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Lukas Sattlegger / Elisabeth Süßbauer

Packaging as a mediator in networks of practices

A transformational approach towards precycling

Zusammenfassung: Kunststoffabfälle aus Einweg-Lebensmittelverpackungen sind eine der größten ökologischen Herausforderungen der Gegenwart. Eine Reduktion des Abfalls kann jedoch nicht alleine durch eine Optimierung des Verpackungsmaterials erfolgen. Verpackungen müssen vielmehr als Schnittstelle zwischen multiplen Praktiken analysiert und bearbeitet werden. Auf Basis dieser praxistheoretischen Perspektive identifizieren wir vier Vermittlerrollen von Verpackungen innerhalb von Praktiken-Netzwerken der Lebensmittelversorgung: sie fungieren als flexibler Körper, abfragbares Gehirn, vertrautes Gesicht und helfende Hand von Produkten. Am Beispiel von Getränkeverpackungen diskutieren wir, wie solche Praktiken-Netzwerke auf ressourcenschonendere Weise umgestaltet und trotzdem die Vermittlerrollen von Verpackungen aufrechterhalten werden können. Weiterhin stellen wir das visionäre Konzept „Precycling“ vor, um die (veränderten) Praktiken nicht nur zu analysieren, sondern auch in Richtung Abfallvermeidung zu transformieren. Dabei zeigen wir, dass sich der Begriff Precycling insbesondere für die Kollaboration zwischen unterschiedlichsten Akteursgruppen eignet, die Teil der Praktiken-Netzwerke sind.

Abstract: Plastic waste from single-use food packaging is one of the greatest environmental challenges of today. However, waste reduction cannot be achieved by optimizing the packaging material alone. Rather, packaging must be analyzed and addressed as an interface between multiple practices. Based on this practice-theoretical perspective, we identify four mediating roles of packaging within networks of food supply practices: it acts as a flexible body, queryable brain, saving face and helping hand of products. We apply this heuristic to the example of beverage packaging showing how practices need to change for more resource-efficient solutions while still maintain the mediating roles of packaging. Furthermore, we introduce the visionary concept of “precycling“ to not only analyze but also transform (changing) practices towards waste prevention. In doing so, we show that the concept of precycling is particularly suited to collaborations between a wide variety of actor groups that are part of networks of practices.

Autor*innen:

Dr. Lukas Sattlegger *studied Sociology as well as Social and Cultural Anthropology at the University of Vienna, and Social and Human Ecology at IFF Vienna, University of Klagenfurt. He works as a research scientist at ISOE – Institute for Social-Ecological Research in the research unit Energy and Climate Protection in Everyday Life. From 2016-2021, he was a PhD student in the junior research group PlastX. His sociological dissertation project at Goethe University Frankfurt am Main dealt with the social dimensions of plastic packaging use.*

sattlegger@isoe.de

Dr. Elisabeth Süßbauer *studied Sociology, Political Science and Romance Studies at the Universities of Münster, Germany, and Salamanca, Spain. She received her PhD in Political Science from the University of Kassel, Germany in 2014. Since 2015, she is research associate at the Center for Technology and Society (ZTG) at Technische Universität Berlin, Germany. Since 2019, she is head of the interdisciplinary junior research group PuR – Precycling as a Means of Resource Efficiency. Her research interests are sustainable consumption in everyday life, transformations of organisations and cities, and sustainability innovation processes.*

suessbauer@ztg.tu-berlin.de

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*Herausgeber*innen:* Benjamin Görgen, Matthias Grundmann, Anna Henkel, Melanie Jaeger-Erben, Björn Wendt

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Anschrift: WWU Münster, Institut für Soziologie
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Institut für Soziologie
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Introduction

Disposable packaging, especially that made of plastic, is a severe threat to ecosystems (Galloway/Lewis 2016). COVID-19 has exacerbated the waste crisis, as the amount of single-use food packaging has risen during the global pandemic, for example due to more takeaway consumption and e-commerce (Leal Filho et al. 2021, Süßbauer et al. 2022). This has led to increased amounts of packaging waste globally. Even before the COVID-19 crisis, Germany produced more packaging waste than the European average: almost 19 million tons annually (Burger et al. 2021). Private end-consumers generate 8.6 million tons annually, which is approximately 46% of the national total of packaging waste. Nearly two-thirds of packaging waste in private households are attributable to beverages and food.

