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Citation (APA)
van den Berge, R. B. R., Magnier, L. B. M., & Mugge, R. (2023). Until death do us part? In-depth insights into Dutch consumers' considerations about product lifetimes and lifetime extension. *Journal of Industrial Ecology*, *27*(3), 908-922. https://doi.org/10.1111/jiec.13372

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DOI: 10.1111/jiec.13372

RESEARCH ARTICLE

JOURNAL OF INDUSTRIAL ECOLOGY WILEY

Until death do us part?

In-depth insights into Dutch consumers' considerations about product lifetimes and lifetime extension

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Editor Managing Review: Keshav Parajuly

Funding information
Horizon 2020 European Union PROMPT (PRemature Obsolescence Multi-stakeholder Product Testing program) Project, Grant/Award Number: 820331

Abstract

Long-lasting electronic products contribute to a sustainable society; however, both expected and actual lifetimes are in decline. This research provides in-depth insights into consumers' considerations about product lifetimes, barriers to extending lifetimes, and responses to a product lifetime label. Results of interviews (n = 22) with Dutch consumers suggest a positive view on long-lasting products. Nevertheless, their products' value depreciated during their lifetimes. Consumers consider themselves unable to estimate how long products should last, which can be detrimental as low expectations tend to negatively influence actual lifetimes. Also, use intensity and consumers' care(less) behavior influence the lifetime. To extend product lifetimes, consumers often disregard the option of repairing malfunctioning products. They have limited knowledge and ability, and believe repair provides poor value for money. Lifetime extension can also be hindered by market-related factors, such as convenient replacement services, new technological developments, and (attractive) deals. We suggest a product lifetime label should contain relevant and reliable information; furthermore, we recommend including (extended) warranty information. When information about repairability is included, potential negative responses should be considered. Finally, raising awareness about the environmental impact of short-lived products via a label may have a positive effect but requires more research attention.

KEYWORDS
circular economy, industrial ecology, product lifetime, product lifetime label, product replacement, sustainable consumer behavior

1 | INTRODUCTION

Today's production and consumption of electronic products are damaging the environment. Production processes require the extraction of (critical) raw materials and produce CO_2 emissions (Allwood et al., 2011). Furthermore, the handling of waste from discarded products causes social and health-related issues in low-income countries (Heacock et al., 2016). Future global scenarios indicate that waste from electronic products will grow from 58 million tons in 2021 to 75 million tons in 2030 and 112 million in 2050 (Parajuly et al., 2019), and thus reductions are essential.

The field of industrial ecology focuses on the stages of the production processes of goods and services from a nature perspective, seeking to mimic a natural system by conserving and reusing resources (Chertow, 2008). One way to achieve this is via a circular economy, which strives to

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maximize the value of products and materials during all cycles, while aiming to eliminate "waste" (Ellen MacArthur, 2013). To date, much attention has been given to the outer loops (i.e., recycling) of the circular economy (Kirchherr et al., 2017). However, value is lost during recycling, because recycling consumes energy and some materials cannot be fully recovered (McCollough, 2009). It would therefore be more beneficial to focus on the inner loops (i.e., prolonging). Product longevity enables value retention by preventing early replacement. As this conserves resources longer, it provides a promising solution for issues resulting from producing and consuming electronic products. However, many products are discarded prematurely. Studies showed that 31% of washing machines, 66% of vacuum cleaners, 56% of TVs, and 69% of smartphones were disposed while still (partly) functional (Harmer et al., 2019; Hennies & Stamminger, 2016; Wieser & Tröger, 2018). It should be noted that a functioning product is replaced for different reasons than a nonfunctioning product. Consumers may replace functioning products because they do not satisfy new desires (Cooper, 2005; Magnier & Mugge, 2022), such as an improved smartphone camera. In such cases, replacement stems from the perception that the product is obsolete (i.e., no longer useful).

