bouwman, H., MacInnes, I., 2006. Dynamic Business Model Framework for Value Webs. In: Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06). Presented at the Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06), pp. 43–43.

Brockhaus, S., Fawcett, S.E., Knemeyer, A.M., Fawcett, A.M., 2017. Motivations for Environmental and Social Consciousness: Reevaluating the Sustainability-Based View. Journal of Cleaner Production 143, 933–947.

Buchert, T., Halstenberg, F.A., Bonvoisin, J., Lindow, K., Stark, R., 2017. Target-Driven Selection and Scheduling of Methods for Sustainable Product Development. Journal of Cleaner Production 161, 403–421.

Caniato, F., Doran, D., Sousa, R., Boer, H., 2018. Designing and developing OM research – from concept to publication. International Journal of Operations & Production Management 38, 1836–1856.

Charmaz, K., 2014. Constructing Grounded Theory, 2nd ed. ed. SAGE Publications, Los Angeles et al.

Clancy, G., Fröling, M., Svanström, M., 2013. Changing from Petroleum to Wood-Based Materials - Critical Review of How Product Sustainability Characteristics Can Be Assessed and Compared. Journal of Cleaner Production 39, 372–385.

Claudy, M.C., Peterson, M., Pagell, M., 2016. The Roles of Sustainability Orientation and Market Knowledge Competence in New Product Development Success. Journal of Product Innovation Management 33, 72–85.

Connelly, B.L., Ketchen, D.J., Slater, S.F., 2011. Toward a "Theoretical Toolbox" for Sustainability Research in Marketing. Journal of the Academy of Marketing Science 39, 86–100.

Corbin, J., Strauss, A.L., 2008. Basics of Qualitative Research - Techniques and Procedures for Developing Grounded Theory, 3rd ed. SAGE Publications, Thousand Oaks et al.

Dangelico, R.M., 2016. Green Product Innovation: Where We Are and Where We Are Going. Business Strategy and the Environment 25, 560–576.

Dangelico, R.M., Pontrandolfo, P., Pujari, D., 2013. Developing Sustainable New Products in the Textile and Upholstered Furniture Industries - Role of External Integrative Capabilities. Journal of Product Innovation Management 30, 642–658.

Debeljak, J., Krkač, K., Bušljeta Banks, I., 2011. Acquiring CSR Practices: From Deception to Authenticity. Social Responsibility Journal 7, 5–22.

Driessen, P.H., Hillebrand, B., Kok, R.A.W., Verhallen, T.M.M., 2013. Green New Product Development: The Pivotal Role of Product Greenness. IEEE Transactions on Engineering Management 60, 315–326.

Dyer, L., Ericksen, J., 2005. In pursuit of marketplace agility: Applying precepts of self-organizing systems to optimize human resource scalability. Hum. Resour. Manage. 44, 183–188.

Dyllick, T., Muff, K., 2016. Clarifying the Meaning of Sustainable Business: Introducing a Typology From Business-as-Usual to True Business Sustainability. Organization & Environment 29, 156–174.

Dyllick, T., Rost, Z., 2017. Towards True Product Sustainability. Journal of Cleaner Production 162, 346–360.

Eisenhardt, K.M., 1989. Building Theories from Case Study Research. Academy of Managament Review 14, 532–550.

European Commission, 2015. User Guide to the SME Definition. Publications Office of the European Union, Luxembourg.

Fauchart, E., Gruber, M., 2011. Darwinians, Communitarians, and Missionaries: The Role of Founder Identity in Entrepreneurship. Academy of Management Journal 54, 935–957.

Fendt, J., Sachs, W., 2008. Grounded Theory Method in Management Research. Organizational Research Methods 11, 430–455.

Finney, R.Z., Lueg, J.E., Campbell, N.D., 2008. Market Pioneers, Late Movers, and the Resource-based View (RBV): A Conceptual Model. Journal of Business Research 61, 925–932.

Ford, S., Despeisse, M., 2016. Additive Manufacturing and Sustainability: An Exploratory Study of the Advantages and Challenges. Journal of Cleaner Production 137, 1573–1587.

Gast, J., Gundolf, K., Cesinger, B., 2017. Doing Business in a Green Way: A Systematic Review of the Ecological Sustainability Entrepreneurship Literature and Future Research Directions. Journal of Cleaner Production 147, 44–56.