There has been a high level of media attention on plastic pollution and marine litter as well as growing opposition to the excessive use of plastic packaging and other single-use plastics, e.g., the zero-waste movement (Kramm/Völker 2017). However, while the issue of plastic waste has gained scientific, political, and public prominence in recent years, its integrated consideration along the supply chain is still in its infancy. Most current policy strategies for packaging waste reduction divide binarily between industry and consumers as agents of change. Regarding the food and packaging industries, the focus is, first, on substituting fossil-based plastics with bio-based and biodegradable alternatives, which are not necessarily more environmentally advantageous (Haider et al. 2019, Zimmermann et al. 2020). A second strategy centers on weight reduction or recyclable packaging redesign (Gustavo et al. 2018). A third approach is the banning of certain products such as disposable crockery (cf. EU Single-Use Plastics Directive[1]), which is a transformative signal to industry and consumers, but may lead to a shift in materials rather than in quantities of waste (Röchling Stiftung 2021). Existing consumer strategies either focus on raising consumer awareness at the point of sale (Heidbreder et al. 2019), for example regarding "zero-waste" shopping (Beitzen-Heineke et al. 2017) or the amount of packaging waste generated by their grocery shopping (Wenzel/Süßbauer 2021). Or they address isolated behaviors such as waste prevention behaviors (Bortoleto et al. 2012), waste sorting behaviors (Tonglet et al. 2004) or reusing behaviors (Barr et al. 2001). However, as recent sociological studies have shown, the way consumers handle and understand packaging waste at home is embedded in other practices of everyday life. Thus, it is highly context-specific, depending, amongst other things, on milieu specific norms and habits (e.g., Katan/Gram-Hanssen 2021, Rückert-John et al. 2021), societal "myths" (Cat-Krause et al. 2021, Otto et al. 2021), and access to infrastructure (e.g. Corral-Verdugo 2003).

While these different strategies have fostered innovative eco-design (e.g., cradle-to-cradle packaging design) and have led to new start-ups being founded (e.g., food catering systems providing reusable containers), they have failed to stop the trend towards increasing quantities of packaging waste. Instead, packaging-intensive consumption patterns have co-evolved with production conditions, new online business models, and the packaging industry (Evans et al. 2020). Despite all the attempts to reduce waste, the interplay of technological innovation, consumer practices and supply logistics is stabilizing the widespread and persistent use of single-use food and beverage packaging. This raises two questions for environmental sociology: First, which sociological

1 Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment.

concepts are suitable for appraoching and grasping the persistence of disposable food packaging throughout the food supply chain? Second, how is it possible to intervene in the status quo to reduce the use of disposable packaging and to guide transformation processes towards sustainability?

The remainder of this article is structured as follows. First, and based on the current state of sociological research on packaging production, consumption, and waste, we introduce a practice-theoretical approach called "networks of practices". This approach highlights the interconnection of different practices and their elements along the food supply chain (Section 2). Second, based on that approach, we develop a heuristic for analyzing the different mediating roles of (disposable) packaging within networks of food supply practices (Section 3). Third, we apply the heuristic to the case of beverage packaging to provide examples of how networks of practices need to change to achieve more sustainability. In order to stabilize and foster (aspired) sustainable practices, we further recommend using "precycling" as a complementary visionary concept for collaboration in transformation processes towards the prevention of packaging waste (Section 4). Finally, we critically examine the analytical and practical potentials as well as limitations of the network of practices approach to understand transformation barriers towards precycling (Section 5).

1. Packaging as an element in networks of food supply practices

To capture the "stickyness" of of disposable food packaging, different approaches have been promoted in recent sociological studies, such as the socio-technical systems approach (Parsons 2022), actor-network theory (Hagberg 2016, Cochoy 2007, Wagner 2013), sociologies of attachment/detachment (Hawkins 2020, Sattlegger 2021b), and social practice theories (Evans et al. 2020, Sattlegger 2021a). All these approaches share an interest in the intertwining of materiality and human actions (Schatzki 2018). Socio-technical system approaches are best at explaining historical socio-technical developments; actor-network theory and sociologies of attachment/detachment can help to reconstruct human-technology interactions and negotiations, whereas social practice theories are strongest in explaining the pervasiveness of human habits and routines in using certain things in a certain way (Schatzki 2010, Rinkinen et al. 2015, Shove 2017). Hence, practice theories provide a promising approach for better understanding the stable and widespread use of disposable packaging along the food supply chain. In an "ontological division of labour" (Schatzki 2018: 160), practice theories can supplement social theories that focus on interactions or power relations with improved understandings of organized activities in specific socio-material contexts. For example, Evans et al. (2020) combine a practice theory approach with socio-technical transition perspectives (Geels et al. 2015) to analyze the co-evolution of materials and society.

Social practices can be defined as routinized types of behavior, that are both reproduced and changed through everyday enactment by people, or "practitioners" (Shove et al. 2012). As socially shared patterns of doings and sayings (Hörning 2004), they take place in specific spaces, at specific times, exerted by specific people. Practices consist of several interconnected elements. Andreas Reckwitz (2002) differentiates between "forms of bodily activities, forms of mental activities, things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz 2002: 249). In contrast, Schatzki (1996: 89) distinguishes three types of linkages between doings and sayings that constitute a practice: understandings, rules, and beliefs. A third more condensed

definition is used by Shove et al. (2012), who define three elements of practices: material, meaning, and competence.

