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Haase, Louise Møller; Lythje, Line Sand

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Article

User Strategies for Prolonging Product Lifetimes: A New Starting Point for Circular Conceptual Design

Louise Møller Haase * and Line Sand Lythje 

Department of Architecture, Design and Media Technology, Aalborg University, 9000 Aalborg, Denmark

* Correspondence: louise@create.aau.dk; Tel.: +45-6146-9372

Abstract: Product life extension is recognized as an important tool for creating more sustainable production and consumption patterns; yet, there is a lack of studies with comprehensive insights into how consumers interact with products throughout the product's life span, or knowledge about the strategies consumers apply to change their behaviors and avoid premature disposal. The purpose of this study is to explore the motives and strategies users apply that positively affect product lifetimes, which provides much-needed input on the consumer's perspective in the circular economy. The study applies a qualitative ethnographic research methodology on 26 households, in which we investigated how differently motivated users engaged with products in their homes; how they approached, developed, and modified products to fit personal needs, and, eventually, end up prolonging product lifetimes. The study contributes a new perspective on user research in the circular economy and suggests a new paradigm for circular conceptual design. Specifically, the study shows how existing user strategies for product longevity can be identified and used as a starting point for designing products and services that prolong product lifetimes.

Keywords: product longevity; product life extension; consumer behavior; sustainability; circular economy; conceptual design



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1. Introduction

Product life extension has been recognized as one of the most important strategies for the transition from a linear to a circular economy [1–3]. Consequently, a substantial body of literature has explored how to increase product lifetimes in terms of durable product design (see, e.g., [4–6]) and manufacturing practices such as repair, refurbishment, and remanufacturing (see, e.g., [7,8]).

However, durable design and manufacturing practices are not enough to create a linear to circular economy transition. In fact, studies show that people often select products with a short durability over those with longer durability. In many cases, they choose to replace durable products without even considering repair, and they discard well-functioning products simply because they do not find them useful or attractive anymore [9–11]. Particularly with electrical products, product lifetimes tend to decrease as a result of premature disposal [9].

This emphasizes the consumer's role as critical for sustainable development, and customer behavior being an important determining factor for a product's actual lifetime, as with, for instance, consumers choosing whether to repair a product [12–16]. Despite its importance for the circular economy, the predominant focus is still from the perspective of product design and manufacturing practices, whereas the customer perspective remains highly overlooked in existing research.

In management and social science literature, the consumer perspective is mainly addressed in terms of how to encourage consumers to adopt pro-environmental attitudes and behaviors [17–19].

In the limited body of literature on design and manufacturing which concerns the customer perspective, the predominant focus has been on customer use behaviors and how to change consumer behaviors into a desired environmental behavior that includes, for instance, repair, upcycling, and product care practices [20–24]. This stream of literature prescribes a general normative behavior guided by what is most appropriate from an environmental perspective. However, behavioral research has shown that behaviors are most often habitual and guided by automated cognitive processes, where actual behavior results from a variety of different motivations [25–27]. As a result, most people will know how to act responsibly regarding the environment, but many products end up being prematurely disposed of nonetheless, despite the availability of durable products that encourage environmental (normative) behaviors such as care, maintenance, and repair [9,22]. This implies that many people are not intrinsically driven by environmental considerations, but rather by other motivations, such as emotional factors (e.g., pleasure) or personal resources (e.g., money). Environmental or normative behaviors often involve sacrificing personal benefits (such as pleasure, money, or convenience) to benefit the environment, and they are often perceived by consumers as less profitable, more time consuming, and requiring more effort than less sustainable alternatives [28]. Thus, many factors other than environmental considerations drive an individual's behavior including status, comfort, pleasure, and effort [27], either consciously or unconsciously.

Building on behavioral research, we argue that, in addition to the current normative design for behavior change approaches [24], there is a need to explore alternative models that support existing user behavior and interactions that imply environmental benefits, thus contributing to a product's longevity. Whereas current circular economy research has described product longevity strategies from a product and manufacturing perspective, this research aims to explore and identify strategies that describe unique user behaviors resulting in prolonged product lifetimes. Therefore, the research question for this study was, *What are the strategies that customers apply to prolong product lifetimes?*

To this end, we conducted an ethnographic study in 26 Danish households to explore how users engaged with their products, specifically how they approached, developed or modified their products (or systems for a product) to serve their personal needs, and how this positively influenced the product lifetime. This approach was adopted to uncover their deeper motivations, beyond the normative goals, and, thus, to identify the strategies they adopted around the product to serve their specific needs. Indeed, products must allow for environmental behavior such as maintenance and repair, but it is only worth the effort if users are intrinsically motivated to keep and care for products over the long term. We argue that, beyond the normative approaches that have been addressed in existing research which focus on encouraging a desired behavior, there is an untapped potential to build on already positive behaviors that contribute to a product's longevity. Such knowledge is particularly relevant for the conceptual design phases, which is highly under-explored in the context of the circular economy. Therefore, the main contribution of this study is to provide insight into the actual behaviors and strategies that could, if designed into new products and services, lead to more sustainable consumption patterns. This study is therefore relevant to service and product designers, and other professionals involved in the conceptual phases.

The remainder of this article is structured as follows. First, we present the theoretical framework based on the different use stages for a product, combined with behavioral research relevant to user research in the context of a circular economy. Then, we discuss the research design for this study, followed by the analyses and findings, where we present nine user strategies for product longevity. Finally, theoretical and practical implications are discussed, and potential future research avenues are addressed.

2. Theoretical Framework

To identify the strategies that users apply for prolonging a product's lifetime, we must first understand the different use phases and the motivations that guide user behavior and interactions within these phases.