Consumers' perceptions thus play an important role in either shortening or extending the lifetimes of electronic products. Research has demonstrated that consumers generally prefer long-lasting and durable products (Gnanapragasam et al., 2018). Nonetheless, there is a widespread belief that products are not made to last (Wieser et al., 2015), and consumers' expectations about the lifetime of electronic products have significantly shortened (Kumar et al., 2017). Consumers seem to acknowledge producers' role in shortening product lifetimes, but neither condemn this nor consider product durability (Echegaray, 2016; Sun et al., 2021). They have come to expect rapid product updates and fast-moving trends, thereby accelerating replacement speeds (Cox et al., 2013; Grewal et al., 2004). However, in-depth insights into consumers' considerations concerning product lifetimes remain limited.

Several opportunities for extending product lifetimes have been formulated in the literature (Van den Berge et al., 2021; Van Nes & Cramer, 2005). Repair is frequently mentioned, as it restores (parts of) the product's functionality (Bocken et al., 2016). However, consumers often face barriers to repair (Jaeger-Erben et al., 2021). Also, technological developments and trends encourage consumers to replace well-functioning products (Grewal et al., 2004). It is noteworthy that most studies on replacement behavior are quantitative (Hou et al., 2020; Jaeger-Erben et al., 2021; Sabbaghi et al., 2017), and do not explore the underlying reasons among consumers. Another opportunity to extend product lifetimes is a lifetime label (Braithwaite et al., 2015; Gnanapragasam et al., 2018), which informs consumers about expected product longevity and has yielded promising results (Bovea et al., 2018; Jacobs & Hörisch, 2021). However, the effectiveness of such a label for changing consumers' purchase decisions is likely to depend on how it is implemented. Our research provides insights into the specific conditions (e.g., related to label design, policy) that will influence lifetime labels' effectiveness.

We contribute to the literature with in-depth insights into consumers' thought processes regarding product lifetimes. We aim to go beyond the quantitative results of prior studies and explore the reasoning underlying consumers' responses. Hereby, we provide a comprehensive understanding of early product replacement, which is useful for industry and policymakers aiming to extend product lifetimes. This paper starts by presenting the theoretical background. Subsequently, we present the results of in-depth interviews exploring consumers' considerations about product lifetimes, their barriers toward lifetimes extension, and responses to potential lifetime labels. Finally, we propose directions for future research.

2 | THEORETICAL BACKGROUND

2.1 | Definitions of product lifetimes and reasons for product replacement

In this paper, the "actual lifetime" of a product is defined as the period between its purchase and the moment it is disposed of or replaced by another product (Den Hollander et al., 2017; Van Nes & Cramer, 2006). This definition focuses on products' first lives. We realize that products can have useful second lives (e.g., second-hand, refurbished) but discarded products frequently end up in the storage (Poppelaars et al., 2020; Wilson et al., 2017), and thus extending the first life is most beneficial. "Expected lifetime" is defined as the time the consumer expects the product to last and "desired lifetime" as the time the consumer would like the product to last. Both expected and desired lifetime are estimated by the users themselves.

Literature defines several types of "product obsolescence" as reasons for replacement. Quality obsolescence refers to a decrease in product performance resulting from wear and tear or malfunctioning parts; for instance, broken pumps in washing machines (Guiltinan, 2009; Mugge et al., 2005; Van Nes & Cramer, 2005). Technological obsolescence refers to new developments offering improved functionality; for instance, new smartphones that can access faster internet networks (Grewal et al., 2004; Jensen et al., 2021). Economic obsolescence refers to products being replaced by cheaper-to-run models; for instance, more eco-efficient washing machines (Cooper, 2004; Khan et al., 2018). Aesthetic obsolescence refers to changes in product appearance caused by wear and tear or emerging trends, for instance scratches on smartphones or changes in color preferences (Burns, 2010; Mugge et al., 2005). Psychological obsolescence refers to the symbolic value of products; for instance, a new product that allows one to keep up-to-date with peers (Cooper, 2004; Van Nes & Cramer, 2005). Frequently, products are replaced because of a combination of multiple previously defined types of obsolescence (Magnier & Mugge, 2022).