Following this three-element-definition, materiality is defined as a constitutive part of social practices that is directly interwoven with the non-material dimensions of meaning (e.g. interests, beliefs) and competence (e.g. knowledge, skills)[2]. The material elements form the hardware of practices, entailing objects, equipment, infrastructure, the built environment, and natural resources, which all are part of practices (Røpke 2009: 2490). Material elements are characterized through their physical presence in time and space. This includes the human body, which is shaped by the engagement in practices. Phenomena like "muscle memory" show that social practices and their performance directly relate to trained bodies as enactors. Furthermore, the use of technologies and tools shapes the stability and dynamic of everyday practices. This includes not only tools that are directly used as part of practices, but also wider infrastructures and the natural environment which are important for the possibility and manner of practices and their performance (Morley 2017, Sattlegger et al. 2020). Hence, analyzing material objects along their roles within specific practices enables a better understanding of unsustainable patterns of technology use (Rinkinen et al. 2015). For Shove (2017: 155), there are three main roles that things play in practices: they act as infrastructures that enable practices, they are used as devices, and they figure as resources that are consumed. Importantly, these roles of objects are not fixed, but are related to practices. Consequently, technologies are always linked to their uses by humans (Morley 2017: 81). For sustainability research, this observation of technologies as "things under use" rather than abstract technical applications is an important advance (Sattlegger et al. 2020). If we want to understand what stabilizes the excessive use of disposable food packaging, it is crucial to study its role in specific practices. For example, research has shown how specific material characteristics of packaging are constitutive for the mainstreaming of self-service shopping in supermarkets (Cochoy 2007, Hawkins 2018).

Single practices do not occur in isolation, but intersect with one another, sharing their elements. This means that objects, skills, and values circulate between practices relating them to each other (Shove et al. 2012). Different elements of practices may travel between places and endure over time, so intersections between practices can occur in the spatial (where?), temporal (when?) and social (who?) dimensions (Castelo et al. 2021, Hui 2017). Along these connections, networks of related practices are formed that co-exist in diverse ways (Bellotti/Mora 2016, Higginson et al. 2015, Lawo et al. 2020). These networks can represent specific sites or organizational contexts: "Practices reproduced in homes, offices and cities condition each other in different ways and with varied consequences. Some interactions result in mutual adaptation, others in destruction, synergy or radical transformation" (Shove et al. 2012: 86). In addition, networks of practices can be defined by temporal connections, for example in supply chains where one practice depends on elements that result from other practices. Networks of practices are crucial for the stability and change of single practices and their elements. Flexible and multifunctional objects that are involved in several different practices are usually harder to replace than isolated and practice-specific objects (Shove et al. 2012).

2 The emphasis on the importance of material objects and human bodies is characteristic of the so-called second wave of practice theories including Schatzki, Reckwitz, and Shove. Sharing the attention for material aspects, these authors differ in their conceptualization of the interrelation between material and symbolic aspects. While Shove et al. (2012) define materials as one element within practices, Schatzki (2010) treats material arrangements as context or counterpart of practices (Sattlegger et al. 2020).

To understand the stability of packaging use, research must not only focus on isolated practices. Instead, it is important to study packaging as an element that is involved in (and links) several practices that are part of the constant coordination and reproduction of food supply (and demand). This includes practices of marketing, production, transport, storage, evaluation, market exchange, consumption, and food preparation. Packaging has proven to be a crucial device in the reproduction of spatial, temporal, and social connections in differentiated networks of supply practices (Cochoy 2007). It fosters the transport, preservation, and exchange of products, information and meaning (Hawkins 2018, Sattlegger 2021a). Furthermore, packaging innovation has enabled technological developments in food preservation, processing, and transport. It has contributed to the transformation of food retailing by enhancing commercial interests while maintaining and enhancing values of standards, quality, safety, freshness, hygiene, and convenience (Parsons 2022). This transformation of food supply allowed the place of food production to be decoupled from the location of food consumption, inducing a spatial, temporal, and social differentiation of food supply chains (Spaargaren et al. 2013). In this process, food supply chains became increasingly complex and global and there are more and more points of intersection where certain forms of engagement with food are interrupted or replaced by others (Macrorie et al. 2014).

Analyzing these points of intersection reveals different roles of packaging that stabilize the interconnection of different practices. If packaging must be reduced or avoided, these intersecting practices are crucial for the transformation process. Research on packaging use and its sustainable transformation should widen the scope for the interrelated networks of practices that are involved in the constant coordination and reproduction of food supply (and demand). A focus on networks of practices makes it possible to overcome the dichotomy between the fields of production and consumption, opening space for studying the relevance of packaging in practices along the supply chain, including intermediary practices such as supermarkets or transport logistics (Sattlegger et al. 2020). This helps to understand the persistence of packaging use and enables policy strategies that consider the interplay of packaging technology, design, infrastructure, logistics, and everyday life practices.

2. The mediating roles of packaging in food supply networks

Based on a review of the literature on packaging's roles and functions and our own empirical research in the field[3], we present a heuristic showing that packaging acts as the *body, brain, hand*, and *face* of products in networks of food supply practices (Figure 1). Through these four mediating roles, packaging enhances practical interactions over an increasing number of points of intersection.