2.1. Understanding Product Use Phases

In a recent study, Shi et al. [12] addressed product use phases through a substantial literature review regarding product life span from the perspective of product design and manufacturing practices. In their study, they suggested that products provide customers with different functional, social, and emotional values during the different product use stages. Moreover, they suggested that different types of customer usage behaviors occur in the various product use stages. The five use stages and related usage behaviors are depicted in Figure 1 (the white area on the right) and further specified in the following sections. Figure 1 also serves as the theoretical lens of the study.

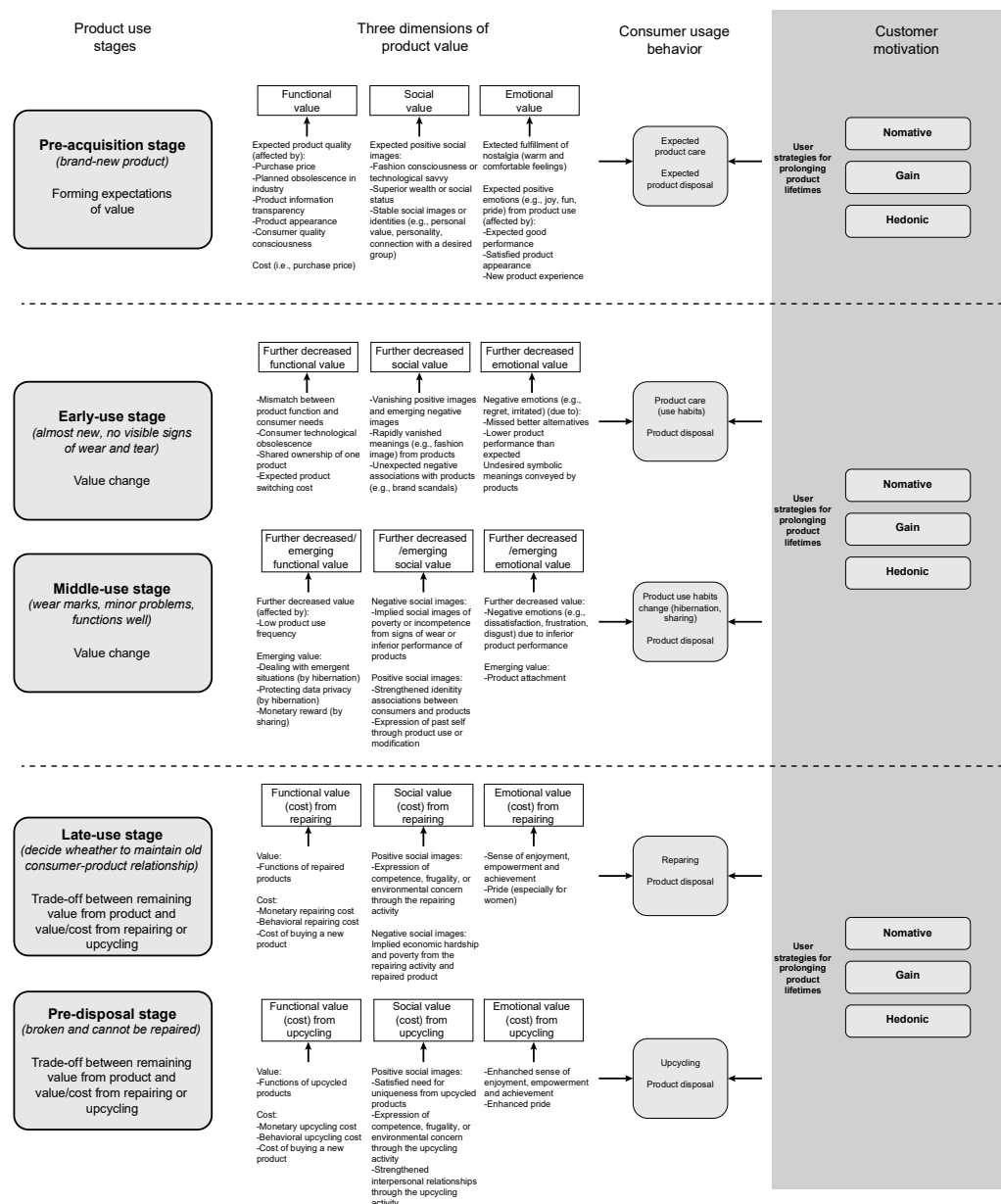


Figure 1. Theoretical framework addressing product use stages, on the one hand (based on [12]), and consumer motivation, on the other hand (based on [28]).

2.1.1. The Pre-Acquisition Stage

In the first use stage, the pre-acquisition stage, the customer evaluates the product, creates use plans, and forms expectations with respect to the product's life span [29]. These expectations influence later product use behavior and, ultimately, the product's lifetime.

For instance, if the product is expensive or is expected to have a long use period, it is more likely to be maintained and cared for [16,30]. In the pre-acquisition stage, the user forms expectations in relation to the product's functional, social, and emotional values, such as the expected product quality, the ability to enhance self-concept or symbolize self-identify, or the expected nostalgia or positive emotions derived from product use. If these expectations are not met in later use stages, it may lead to early product disposal [12].

2.1.2. The Early Use Stage

In the second use stage, the early use stage, the user becomes familiar with and continues evaluating the product. In this stage, the user also cultivates their product use habits which are usually maintained until the end of the product's lifetime, including minimizing signs of wear and tear, using the product properly, and ensuring maintenance [30,31]. In this stage, the perceived product value may also start to decline over time as the product gets older. The functional value may, for instance, decline if there is a mismatch between the product's function and the customer's needs as a consequence of misleading product information, or if the customer fails to evaluate the needs accurately or carefully such as an impulse purchase [16,32–34]. This functional mismatch may also occur during this or in later stages if the customer changes living environment or conditions (major life events, moving residence, etc.) [35,36]. Moreover, the functional value of the product may also change if a new model with better functions and features is introduced to the market, known as technological obsolescence, or if the expected cost of switching is manageable [37–40].