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2.2 | Product replacement process

We can consider the product replacement process as a subtype of the general Engel Kollat Blackwell (EKB) model. This model shows that decision making involves extensive thought processes that consider many factors (Engel et al., 1968). The replacement decision-making process is different from the general process of buying because consumers already own a similar product. Specifically, the decision to replace or retain a product involves a trade-off. Consumers compare the costs and values of a new product to those of their owned product (Van den Berge et al., 2021). The previously defined types of obsolescence revealed that product replacement decisions are often not solely rational (Guiltinan, 2010). The weighted product values can be functional (e.g., providing good functionality), emotional (e.g., evoking memories), social (e.g., providing social status), epistemic (e.g., providing novelty), and conditional (e.g. fitting a certain life stage) (Sheth et al., 1991). Replacement results from a relative change in one or more of these values. Differences in value importance can be found between product categories. For example, emotional value is generally more important for hedonic than for utilitarian products (Korhonen et al., 2018).

To extend a product's lifetime, it is important to keep its value high. During ownership, consumers mentally write off products (Okada, 2001). The depreciated value of an owned product compared to the potential value of a new product influences the replacement process. Past research recommended that products should be both physically durable (sustaining functional value) and resilient toward future developments (sustaining epistemic value) (Haug, 2018) to ensure long-term value. Early product replacement may also evoke feelings of dissatisfaction and guilt because it is wasteful (Wilhelm et al., 2011). Conversely, marketing efforts and trade-in promotions can trigger the replacement tendency (Van den Berge et al., 2021). The replacement tendency greatly depends on how long the consumer has owned the product and to what extent it "has made its money's worth." During ownership, repeated use and satiation contribute to product value depreciation (Hou et al., 2020; Magnier & Mugge, 2022).

2.3 | Consumers' considerations about product lifetime extension

Product failure decreases its functional value and can trigger a replacement (Wilhelm, 2012). Repair has been proposed as a critical strategy to extend product lifetimes (Bocken et al., 2016; Kirchherr et al., 2017). It recovers products' functional value and may increase emotional value because successful repairs can evoke positive feelings, such as pride (Ackermann et al., 2018). Nevertheless, prior research also revealed multiple barriers that hinder consumers from executing repair activities, such as high costs (Bovea et al., 2017; Laitala et al., 2021; Tecchio et al., 2019). Although tax incentives for repairs appear to be an interesting avenue to stimulate repair, recent research suggested that it remains unclear whether the resulting cost reduction would be sufficient to lower the barrier (Svensson-Hoglund et al., 2021). It is also interesting to note that consumers often overestimate repair costs, which may prevent them from considering repair as an option (Brusselaers et al., 2019). Extended warranties may make repair a more worthwhile option (Bocken et al., 2014; Ertz et al., 2019). However, compared to other product features their influence on purchase decisions is low because extended warranty rights are often poorly understood and confused with legal guarantees (Maronick, 2007; Svensson-Hoglund et al., 2021). Other barriers to repair are lack of skills (Rogers et al., 2021), low spare part availability (Tecchio et al., 2016), and inconvenient repair infrastructures (Jaeger-Erben et al., 2021; Sabbaghi et al., 2017). Manufacturers may also be uninclined to increase repairability because it could limit sales of new devices (Sabbaghi & Behdad, 2018). To encourage manufacturers to increase repairability, various initiatives have emerged, such as the "The Right to Repair" movement. Additionally, the "French Repairability Index" requires manufacturers to inform consumers about products' repairability. Nonetheless, consumers do not seem to look for repairability in products (Bovea et al., 2018; Sabbaghi et al., 2016). For lifetime extension, it is therefore important to obtain a comprehensive understanding of the reasons underlying consumers' hesitance toward repairability.

2.4 | Potential of a product lifetime label to extend lifetimes

Consumers have highly varied lifetime expectations (Jaeger-Erben & Hipp, 2018) and are generally unable to judge the environmental aspects of products. They often rely on labels for related information (Atkinson & Rosenthal, 2014). Therefore, lifetime labels have been identified as a promising tool to support consumers in considering product lifetimes at purchase (Gnanapragasam et al., 2018). Previous studies demonstrated that a product's lifetime label (expressing lifetime in years) may even be perceived as more important than the brand or energy consumption of washing machines (Jacobs & Hörisch, 2021). Lifetime labels can include information about the reliability of materials and components and/or products' repairability. A high score on a lifetime label may cause consumers to mentally write off their product's value more slowly, resulting in a higher likelihood to keep using and repairing it. In eco-design regulations, a label presenting the minimum lifetime is currently considered for some products (Marcus, 2020). However, there are some concerns. Misinterpretation of labels can cause unintentional rebound effects; for example, the energy-efficiency label can trigger the belief that buying more electronic products is unproblematic as long as these are energy efficient (Waechter et al., 2015). Second, consumers indicate their own behavior (i.e., use intensity) also impacts lifetime, and thus prefer labels displaying useful lifetimes