First, packaging acts as a *flexible body* that transforms products into manageable and stable units that can be physically processed by various actors. Second, it acts as a *queryable brain* that allows stocks and flows of products to be assessed digitally. Third, it acts as a *saving face* of products, giving these characteristics, meaning and recognition value. Fourth, it acts as a *helping hand* that provides skills and guidance to prepare and handle food. In all its functions, food packaging cannot be separated from the product it wraps or

3 The empirical findings are based on ethnographic research on work practices in retail (Sattlegger 2021a; 2021b) as well as on a combined diary-interview study with consumers in Berlin (Wenzel/Süßbauer 2021; Müller/Süßbauer 2022). The different ways of dealing with packaging in food supply networks guided our research perspective. This included investigating several links in the supply chain (e.g., wholesaler, supermarket distribution center, retailer, households) and connections between these sites (e.g., truck transport).

Figure 1: The four mediating roles of packaging in networks of food supply practices (© Angelika Ullmann, CC BY 4.0, https://creativecommons.org/licenses/by/4.0/, modified).

encases. Thus, packaging is not only a mediator between different practices along the supply chain, but also between products and their consumers. This versatility of food packaging is illustrated by the different elements and dimensions of the matryoshka in Figure 1. To make the connecting functions of packaging tangible, we continue with condensed descriptions of these four mediating roles of packaging.

Packaging as a flexible body – the mediation of physical handling

Packing and unpacking foods allows product units to be gathered and split, making them manageable along the supply network (Sattlegger 2021a). The definition of "manageable" depends on the specific human bodies and machines that handle or use these units in certain practices and processes. This means that the warehouse workers, as well as the forklifts, product scanners and final consumers, must be able to handle the products. Product units are predefined (e.g., primary and secondary packaging) and constantly transformed and adapted to the practical requirements of the respective situation to meet the requirements of certain practices (Evans et al. 2020). The more complex a supply network is, the more requirements the product's materiality must satisfy to be manageable. Different types of packaging are an essential part of the evolving materiality of product units. The decisive product units alternate along the supply network, from pallets for transport to the warehouse to secondary packaging

for delivery to supermarkets, and then primary packaging for final consumption. This means that longer and more differentiated food supply networks usually involve a wider variety of different packaging units. Importantly, packaging units are not only split by unpacking packaging layers at certain stages of the supply network but are also regrouped for transport by combining packaging units on pallets, or in boxes. Such practice-based adoptions of packaging units give products a flexible body that proves itself along very heterogeneous practices.

Packaging as a queryable brain – the mediation of digital manageability

Packaging units do not only facilitate the physical handling of products, but they are also crucial for digital product management. Packaging fosters digital practices of tracking products and linking them to further resources of product information. In differentiated food supply networks, the associations between practices and sites are highly digitalized: "Indeed, to a significant degree, code is the structural glue that binds distributed and distanciated activities together and ensures that products are (almost) always available for purchase and in a way profitable to the end business" (Kitchin/Dodge 2014: 200). A major part of the work in the supermarket distribution center involves the digital management and evaluation of product stocks and flows using enterprise resource planning (ERP) software. Practices that connect and synchronize the physical space (stock and flow of products) to the virtual space of the ERP system (digital stock and flow evaluation) depend on physical technologies (e.g., packaging, labels, and lists) and digital technologies (e.g., software and hardware). For example, the worker who orders the products in the distribution center is not physically present in the warehouse to estimates demands, but assesses product stocks in the ERP system. Looking at these practices more closely, packaging is particularly crucial for digitizing stocks and flows. As a hybrid technology, packaging allows the physical handling and assessment of goods (e.g., collecting products in the storage) and the digital registration of products through scannable barcodes (Sattlegger 2021a). Digital readability via barcodes and numbers on packaging gives products a queryable brain that enables product flows to be managed efficiently.

Packaging as a saving face – the mediation of emotional attachment

In differentiated food supply networks, quality standards, product certification and brands typically replace social trust and loyalty between consumers and producers. When face-to-face interaction is replaced by face-to-packaging interactions, product communication is strongly connected to packaging as a visual interface of products (Cochoy 2007). The information and meaning conveyed by product packaging mediates the exchange between the spheres of production and consumption by providing brand recognition, trackable responsibility, predictable prices, readable shelf life and virgin sealing. This is relevant for advertising and marketing towards consumers, but it also appears in the work practices of retailers and wholesalers. For example, new products are listed in catalogues containing pictures of product packaging act as profile images for these products. Hence, packaging gives abstract products as "saving face" (Goffman 1967) that enhances trust and loyalty in market interactions.

Packaging as a helping hand – the mediation of food processing and preparation

The differentiation of food supplies has also influenced how food is processed and prepared for meals. Modern food packaging has gained more convenience functions, like dosing capability or portionability (Burger et al. 2021). As a time-saving and "time-shifting device" (Warde 1999),

packaging takes the place of many practices that have traditionally been an integral part of everyday nutrition such as transporting, storing, preserving, or preparing food (Müller/Süßbauer 2022). Processing practices (e.g., pressing oranges to get juice) have been transferred to industrialized companies. By prolonging the shelf life, packaging allows consumers to prepare and eat food whenever they want. In the case of convenience food, packaging offers special functions that even eliminate the need to prepare food, e.g., prepared pasta sauce or ready-to-eat dumplings. Moreover, this mediation of food preparation skills by packaging is relevant for both private consumers and professional actors like supermarket employees. For example, the industrially pre-packed fresh food, like cheese and meat products, makes shop assistants' skilled preparation and counter service redundant. Moreover, for products that are not pre-packed, packaging allows shop assistants to prepare for peaks in demand by manually prepacking pieces of cheese or ham. Hence, packaging works as a helping hand at the workplace as well as in consumers' kitchens.