Gerstlberger, W., Praest Knudsen, M., Stampe, I., 2014. Sustainable Development Strategies for Product Innovation and Energy Efficiency. Business Strategy and the Environment 23, 131–144.

Gioia, D.A., Corley, K.G., Hamilton, A.L., 2012. Seeking Qualitative Rigor in Inductive Research - Notes on the Gioia Methodology. Organizational Research Methods 16, 15–31.

Gmelin, H., Seuring, S., 2014a. Achieving Sustainable New Product Development by Integrating Product Life-Cycle Management Capabilities. International Journal of Production Economics 154, 166–177.

Gmelin, H., Seuring, S., 2014b. Determinants of a Sustainable New Product Development. Journal of Cleaner Production 69, 1–9.

Hahn, T., Figge, F., Pinkse, J., Preuss, L., 2010. Trade-offs in Corporate Sustainability: You Can't Have Your Cake and Eat It. Business Strategy and the Environment 19, 217–229.

Hallowell, R., 2001. "Scalability": the paradox of human resources in e-commerce. Int J of Service Industry Mgmt 12, 34–43.

Hallstedt, S., Thompson, A.W., Lindahl, P., 2013. Key Elements for Implementing a Strategic Sustainability Perspective in the Product Innovation Process. Journal of Cleaner Production 51, 277–288.

Hart, S.L., 1995. A Natural-Resource-Based View of the Firm. Academy of Management Review 20, 986–1014.

Hart, S.L., Dowell, G., 2011. A Natural-Resource-Based View of the Firm: Fifteen Years After. Journal of Management 37, 1464–1479.

Held, M., Weidmann, D., Kammerl, D., Hollauer, C., Mörtl, M., Omer, M., Lindemann, U., 2018. Current Challenges for Sustainable Product Development in the German Automotive Sector: A Survey Based Status Assessment. Journal of Cleaner Production 195, 869–889.

Hopkins, M.S., 2010. How Sustainability Fuels Design Innovation. MIT Sloan Management Review 52, 75–81.

Johansson, G., 2008. Product Innovation for Sustainability: On Product Properties for Efficient Disassembly. International Journal of Sustainable Engineering 1, 32–41.

Kammerl, D., Schockenhoff, D., Hollauer, C., Weidmann, D., Lindemann, U., 2017. A Framework for Sustainable Product Development. In: Matsumoto, M., Masui, K., Fukushige, S., Kondoh, S. (Eds.), Sustainability Through Innovation in Product Life Cycle Design. Springer, Singapore, pp. 21–32.

Kern, C., 2010. Die Konsumgüterindustrie. In: Meinhardt, S., Kern, C., Kauffmann, K., Jahraus, J. (Eds.), Innovative Gestaltung von Geschäftsprozessen in Der Konsumgüterindustrie. dpunkt.verlag, Heidelberg, pp. 3–63.

Kono, J., Ostermeyer, Y., Wallbaum, H., 2018. Investigation of Regional Conditions and Sustainability Indicators for Sustainable Product Development of Building Materials. Journal of Cleaner Production 196, 1356–1364.

Lion, A., Macchion, L., Danese, P., Vinelli, A., 2016. Sustainability Approaches within the Fashion Industry. Supply Chain Forum: An International Journal 17, 95–108.

Longoni, A., Pagell, M., Shevchenko, A., Klassen, R., 2019. Human Capital Routines and Sustainability Trade-offs: The Influence of Conflicting Schemas for Operations and Safety Managers. International Journal of Operations & Production Management.

Lozano, R., 2015. A Holistic Perspective on Corporate Sustainability Drivers. Corporate Social Responsibility and Environmental Management 22, 32–44.

McDowell, W.C., Harris, M.L., Geho, P.R., 2016. Longevity in Small Business: The Effect of Maturity on Strategic Focus and Business Performance. Journal of Business Research 69, 1904–1908.

Nestlé, 2019. The Planet: Stewarding Resources for Future Generations.

Oliver, C., 1997. Sustainable Competitive Advantage: Combining Institutional and Resource-based Views. Strategic Management Journal 18, 697–713.

Pagell, M., Johnston, D., Veltri, A., Klassen, R., Biehl, M., 2014. Is Safe Production an Oxymoron? Production and Operations Management 23, 1161–1175.

Pagell, M., Wu, Z., 2009. Building a More Complete Theory of Sustainable Supply Chain Management Using Case Studies of 10 Exemplars. Journal of Supply Chain Management 45, 37–56.