In this stage, declines in social or emotional value are not typical but can occur due to brand scandals which give the product negative associations [41], if the customer realizes that a better alternative in the market was missed, or if the product is not as good as expected [42].

2.1.3. The Middle Use Stage

In the third use stage, the middle use stage, the product condition changes and new factors start to change the value of the product either positively or negatively. Two new types of customer usage behaviors are likely to occur in this stage: hibernation and sharing.

The perceived product value may decline in this life stage due to low or limited use, for instance, because of limited fit with customer need [43,44]. Likewise, the product might enter a dead storage or hibernation period due to the protection of personal data or for the sake of keeping spare parts [37,45–48].

In this stage, the social and emotional value of the product can either increase or decrease depending on how the customer perceives the product's social value. If newness, fashion, and technological savviness are the main values, product wear and tear might be a reason to replace the product if the user does not want to signal poverty or incompetence [49]. Conversely, long term product–user interaction may lead to product appreciation and attachment [50], as well as investment in the product such as with personalized use or modifications [51] that increase the product value and encourage the customer to keep the item.

2.1.4. The Late Use Stage

In the fourth use stage, the late use stage, the product may start to have minor or major malfunctions. The customer will start to evaluate the trade-off between investing resources to keep the product's value in use, such as investing money and time to repair or replace it. These considerations are affected by the costs of service and spare parts, repair knowledge and skills, accessibility of repair tools, and the cost of buying a new product [52–57].

Repair considerations are also influenced by potential increases in social and emotional value. Repair can, for instance, show competence, frugality, or environmental considerations [22,57,58], but may also signal poverty [22]. Likewise, the repair activity may generate a sense of enjoyment, empowerment, and achievement [57].

2.1.5. The Pre-Disposal Stage

The fifth and final use stage is the pre-disposal stage. In this stage, the customer is likely to dispose of the product. The original function cannot be restored, and therefore a trade-off between the remaining value of the product (e.g., valuable or useful material, distinct designs or patterns) are worth the investment in money and time to upcycle the product. As in the late use stage, the decision to upcycle the product is influenced by knowledge and skills, such as creativity, accessibility of tools, and considerations of money, time, and effort compared to the cost of buying a new product [23,59–62].

Upcycle considerations are, as in the previous stage, also influenced by potential increases in social and emotional value. Such a product will typically be more unique than mass-produced products, and thus allow the customer to display competence, environmental consideration, creative self-image, and so on [23,62–64]. Likewise, the upcycling process might also generate a sense of accomplishment, pride, and enjoyment, and will typically also strengthen interpersonal relationships as upcycling typically becomes a group or community process [23,63,65,66].

2.2. Understanding User Motivations

To fully understand user behaviors in the different stages described above, it is also important to understand the customer's underlying motivational drivers, as they will also influence behaviors. For example, customers with environmental concerns will behave differently when it comes to product use and care [19,20] than materialistic consumers, who are known to dispose of products before they break [67,68]. Likewise, customers who purchase products to portray self-identity, fashion consciousness, or technological savviness, or those who purchase products that signal wealth or social status, are likely to replace a product prematurely. Hence, we found it relevant to extend the theoretical framework presented by Shi et al. [12] to include a behavioral theory, namely goal framing, that has been recognized as suitable in integrative frameworks for understanding users' environmental behaviors, specifically [27] (see Figure 1, gray area on the left).

In the present literature, a goal frame is identified as the main determinant of how one looks at a certain situation, evaluates different aspects of the situation, considers alternatives, and then acts accordingly [69,70]. Goal framing theory suggests that there are three main types of motivations (or goals) that steer our behaviors and decision-making in a given situation: normative, gain, and hedonic motivations [28]. When a normative goal frame is dominant, one is driven by norms in terms of what is most "appropriate" from an environmental perspective. Thus, one's decision-making would be based on what one ought to do, such as showing exemplary behavior and contributing to a cleaner environment. When a gain goal frame is dominant, one is guided by the rational choice in terms of "what would I get out of it," based on personal resources such as money, status, or time. Typically, one's decision would be based on considerations such as what is most profitable, requires less effort, and is less time consuming. Finally, when a hedonic goal frame is dominant, one would aim to improve how one feels, thus making decisions based on one's emotions at the given time, such as seeking pleasure or excitement.

In their conceptual study, Steg et al. [28] proposed that an interplay between the motivational factors leads to sustainable consumption. This was confirmed in later studies by, for example, [71,72], who proposed that gain motivation can be used as a mediator for sustainable consumption.

In practice, multiple goals or motives would be activated in a given situation, but one will be dominant and most strongly influence our decision-making and behavior, while the other motives are in the background [28]. Based on this understanding, one way to encourage environmental behavior is for a hedonic or gain goal to support a normative goal, meaning, for instance, the circular or sustainable product is also the most pleasurable or least time consuming.

Building on this understanding, this paper suggests that a starting point for creating products with long lifetimes is to build on users' actual behaviors that have a positive effect on product lifetimes. This means that we need to also account for users that are not naturally driven by normative goals, but who have different motivations that directly or indirectly support a normative behavior. In this study, we were thus interested in the strategies that users apply to obtain a more environmental behavior, as these can be some of the bridges or mediators for more sustainable consumption patterns that, if designed into new products and service offers, may encourage more people to adopt sustainable customer usage behaviors.

The present study aimed to contribute to the aforementioned behavioral research by exploring the underlying motivations of behaviors and user strategies that lead to prolonged product lifetimes in the use stages, from pre-acquisition to the pre-disposal stage, and determine how these postpone replacement or prevent premature disposal. The theoretical lens outlined in Figure 1 thus serves as the analytical framework and starting point for this research.