Our heuristic of the four mediating roles shows the relevance of packaging as a mediator and connector of different spheres, practices, people, and sites in multi-sited networks of food supply practices. However, these four mediating roles of packaging are not exhaustive; rather, they represent an analytical heuristic that targets certain central dimensions of packaging in intersecting networks of food supply practices. While all these roles appear at several stages of the supply chain, their relevance differs between practices and stages. For example, while digital manageability is essential for retailers to have an efficient workflow, it is not as relevant for consumption practices – although QR codes and smartphones are increasingly used for purposes of consumption. In contrast, packaging conveying an emotional attachment is foremost directed towards consumer communication, although the management of trust and responsibility is relevant along all stages of the supply chain and between heterogeneous actors (e.g., Business-to-Business, Business-to-Consumers, Business-to-Employees or Business-to-Administration relationships). As a result, packaging roles overlap and intersect in practices and therefore must be considered in their interplay. Furthermore, the mediating roles are not fulfilled by packaging alone; packaging is one important material element but integrates with other elements. For example, food preparation skills are also mediated by food design, which interacts with packaging. In the next section we will use the case of beverage packaging to provide practical examples showing the analytical value of our heuristic.

3. Transforming networks of practices

As shown by the previous sections, disposable packaging is part of a "sticky" network of practices and takes on several mediating roles that hold these practices together. In striving for a socio-ecological transformation, the question arises on how the links between these practices can be "broken" (Shove et al. 2012) to prevent or reduce waste from packaging. We argue that, rather than focusing on the optimization of the packaging itself (e.g., reducing its weight or replacing certain materials like plastics) or its public perception (e.g., zero-waste campaigns for consumers), we need to look at the mediating roles of disposable packaging to find ways on how to rearrange the network of practices in a less resource intensive way. However, to find ways of reducing waste from packaging, establishing less resource intensive practices is only the first step. A next step to sustainably transform networks of practices is to look at challenges for aspired changes of practices (Castelo et al. 2021) – how can the interlinkages of alternative practices be stabilized? To illus-

trate these two steps of transforming networks of practices, we discuss the example of beverage packaging. First, we illustrate which different practices – including competences, meaning and materials – are interlinked with alternative forms of beverages and how the mediating roles of disposable packaging can be substituted in these practices. Second, we argue that, in order to stabilize and normalize these alternative practices, there is a need for a joint visionary concept that can be used for collaboration among diverse stakeholders. We propose "precycling" as such a visionary concept and introduce its characteristics compared to other discourses in the waste prevention field.

Analyzing (changed) practices: the example of beverage packaging

Most beverages (e.g., for water or soft drinks) are sold in single-use PET plastic bottles. In Germany, beverage cans and disposable glass and plastic beverage bottles with a capacity between 0.1 liters and 3 liters have a deposit of 25 eurocents that consumers get refunded on return.[4] This allows recycling, but these bottles are not reused. Further, the consumption of beverages in plastic bottles in Germany is quite high (e.g., mineral water) resulting in high CO2 emissions during their production, transport, and recycling (GUTcert 2020). In the following, we use our heuristic to discuss two alternative networks of practices that have the potential for drastically reducing the waste problem of beverages: first, practices related to the use of returnable bottles; second, practices related to alternative ways of producing and consuming beverages based on tap water and the refilling of private containers.

Practices related to returnable bottles

A possibility to "intervene" in the single-use beverage container market is to implement returnable bottles as a reuse solution. Returnable bottles can be refilled up to 50 times (glass bottle) or 25 times (PET bottle), thus avoiding the production of many bottles and conserving resources. Although a reusable target of 70 % for bottles was introduced for 2019 by the German Packaging Act (VerpackG, 2017), in fact only 41.8 % of beverages consumed in Germany were packaged in reusable packaging in that year (Cayé/Leighty 2019). What practices need to change to implement and use returnable bottles comprehensively?

The infrastructures of collection such as reverse vending machines are crucial for an efficient flow of bottles and information. This has implications for the mediating role as a *flexible body*. Practices of collecting, sorting, and transporting empty bottles produce additional demands in this regard and might result in reverting to single-use plastics. Returnable bottles as primary packaging require returnable secondary and tertiary packaging in the form of crates and pallets to circulate efficiently in heterogeneous practices. Furthermore, when introducing returnable bottles, it is not trivial to renounce all other single-use plastics along the supply chain. For example, Sattlegger (2021b) found that substituting reusable strings for single-use plastic wrap to secure pallets and crates for transport met with resistance that originates from the attachment to plastic wrap as a flexible and easily used technology for all kinds of products and affordances. Resistance manifested in the displeasure and competence-loss of workers, who had to adjust their routine practices, as well as in the obstinacy of technology, as the strings were very recalcitrant when workers tried to bundle or unbundle them. The very specific requirements of applying, collecting, and reusing the strings contrasted with the plastic wrap as a flexible and protective cover that is habitually used for diffe-

4 From 01.01.2022, the deposit obligation in Germany has been extended to previously exempt one-way plastic beverage bottles and cans.

rent kinds of packaging. Hence, supplementing and avoiding plastic wrap in the logistics of collection calls for the consideration and support of everyday work practices and of employees' skills and views (Süßbauer et al. 2019).