Petersen, M., 2017. Considering Sustainability in the Development of Consumer Goods. Hamburg University of Technology, Hamburg.

Petersen, M., 2019. How Corporate Sustainability Affects Product Developers' Approaches Toward Improving Product Sustainability. IEEE Transactions on Engineering Management 1–15.

Pettus, M.L., 2001. The Resource-Based View as a Developmental Growth Process: Evidence From the Deregulated Trucking Industry. Academy of Management Journal 44, 878–896.

Porter, M.E., Kramer, M.R., 2006. Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility. Harvard Business Review 84, 78–92.

Rappa, M.A., 2004. The utility business model and the future of computing services. IBM Systems Journal 43, 32–42.

Reuter, C., Foerstl, K., Hartmann, E., Blome, C., 2010. Sustainable Global Supplier Management: The Role of Dynamic Capabilities in Achieving Competitive Advantage. Journal of Supply Chain Management 46, 45–63.

Rogers, D.S., Lambert, D.M., Knemeyer, A.M., 2004. The Product Development and Commercialization Process. The International Journal of Logistics Management 15, 43–56.

Ross, A.M., Rhodes, D.H., Hastings, D.E., 2008. Defining changeability: Reconciling flexibility, adaptability, scalability, modifiability, and robustness for maintaining system lifecycle value. Systems Engineering 11, 246–262.

Schöggl, J.P., Baumgartner, R.J., Hofer, D., 2017. Improving Sustainability Performance in Early Phases of Product Design: A Checklist for Sustainable Product Development Tested in the Automotive Industry. Journal of Cleaner Production 140, 1602–1617.

Schulte, J., Hallstedt, S.I., 2017. Challenges and Preconditions to Build Sustainability Capabilities in Product Innovation. In: 21st International Conference on Engineering Design. pp. 1–10.

Sihvonen, S., Partanen, J., 2016. Implementing Environmental Considerations within Product Development Practices: A Survey on Employees' Perspectives. Journal of Cleaner Production 125, 189–203.

Snyder, A. V., Ebeling, H.W., 1992. Targeting a Company's Real Core Competencies. Journal of Business Strategy 13, 26–32.

Sodhi, M.S., 2015. Conceptualizing Social Responsibility in Operations. Production and Operations Management 24, 1375–1389.

Stampfl, G., Prügl, R., Osterloh, V., 2013. An explorative model of business model scalability. International Journal of Product Development 18, 226–248.

Strömberg, H., Selvefors, A., Renström, S., 2015. Mapping Out the Design Opportunities: Pathways of Sustainable Behaviour. International Journal of Sustainable Engineering 8, 163–172.

Taneja, S., Pryor, M.G., Hayek, M., 2014. Leaping Innovation Barriers to Small Business Longevity. Journal of Business Strategy 37, 44–51.

Thomé, A.M.T., Scavarda, A., Ceryno, P.S., Remmen, A., 2016. Sustainable New Product Development: A Longitudinal Review. Clean Technologies and Environmental Policy 18, 2195–2208.

Verhulst, E., Boks, C., 2012. The Role of Human Factors in the Adoption of Sustainable Design Criteria in Business - Evidence from Belgian and Dutch Case Studies. International Journal of Innovation and Sustainable Development 6, 146–163.

Verona, G., 1999. A Resource-Based View of Product Development. Academy of Management Review 24, 132–142.

Waller, M.A., Fawcett, S.E., Johnson, J.L., 2015. The Luxury Paradox: How Systems Thinking and Supply Chain Collaboration Can Bring Sustainability Into Mainstream Practice. Journal of Business Logistics 36, 303–305.

Wang, W., Koren, Y., 2012. Scalability planning for reconfigurable manufacturing systems. Journal of Manufacturing Systems 31, 83–91.

Wernerfelt, B., 1984. A Resource-Based View of the Firm. Strategic Management Journal 5, 171–180.

Wowak, K.D., Craighead, C.W., Ketchen, D.J., 2016. Tracing Bad Products in Supply Chains: The Roles of Temporality, Supply Chain Permeation, and Product Information Ambiguity. Journal of Business Logistics 37, 132–151.

Wright, C., Nyberg, D., 2017. An Inconvenient Truth: How Organizations Translate Climate Change into Business as Usual. Academy of Management Journal 60, 1633–1661.