3. Materials and Methods

To gain deep insight into users' actual behaviors, motivations, and habits, we applied an ethnographic approach in the study. More specifically, the data set consisted of videos recorded during home tours in 26 households along with contextual interviews. These methods were central to this study in order to gain contextual knowledge about the everyday practices users engaged in with products, which we would normally not encounter in a common interview detached from the specific circumstances [73]. Furthermore, visual ethnography, such as video tours, has been highlighted as a way to comprehend unspoken, tacit, or latent knowledge [73,74], which were essential aspects of this study for gaining insight into the respondents' deeper values, dreams, and aspirations. Moreover, the contextual interviews provided contextual understanding of the consumers' experiences, behaviors, and the specifics they were referring to during conversations [75].

The respondents were selected to represent a wide demographic variety in terms of age (23–60 years), size of household (1–5 people), gender, income, education, and employment (see Table 1). All respondents were Danish but resided in big cities, smaller cities, and rurally. The visits focused on how the respondents used and interacted with their products, which were centered on three main categories: furniture, domestic appliances, and consumer electronics. The following themes were addressed during the visits: the perceived experience of certain products, expected lifetimes of the products, interactions with the product over its lifetime, the reason they acquired the product in the first place, the acquisition process, their expectations when acquiring the product, and how their expectations eventually changed over the product's lifetime.

The home tours, including contextual interviews, lasted from 1.5 to 2.5 h and were video recorded and supplemented with photos of the products in the homes and the researchers' field notes.

Table 1. Overview of participants in the study.

Respondent	Gender	Age	Household Size	Employment
Respondent A	Female	58	2	Kindergarten manager
Respondent B	Male	26	2	Sales assistant
Respondent C	Male	36	4	Constructing architect
Respondent D	Female	48	1	Secretary
Respondent E	Female	60	2	Dentist
Respondent F	Male	27	2	Consultant
Respondent G	Male	26	2	Case manager
Respondent H	Female	35	2	Unemployed
Respondent I	Male	34	5	Software developer

Table 1. *Cont.*

Respondent	Gender	Age	Household Size	Employment
Respondent J	Female	27	1	Nurse
Respondent K	Female	26	1	Administrative assistant
Respondent L	Female	55	2	Social worker
Respondent M	Male	58	2	Logistics manager
Respondent N	Female	30	1	Engineer
Respondent O	Female	28	1	Experience designer
Respondent P	Female	33	3	Teacher
Respondent Q	Female	43	4	Self-employed
Respondent R	Female	23	2	Student
Respondent S	Female	45	2	Substance abuse consultant
Respondent T	Male	32	2	Consultant
Respondent U	Female	29	3	Consultant
Respondent V	Female	46	4	Pharmacist
Respondent W	Female	25	2	Student
Respondent X	Female	56	2	Service assistant
Respondent Y	Female	28	2	Consultant
Respondent Z	Male	35	3	Unemployed

4. Results

This section presents the results based on the data set built from the 26 cases. The analysis is based on the semi-transcribed video recordings, photos, and field notes, with nine strategies retrieved according to the different use phases shown in Figure 1. Specifically, the strategies were identified based on the respondents' reflections and motives that demonstrated a positive usage behavior that potentially would positively influence the product's lifetime across the different product categories.

4.1. User Strategies in the Pre-Acquisition Phase

User strategies in this phase were identified based on the respondents' reflections on their approaches and processes when acquiring a new product. This stage reflects user expectations, needs clarification, and specific values and features they were looking for before acquisition. For this study specifically, the strategies were identified based on considerations that might influence later product use behavior and, ultimately, the product's lifetime. The strategies are discussed in the following, accompanied by examples from the data set in terms of (1) the observed behavior, (2) the underlying motivation for that behavior, and (3) how that influenced later product use stages and thus the product's lifetime.

4.1.1. Seeking Deep Product Knowledge

Seeking deep product knowledge is one of the main strategies observed in the data set across the cases and product categories. This was used as a way to ensure product reliability, and thus an incentive to take care of and maintain the product over time. The strategy mainly applied to users who sought deeper product knowledge through experts as part of the acquisition process, or that sought background knowledge for themselves about the product (e.g., in terms of production).

Examples from the data set:

One observed behavior was the seeking of an expert's knowledge and evaluation before acquiring a product. This was a pronounced pattern for Respondent O as a way of securing product reliability. For instance, when she acquired headphones for running she relied solely on the expert's recommendation/review: "I didn't know the product beforehand, but there was an expert vouching for it" [Respondent O, 42:15]. This means that the expert's experience and knowledge formed her evaluation of and expectations for the product, which in turn influenced her care behavior at the later use stages, based on the deep product knowledge she acquired from the expert.

A similar behavior was seeking products that are used by professionals. For instance, Respondent P was looking for a kitchen appliance, but rather than seek an expert's opinion, she looked at the appliances used by professionals. This meant that her evaluation and expectations were based on professional products that she perceived as durable and high-quality. Also, in this case, the user ended up with a brand she had not previously known, and she even compromised on her esthetics and preferred size: "It's a giant, and I was disappointed in the beginning because I spent so much money . . . Until I figured out how it worked. Now I am very pleased with it. And it can last for 30 years!" [Respondent P, 13:55]. Her positive experience influences her current care behavior (the later use stages), and she intends to keep the product for as long as possible.

The same pattern was present in a different case, where Respondent E went to the local coffee house as part of the process of buying a coffee machine. Instead of going to a hardware dealer, she sought a barista to acquire deep knowledge about making coffee and, thus, the important features in a good coffee machine: "The coffee specialist knows better about the process of making a good espresso than in the general hardware shop" [Respondent E, 13:05]. This provided her with the necessary knowledge to make an informed and confident choice, which influenced her positive attitude about maintaining the product over time.

Another observed behavior was a user who allocated a broker to the acquisition stage. Specifically, when Respondent E intends to acquire domestic appliances, she allocates the process to an electrician (she has used the same electrician for more than 30 years). She relies on his knowledge about the market, important product features, and what would fit her long-term needs. This also means that she is likely to keep and maintain the product, because she is confident that it is a good investment.