Regarding the mediating role as a *queryable brain*, packaging is involved in circulation and coordination of information. For returnable bottles, these affordances are expanding in comparison to single-use bottles. The collection, cleaning and refilling of bottles widens the network of practices, affording stronger coordination. Information on system performance can still be gathered by incorporating digital technologies such as Radio Frequency ID tags, sensors, and GPS tracking into the reusable packaging system (Ellen MacArthur Foundation 2019). However, it is crucial that information can be accessed and understood by all practitioners involved, including consumers. When purchasing a bottle, consumers must know how to use and return it in the right way. Therefore, the interlinkage between the practices of producers, retailers and consumers needs to be improved to foster circularity. Surveys show that German consumers mix up disposable and reusable bottles, since both have a deposit (Arbeitskreis Mehrweg 2021). Thus, the information on the bottle must be clear to simplify disposal practices.

Furthermore, both the bottles and the return infrastructure should preferably be standardized to be easy to use and recognizable. This targets the role of packaging as a *saving face* that communicates not only information, but also meaning and emotion. A sustainability challenge in this regard is the supraregional sale of beverages in refillable individual bottles for marketing purposes (approximately one third). Standardized pool bottles are more sustainable, as they can be used by different companies and therefore do not have to be transported as far for rinsing and refilling (Institut für Energie- und Umweltforschung 2021). Thus, there is a need for joint rinsing and refilling practices by producers. However, individual bottles allow a recognizable presentation of brands and products, which stands in the way of such standardization efforts. Nonetheless, examples of standardized beer bottles as well as the current expansion of the standardized yogurt glass into different product categories indicate, that standardized bottles can become a trustable symbol that acts as a *saving face* for product marketing if values change (Rau 2021).

Concerning the mediating role as a *helping hand*, returnable bottles provide similar possibilities as their single-use counterparts. However, it is crucial that practices of takeaway consumption do not come into conflict with the collection of empty bottles. This requires an easily accessible and extensive collection infrastructure. The informal collection and return of used bottles for deposit is an important part of an efficient circulation of bottles. Initiatives like "deposit belongs aside"[5] or the installation of deposit rings or boxes at waste hotspots in public spaces, can reduce the number of empty bottles in public spaces and increase the recycling rate at neuralgic points (Bezirksamt Friedrichshain-Kreuzberg von Berlin 2021).

Practices related to private refill practices

Other practice-based interventions in the single-use beverage market are alternative ways of producing and consuming drinks based on private refill of tap water. The environmental potential of substituting bottled water by tap water is relatively high: In a Swiss case study, unrefrigerated, still mineral water had more than 450 times the environmental impact of tap water (Jungbluth et al. 2014). The availability of high quality and trustworthy tap water is crucial for such alternative drinking practices. Examples are drinking water fountains to refill private bottles or the use

5 https://www.pfand-gehoert-daneben.de/

of syrups and water bubblers to make lemonades based on tap water. Using tap water and concentrates or solids (e.g., as tablets) for mixing drinks offers the potential for a substantial reduction of packaging waste in particular and environmental impacts in general (Garfí et al. 2016). However, studies show that despite growing knowledge about its environmental downsides, the consumption of bottled water is stabilized by everyday practices, social norms (Geerts et al. 2020), as well as political efforts of the beverage industry (Hawkins 2017). Again, the heuristic of packaging's mediating functions can help to identify barriers and potentials for a sustainable rearrangement of practices based on tap water.

Refills maintain the mediating role as a *flexible body*, as concentrates are low weight and easy to transport for logistics and consumers. When needed, they can change their form and be flexible and adapted to different container sizes. The crucial aspect in this regard is the easy and flexible availability of filling stations as well as drinking containers like glasses or bottles. Initiatives for a comprehensive network of public drinking water fountains or privately provided refilling facilities can enhance this flexibility (Tat 2019).

Furthermore, private refill practices based on public and uncommercial water sources fundamentally change affordances for the evaluation of product flows related to packaging and its function as a *queryable brain*. The supply infrastructures of public water provide practices of measuring and governing flows that are independent of packaging and mobile infrastructures (Whelan 2009). Furthermore, the public control and guarantee of drinking water and its qualities and quantities reduces requirements for traceability and measurability of private use flows.