A different behavior involves seeking background knowledge about a product before acquisition. One example is Respondent M, who seeks production information about furniture, which ultimately influences his product choice. Specifically, he values local production not for environmental reasons, but because he associates local production with good quality and reliability (e.g., in case of needed repairs, the process would be more direct). Locally produced products have a positive influence on the environment (e.g., in terms of transportation), but in this case, it also impacts the product lifetime, as it is considered a quality label for the user (thus encouraging care behavior) and repair is perceived as being more effortless.

4.1.2. Clarifying Needs

This strategy applies to users who seek to clarify their needs before acquiring a product. This means that the acquisition process often takes a long time to identify a product with the specific features that will fit perfectly with their needs. Accordingly, users of this strategy will never consider impulse buying, focusing instead on making safe choices.

Examples from the data set:

One example of this strategy is a long acquisition process taking into consideration, "Is it a real need?" For instance, for Respondent K, a pronounced behavior is conducting a lot of research before acquiring a product, and next considering whether the certain product meets a real need. Her motivation is to make a safe choice that she will not regret over time. This also means that she aims to keep the product for as long as possible given that a new acquisition process is full of effort.

In a different case, the user is also very careful in the acquisition process and is quite aware of her own consumption behaviors, both in terms of acquisition and in later use stages: "It feels better with few things. Then I know exactly the things I have, and I use them more" [Respondent N, 15:45]. In this case, the behavior is not driven by environmental considerations, but rather by an awareness and clarification of her own well-being in serving her needs with as few products as possible.

Another behavior observed in the data set is Respondent R, who acquires secondhand products to test her needs before investing in a new product. The motivation behind this

behavior is part of a process of clarifying or testing her needs without any risk: “It’s a process of testing it out; otherwise, we can just deliver it back” [Respondent R, 12:50]. Specifically, she views these products as “secondhand prototypes,” which means that when she acquires a new product, she is conscious of her needs, preferences, and the long-term perspective, meaning that she takes good care of her products and avoids disposal whenever possible.

Another example of the strategy is Respondent L, who seeks products with no unnecessary features. For instance, when she acquired her microwave oven, the critical feature was to heat up food—and nothing else (such as many different programs). In her view, it should only serve the basic needs, and serve them very well (i.e., the simpler, the better). This understanding influences her behavior in the later use stages, as she perceives that it might be easier to operate fewer features and components, as well as in the case of repair.

A similar behavior is seeking specific product features that fit certain needs and provide convenient interactions. For instance, Respondent F is very aware of small product details that influence the product experience in the long term. Specifically, if he buys a product that he intends to keep for a long time, everyday moments are thought through carefully, such as with the SodaStream machine that should have a snap lock instead of being screwed into place (convenient experience) or a laundry basket that needs to have wheels (to avoid losing a sock on the way to the washing machine). This means that if he should keep a product for a long time, it needs to provide convenient interactions throughout the long term, which positively influences his care behavior during a product’s lifetime.

4.1.3. Acquiring for the Future

This strategy applies to users who seek products or product features that are “future-proof,” meaning they imagine what their future needs will be (even though their current needs might be different). A general pattern of this strategy is that the products are acquired to serve long-term needs, which positively influences care behavior in the later use stages.

Examples from the data set:

One example of this strategy is Respondent G, who acquired a TV that was too big for his current home, but will meet future needs when they move into a new house in the future. His motive was to avoid buying a new TV when their current home becomes too small and their needs change as they have children.

Another example of future-proof decisions is choosing discrete or neutral colors when acquiring a new product. This was a general pattern identified across the participants (Respondents G, R, and S). For instance, one of the respondents argued about the white lamps in her kitchen, “I chose a neutral color . . . because what if my future kitchen is green . . . then I know they will always fit” [Respondent R, 41:50].

Yet another example of this strategy is Respondent N, who acquires products that can be changed over time to serve her changing needs. For instance, when she acquired her sofa, it took a long time to find one with replaceable upholstery, which was her main criteria in the acquisition process. In the user’s view, this was a future-proof feature to ensure that she could keep the sofa for many years without concerns about disposing of it due to worn upholstery.

In a different case, Respondent T described how he acquires products that he and his family can create stories with. For instance, when acquiring their sofa, it was important that it could withstand their future children’s activities and that it was big enough for an entire family. Likewise, when acquiring their dining chairs, they imagined what their future home would look like, as well as future scenarios involving a family.

Another interesting behavior observed in the data set was Respondent K, who had acquired no-name furniture many years ago. At that time, they were acquired for temporary purposes, but instead of disposal, she just found a new purpose for a shelving unit as her needs changed. In her view, the durability exceeded her expectations, and its discrete look made it fit different purposes over time, which made her keep it in the long term.

4.1.4. Maintaining a Current System

This strategy is based on users who take a systemic view when acquiring a product. This means that their choice is dependent on whether a product is perceived as fitting into a current system (products that are connected and intended to stay together) or whether it has a systemic potential to further build upon in the future (which ensures that it will not become obsolete).

Examples from the data set:

An example of the system strategy is Respondent S, who acquired a candleholder with a systemic feature (it can be extended with more elements). Due to this core feature, she found the product to be relevant in the long term because she had the possibility to extend the product, renewing it instead of replacing it.

In a similar manner, different respondents (G, V, U, Z) described a systemic view in terms of acquiring products that are part of a current product series, which means that they are intended to stay together. This behavior applies to products with a long legacy (such as Vipp and the KitchenAid series). As one of the respondents explained about KitchenAid products, “We like that it goes together, and they are acquired for the same reason. Just like we don’t buy three different types of plates” [Respondent G, 05:55]. The user views this connection as a long-term quality that extends the experience of each product. This also means that there will not be different products making one in the current product line obsolete as that would separate or disconnect the “system”.