Packaging's mediating function as a *saving face* that stands for high quality and safety of its content is an important barrier for changing water consumption to more tap water use (Sattlegger et al. 2020). Hence, enhancing trust and safety of the public drinking water supply is crucial for a shift of practices (Qian 2018). In some consumer groups, misconceptions about supposed health risks of "unsafe" tap water in comparison to bottled water are still common (Geerts et al. 2020). In addition to the water itself, private refillable bottles for takeaway consumption of beverages can have an emotional meaning as a reliable and safe partner for drinking on the go. Such bottles can figure as a symbol for environmental awareness, healthiness and zero-waste lifestyles (Sartin/Krauss 2017). If used on a routine basis, people can get a closer relationship to their containers by, for example, cleaning them regularly and taking care of them (Süßbauer et al. 2020).

Regarding the role of a *helping hand*, the use of these refills or syrups calls for new skills of consumers, who must engage actively in the bottling and mixing of their drinks (Daniel-Chever et al. 2021). For example, consumers can make their own drinks at home based on tap water, and they are able to choose the concentration and sweetness of their mixes. The packaging of the concentrate or syrup can guide and support these practices by providing recipes, suggestions, or dosing aids. These preparation practices can foster experimentation and the regaining of skills on growing and preparing food in general, e.g., creating own drinks on the basis of home-grown herbs. Promoting such drinking practices based on tap water to new consumer groups and especially to low-income households requires education about tap water safety and an active enhancement of competences regarding self-mixing of drinks and food preparation skills in general.

Stabilizing (future) practices: Precycling as a joint visionary concept

The analysis shows that both returnable bottles and increased tap water consumption involve more than just changing technologies. Rather,

such strategies tackle the configuration of practice networks and all elements of practices, including meanings and competences. The advantage of this conceptualization is that it shifts the perspective from "who has to start acting" to "how a change in practices can be mutually reinforcing" for reaching the goal of waste reduction. By zooming in on different parts of the network, our sociological analysis reveals that single-use food packaging can interlock with seemingly unrelated practices (Müller/Süßbauer 2022). For example, increased tap water use relates to food preparation skills, or substituting plastic wrap in logistics is related to employees' everyday work practices. Thus, new routines can be initiated in different parts of the practice networks. They can emerge from consumers' zero-waste values, from technological developments, as well as from new political regulations, for example clear and comprehensible labelling of packaging materials. In consequence, no single group – politicians, consumers, or engineers – is responsible for the reduction of single-use packaging. Instead, transformation is distributed among multiple parties, who intervene at different stages and in different practices (Schatzki 2015). Hence, interventions need to be positioned at the intersections of different practices within the food supply network.

Thinking of transformation as a process in which practices need to be stabilized and normalized, there is a need for a joint visionary concept that links these interventions of the various parties involved and that facilitates collaboration among them. For this, we propose the term "precycling".[6] Compared to other concepts in the waste prevention discourse like "recycling", "zero waste", or "circular economy", precycling includes and addresses all actors within the food supply network – from production, logistics and retail to consumption and disposal.

Precycling extends the perspective of recycling and underlines that the waste problem cannot be solved by taking an end-of-life perspective. It is a preventive approach focusing on the roots of the problem (Bartl 2005). According to the hierarchy of waste management within Germany's Waste Management Act,[7] waste should preferably be prevented from being created in the first place – rather than recycling the waste that is already there. However, increasing the recyclability of packaging is still an important strategy. As the example of returnable beverage packaging has shown, real-world solutions are always a combination of practices and strategies: enhancing the recyclability of returnable beverage packaging, reusing them, and using tap water are not mutually exclusive pathways. Thus, precycling allows for combining different waste prevention strategies like reusing, recycling, and reducing.

Further, precycling reacts to critics of the current circular economy discourse, which renders an under-socialized concept of consumers and a simplistic idea of the citizen and how social change happens (Hobson 2020). Precycling deliberately integrates the user perspective from the beginning. Compared to other types of waste this is especially important for packaging, as a major part of packaging waste stems from consumption linked to everyday household practices. Precycling conceptualizes consumers not as rational actors who "decide" what food to buy or eat, but sees them as situated in social norms, routines, and material arrangements. For example, the routine use of returnable beverage bottles depends on how

6 The term was coined by Maureen O'Rorke for a public waste-education campaign in the United States in 1989 (O'Rorke 1989). Thus, originally, precycling was used for consumers as key actors of waste reduction. In the field of psychology, precycling encompasses behavioral strategies adopted by households to prevent waste from fast-moving everyday products such as food or drugstore items, e.g., refusing a plastic bag or over-packaging (Klug 2018; Wenzel/Süßbauer, 2021).

7 German Act to Promote the Circular Economy and Ensure the Environmentally Sound Management of Waste (KrWG)

grocery shopping is organized among household members: where they shop and how often and how they transport their purchases (Hennchen et al. 2020).

In contrast to the zero-waste discourse, precycling does not mean totally renouncing packaging, but involves strengthening strategies that have less resource and CO2 impact, such as reusing. Reusing strategies are only environmentally friendly if the reusable containers are used frequently, because reusable packaging is generally more resource-intensive to manufacture than disposable packaging (Jarupan et al. 2004). Thus, reusing needs to be spread and become "normal" for most consumers. Most narratives of transitioning to zero waste, however, address only certain social groups with higher cultural and economic capital (Müller/Schönbauer 2020). For example, organic bulk stores or farmers' markets do not exist in low-income neighborhoods.