Another interesting behavior was observed in the data set with Respondent H, who created a master plan as part of her acquisition process. In this case, she had gotten divorced and moved into a new apartment without any furniture, domestic appliances, or consumer electronics. She found this situation to be an opportunity to make a long-term plan for her future products by creating a master plan before acquiring any product. In this way, she would make sure that every product would fit into her planned “system.” Thus, the products were “born” together, which influenced her care behavior at the later use stages to sustain this organized system.

4.2. User Strategies in the Early and Middle Use Phases

Early and middle use strategies are identified based on a user’s reflections on product care and maintenance over time, meaning what factors encourage maintaining the product. It also considers motivations for how to avoid hibernation and dead storage, thus ensuring that the product has an active lifetime. These strategies are described in the following, accompanied by examples from the data set.

4.2.1. Planning Next Use

Planning next use is a general strategy at this product stage. In particular, resale value is a main factor that encourages product care and maintenance to maintain value also for the next owner. This strategy is present in different activities, such as storing the original packaging or ensuring an active product life via a prescribed legacy sequence for a product.

Examples from the data set:

An interesting example of this strategy was Respondent F, who stores the original packaging when he acquires a new product. He describes himself as a “hype boy” keen on new technology; a behavior that is normally associated with premature disposal to keep up with the latest technological features. However, this user is very conscious that the product has a next user, and therefore, he makes a virtue of maintaining the product, keeping it in as good condition as possible, and storing the packaging as a way of sustaining the product’s resale value.

In the same manner, there are examples that show how users generally treat their products with greater care to maintain resale value. For example, Respondent L acquired a set of dining chairs and though she has no plans to resell them, she is conscious of their potential resale value if she maintains and takes good care of them.

Another example of this strategy is a user who describes how many of his products follow a “legacy sequence” to ensure maximum use before disposal. This means that when he acquires a product, the next user is planned to be his brother, who then passes it on to the mother, and so on. In this case, the user is aware of his changing needs, but it is still important to him that the product has a long lifetime and lives for as long as possible: “It deserves to live on . . . It should not end up as dead storage or waste” [Respondent F, 41:50]. This means that he treats the product with great care because he is aware it should have a continuing life.

4.2.2. Seeking thorough Understanding of Correct Use

This strategy is considered to be a continuation of the strategy of seeking deep product knowledge before acquisition. After acquiring a product, seeking thorough understanding its correct use is a way of ensuring the highest levels of maintenance and product care.

Examples from the data set:

Here, there is the example of Respondent M, who always reads the instruction manual for every product he acquires. His aim is to understand every detail of the product, how it works, and thus, how he can optimally use the product over time. This also means that he feels equipped for what to do in the event of an error message and would then seek to fix it himself rather than dispose of the product.

4.3. User Strategies in the Late Use and Pre-Disposal Phases

At these use stages, strategies are identified based on behaviors where the user aims to avoid disposal of products even when the product is considered obsolete, such as in terms of aesthetics (when the look does not fit into the home anymore), physical functions (part of the product is broken), or due to changed needs (the product no longer fits the user’s needs).

4.3.1. Enabling a Second Life

This strategy is different from an upcycling strategy in that it reflects a behavior that intends to retain the product in the current condition (despite obsolescence) but for use in a new context.

Examples from the data set:

There were several examples of this strategy. For instance, Respondent V described how her vacuum cleaner broke at the mouthpiece, which meant that she could not use it for daily cleaning of the floors. Instead of disposal, she found that it could be used for cleaning the car in the garage, where the mouthpiece was not needed. Likewise, she found a new context for old table mats, using them on the garden table to protect the table from grooves and scratches. Similarly, Respondent A uses her worn-out clothes for working in the garden.

4.3.2. Finding Potential in the Existing

This strategy reflects the situation where the user has recognized the product is obsolete, but instead of disposal they look for potential ways to change the product to fit new needs.

Examples from the data set:

One example of this strategy is Respondent G, who extended the life of an old shelving unit. When he moved in with his girlfriend, the old shelving unit did not fit in the new apartment but rather than disposing of it, they looked for how it could be changed to fit their new needs.

A similar example is Respondent Q, who has a 40-year-old shelving unit that she has transformed in different ways over the years. Recently, she removed the base and mounted

it on the wall “to keep up with the times” [Respondent Q, 21:10]. She also argued that it is a great opportunity to make her furniture unique.

Finally, in a different case, Respondent R had an old plate rack that no longer fit in the house. However, she wanted to give it another chance before disposal so she sought to renew it and ended up with a fairly different product in better condition and an updated color: “Now I will never dispose it” [Respondent R, 53:15].

4.3.3. Seeking the Convenient Choice

This strategy is identified based on behaviors that postpone disposal solely because it is the less effortful choice (i.e., not for environmental reasons).

Examples from the data set:

One example of this strategy is Respondent D, who avoids disposing of products, but not for environmental reasons. In most cases, it is the most convenient choice: “It is much easier to pass it on or sell it than it is to dispose of it” [Respondent D, 04:30].

In a different case, Respondent S avoids disposing of products but chooses, in terms of repairs to, keep it for herself. In this case, it is not a matter of whether to repair but rather the choice of repair. She describes a situation where her KitchenAid blender stopped working: “I found out that it was much easier to repair it myself than bringing it to the shop, which then passes it on to the repair supplier, then I have to wait three weeks or so ... and then in the end, spend 10 times more than if I could do it myself. I found out that I could buy the repair tool for a small amount, and then look up on YouTube how to fix it ... And next time, it would be even easier” [Respondent S, 29:35]. As such, this user has already adopted an environmental behavior (in terms of repair), but the critical point in this process is what is most effortless, less time consuming, and most profitable.

5. Discussion

The aim of this study was to better understand the user perspective of product life extension, namely, user behaviors that end up prolonging product lifetimes. While the role of the customer has been highlighted as an important determinant of product lifetimes in the existing literature, it remains highly overlooked. This study attempted to fill this gap by studying how users interact with their products, and specifically how they approach, modify, or develop a product or a product system to serve their personal needs. This resulted in nine main user strategies that were identified at the different use stages, which are summarized in Figure 2.

The strategies contribute to current circular design strategies with a nuanced view of current behavioral research on the circular economy. User behavior has mainly been addressed from a normative view that explores how to change current user behavior into a desired behavior that fits into new circular business models. However, these normative approaches do not consider the users’ acceptance of these circular models, nor the users’ motives for purchasing a product in the first place or how they actually engage with a product during its different use stages, which ultimately determines the product’s lifetime. Instead, we advocate that a descriptive approach is central for the design process of circular products in order to support consumers’ existing behaviors and motivations (that have a positive influence on product lifetimes). For instance, the study identified that maintaining a current system is a main strategy used in the pre-acquisition stage where the user creates a (mental) system around one or more products. Thus, when acquiring a new product, the choice is based on that it fits into this system which also ensures its (long-term) relevance. This user strategy could be important to build a new product concept upon; for instance, by exploring how the systems view could be part of the product or service itself or part of a larger system that extends the experience when connected with other artifacts. Similarly, the study identified that clarifying needs is a main strategy used in the pre-acquisition stage as well to identify what product would best fit specific needs. Because this is often a very effortful process, the user acquires the product with a long-term perspective, not for environmental reasons but because the acquisition process is so effortful. This could

be an important insight to build upon to help the user in this process. For example, a trial period could be part of the product concept or easy access could be provided to the needed product knowledge (in the product itself and in marketing material) to support a user in making a confident decision. In this way, the user strategies are relevant when these are supported in a new product concept, which could then be some of the bridges that may increase the product's longevity because it builds on the users' existing behaviors and motivations.

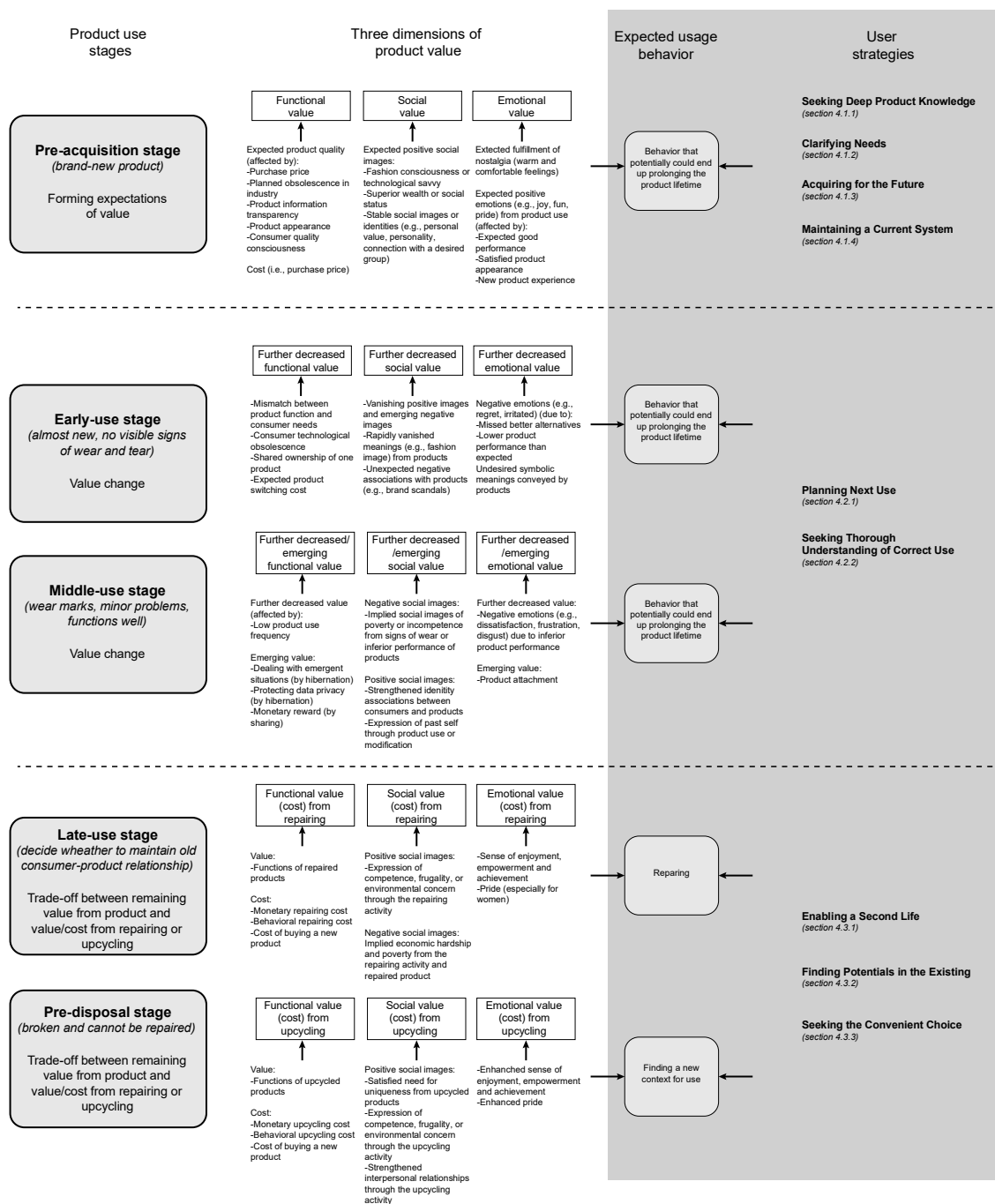


Figure 2. Contribution of the study (grey area to the right) in comparison to the theoretical framework outlined in Figure 1.