Due to these characteristics, precycling is suitable as a shared vision for experts and non-experts, buyers and sellers, economists, and environmentalists. Hence, it can work as a "boundary object" (Star/Griesemer 1989) within socio-ecological transformation processes. Through easing the communication and mediating between actors from different social realms or disciplines, precycling maintains at least some common identity that facilitates coherence and translation across worlds. Moreover, its practice-based and multi-optional approach fits well to practice theoretical research and policy in general and to our heuristic of mediating packaging roles in networks of practices in particular.

4. Conclusions

In this paper, we used the network of practices approach to understand the persistence of disposable packaging in several domains of the food supply network. In doing so, we complemented the work from sociologists like Gay Hawkins, Frank Cochoy and others who focus on the performative aspects of packaging, highlighting its central role as mediator between product and consumers. By defining consumption as an integral part of everyday life (Warde 2005), our approach widens the scope beyond the point of sale (Müller/Süßbauer 2022). It emphasizes not only practices that are beyond shopping (like collecting and storing beverage bottles), but also practices from other parts of the value chain, like practices in production or logistics (such as the use of pallets for transport in wholesale trade; Sattlegger 2021b). This wider approach is important to find systemic solutions towards packaging waste prevention.

The network of practices approach is not only useful for analysis but can be used as a basis for transformation processes. Compared to common system approaches in sustainability research, for example the "household metabolism" (Padovan et al. 2015) or "sustainable social metabolism" models (Haberl et al. 2021), the network of practices approach neither distinguishes between the micro and macro level nor does it induce hierarchies between the different practices of the food supply network. Consequently, it conceptualizes power and responsibility as something distributed among multiple parties (Schatzki 2015, Shove 2010). This is in line with the reflexive governance of sustainability discourse (Rip 2006). Applying an integrated view of production and consumption patterns in waste prevention is more important than ever, since recent studies have shown that consumers lack knowledge regarding the impact and the right disposal of packaging materials (Otto et al. 2021). Thus, there is a need for re-integrating competences and knowledge into the everyday life of consumers and, conversely, for integrating consumer needs in packaging design and recycling practices.

We have shown that packaging is a special sort of waste: due to its mediating roles in production,

retailing, consumption, and disposal practices, it is not possible to simply omit packaging along the entire supply chain. For example, packaging can be saved in one phase of the supply chain, such as consumption packaging in the store, but is needed in other phases like transportation to the stores. By unraveling these diverse functions of packaging as a material element in food supply networks, we provide further insights into the co-evolution of materials and society (Evans et al. 2020). In using the metaphors of body, brain, face, and hand, we point out that through the evolution of food supply networks, packaging has taken over roles that belonged to people before. Accordingly, precycling is also about regaining and reintegrating competences that are nowadays done by disposable packaging, for example, how to use refills for beverages. More research is needed on how to foster these "lost" competences.

Further, by presenting the example of returnable packaging and tap water use, we demonstrate the need to look at the practices involved with the introduction of new solutions, how their interrelationship is transformed and how the mediating roles of packaging can still be maintained by less resource intensive solutions. These examples are inspired by our empirical studies but mainly ground on desk research and literature review; we suggest using our heuristic for empirical analysis of packaging examples from different (food) product areas. Different verbal and non-verbal methods like interviews, photos and participant observations can be combined in doing so. One challenge in empirically applying our approach could be the accessibility of certain practices, especially in retail and industry. These practices are often investigated with the help of expert interviews with managers from innovation or sustainability departments. We recommend, instead, implementing participatory or experimental research methods that also draw on the experiences of other employees, especially from the grassroots level, to fully understand work practices (Süßbauer et al. 2019, Sattlegger 2021a).

Finally, to stabilize and foster sustainable practices within these networks, we have presented precycling as a joint visionary concept. As shown in Section 4, precycling complies with the flat ontology of the network of practices approach since it does not imply hierarchies among practices or actors involved. For transdisciplinary research processes, we recommend involving social scientists, engineers, and practitioners from across the supply network. Precycling strategies should reduce resource consumption and waste (environmental perspective), and also be feasible from an economic and everyday life point of view (social and economic perspectives). In our opinion it is important to first analyze real-world practices (for example how new refill solutions change retailing practices) and, based on this, create life cycle analyses to integrate this knowledge into common tools and methods used in the waste prevention field. Hence, we are convinced that the sociological understanding and analysis of everyday practices is crucial for the practical suitability of precycling efforts.

We conclude that waste prevention policy strategies that simply target technological improvement or consumer selection fail to consider the importance of packaging as a mediator in differentiated networks of practices. Reflecting on the interplay and outcome of mundane practices can help to avoid corporate greenwashing strategies, such as substitution of plastics through bio-degradable plastic. However, the implementation of distributed governance in current policy processes remains a challenge. Since "interventions go on within, not outside, the processes they seek to shape" (Shove 2010), it is important that political rules and practices themselves are also part of this transformation process.

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Disclosure Statement

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