When we consider the methodological approach applied in this study, it reflects a user-centered innovation process (as described by e.g., von Hippel [76]) in which users develop or modify products to get exactly what they want which might be different from the manufacturer's original intent with the product. Many products are designed from a manufacturing perspective to meet some overall needs of a large market segment which ensures profit from a large number of customers. However, the user-centered innovation process provides an important complement to innovation in a circular economy context where (positive) user behavior is so critical. Therefore, the user-led process might be an important perspective to ensure that new solutions meet the actual needs of the users and support their already positive behaviors. This research aimed to illustrate the potential of this approach, concretized into nine user strategies that are considered relevant to the conceptual phases of the circular design process in particular.

In this paper, we advocated for a descriptive approach as a central part of circular conceptual design which is in line with Skibsted and Bason [77], who pinpoint that a critical part of the sustainable transition is not only to slow down the consumption cycle, but to also slow down the design process to create products that people would keep and take care of in the long run. Many companies feel the pressure to cater to ever-shifting customer needs that, in turn, leads to increasingly rapid product development that often skips the user research that is a critical part of the design process for identifying what really resonates with users in the long term. Specifically, user research is a critical part of the conceptual phases that is the core synthesis of design, in which the main idea and foundation for a product is developed—the key functions, interactions, and experiences that, together, forms its reason for existing. In the context of circular economy, it is difficult to identify studies that address this stage of design, and in particular, the knowledge needed for the process. While the current product and manufacturing strategies for product life extension are applicable to later design stages, circular conceptual design (for the early design stages) is highly overlooked. This study sheds light on this gap and provides some much-needed input on the customer perspective for the circular design process.

In addition to the strategies described in this study, the data set also found examples of emotional attachment, which has also been categorized as a motivation that potentially can prolong product lifetimes. This study did not include these strategies as this focus had been addressed in previous studies on the customer perspective (see, e.g., [78,79]). While a relevant point in the circular economy discussion is that users also need to take care of products they are not emotionally attached to, the current study takes a different approach to contribute with additional strategies.

5.1. Limitations and Future Research

When we interpret the findings of the present study, it does not represent a comprehensive list of user strategies for product life extension, and should therefore be seen as a preliminary study that initiates a new starting point for circular conceptual design, namely a user-centered innovation process. For this reason, the following limitations of the study need to be addressed, and accordingly, potential future research avenues are outlined.

First, the empirical data are based on 26 households in a Danish context which reflects certain cultural aspects in terms of consumption that may affect the results. Therefore, in future studies, more empirical evidence from different contexts is needed to support our findings and add further strategies to a future framework.

Second, it is relevant to acknowledge the gender distribution in the dataset. Around 25% of the respondents are male, which may influence the results as males generally are known as having access to higher income in average, and therefore the ability to buy more than females. However, in most of the cases from this study, the male was representative of the entire household, but still there was a tendency that it was the male who was most likely to make the physical moderations to a product. In this study, the gender distribution was not explicitly considered in the data analysis, and thus, how this impacted the results, but this topic could be an interesting avenue for future research.

Third, it is relevant to mention that the findings are based solely on the respondents' memories and reflections on their everyday behavior, which means that their actual interactions are not observed in real time. However, this was found to be a suitable approach for this study as it is focused on the underlying motives of certain behaviors. In future studies, ethnographic research could be supplemented with real-time data.

Finally, the study has concentrated on three main product categories: consumer electronics, furniture, and domestic appliances. The strategies were identified across these categories, but there might be some strategies that would be more dominant in one category than in another, which could also be a topic of interest in future studies.

5.2. Implications for Practice

The circular economy is an inevitable topic in most companies, but also a difficult subject to approach in practice (as shown in, e.g., [80]). While many companies attempt to adopt more sustainable production patterns and even succeed in creating more circular product offerings, the issue of customer acceptance is often overlooked, despite customers' impact on a product's lifetime. We argue that customer acceptance of new circular business models is more probable if built on already existing behaviors and intrinsic motivations, which underly the nine strategies identified in this study. However, the results from this study is not a comprehensive list of strategies and at the current state, a more comprehensive framework is needed to be directly applicable for practice. In this sense, the current strategies should be seen as inspiration for organizations to experiment with new types of value propositions of circular concepts based on a user-centered innovation process.

In this perspective, the current research is mainly targeting service- and product designers involved in the conceptual phases, as this is where the strategies are considered relevant.

5.3. Implications for Research

This study hopes to initiate new research concerning the user perspective as well as the conceptual phases in a circular economy context. As mentioned earlier, this study is not comprehensive and much more research in the area is needed. So far, there are no comprehensive studies of conceptual design in a circular economy context. This is critical to reach more sustainable consumption patterns, namely to develop sustainable solutions that also resonates with the users. This study opens up new alleys for alternative models and approaches to develop new kinds of value propositions to reach customers' acceptance to new circular business models, besides the current normative approaches which have been a main focus in the current literature.

Specifically, this study approaches the user perspective from an innovation viewpoint through an ethnographic study to provide insight into the actual behaviors and strategies that potentially could end up prolonging the product lifetime. This suggests a new paradigm for conceptual design in the circular economy which needs further exploration in future research.

6. Conclusions

In conclusion, current literature shows that consumers play a critical role for product life extension, which means that it is not enough to only involve product design strategies (such as design for maintenance, repair and remanufacturing) which a substantial body of literature has explored. This study suggested how conceptual design can benefit from user-centered innovation by studying how users actually approach, develop, and modify their products to serve individual needs. This resulted in nine user strategies that reflected behaviors at different use stages which positively influenced the product's lifetime. This paper advocates that insights into current user motives that reflect positive environmental usage behavior that could, if designed into a new product or service concept, move people toward more sustainable consumption patterns.

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