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in use cycles over displaying lifetimes in years (Dalhammar & Richter, 2017; EESC, 2016). Finally, research suggested low awareness regarding the impact of short product lifetimes on the environment (Islam et al., 2021). However, more research is required to determine whether raising environmental awareness via lifetime labels can influence consumers to choose longer-lasting products.

3 | METHOD

3.1 | Semi-structured interviews

To uncover people's feelings, thoughts, and experiences, in-depth face-to-face interviews are an effective method (Patton, 2002). The interviews were semi-structured, leaving room for new topics to emerge and enabling building further on established findings (Gioia et al., 2013). Open-ended questions allowed participants to describe experiences in their own words. "Why" questions stimulated the further elaboration of the discussed topics.

3.2 | Product categories

The product categories researched in this study met several criteria. They all have significant market penetration, environmental impact, importance to consumers, and use frequency. We additionally ensured variety in technological advancement and functionality. Accordingly, we selected washing machines, vacuum cleaners, TVs, and smartphones. Technological advancement was considered high for smartphones and TVs, medium for vacuum cleaners, and low for washing machines. We chose smartphones because of their centrality in daily life and susceptibility to (portable) usage damage (e.g., replacement due to broken screen or battery failure), and TVs because of their susceptibility to trends (e.g., replacement with a higher-resolution model).

3.3 | Sample

Participants were recruited via a university-based consumer panel. Our sample reflects a Dutch perspective, with relatively wealthy consumers, widely available products, and fast delivery. This context is especially interesting, as Dutch consumers are more prone to replace their products prematurely (Islam et al., 2021). Replacement behavior in the Netherlands is comparable to other Western European countries, such as France, Belgium, Germany, and Spain (Magnier & Mugge, 2022). Our insights are therefore expected to be useful for countries with similar consumption patterns. Finally, interviewing Dutch consumers allowed us to conduct interviews at participants' homes, and thereby use the newly bought products to stimulate discussion about replacement. An online selection form was sent to 940 panel members. To ensure reliable responses, panel members could only participate if they had replaced one or two of the selected products within the 6-month period preceding the interview. Participants should have bought the product either new or second-hand for personal use (excluding gifts). From the 232 responses, 59 panel members had replaced one or two of the selected products during the preceding 6 months. We selected 22 participants varying in age (29–73 years; mean: 52 years), gender (41% male, 59% female), and monthly net household income (cf. Table 1), covering each product category with insights from eight participants. All participants were rewarded a 10-euro voucher.

3.4 | Procedure

The developed interview guide (cf. Supporting Information S1) was refined after two pilot interviews. All interviews took place at participants' homes (November 2019) to ensure they would feel comfortable sharing personal experiences and to observe their new and (if still owned) replaced products (cf. Figure 1). Interviews lasted 30–60 min, depending on whether one or two products were discussed. All participants gave permission to audiotape the interview and signed an informed consent form. Participants described their reasons for replacing the product, satisfaction with the lifetime of the replaced product, and the lifetime expectations of the new product. We discussed the repair activities executed and/or considered for both the replaced and new product, and asked if participants took lifetime expectations into account when acquiring the new product. Also, we asked about the extent to which lifetime labels could influence their purchase decision. All questions were probed with a "why" question. We focused on repair and lifetime labels as these can strongly impact lifetime extension. Prior literature demonstrated that 70% of partly malfunctioning products were not considered for repair before being replaced (Magnier & Mugge, 2022). This illustrates that encouraging repair practices is still much needed. Additionally, labels have been proven to be influential in choices of products in other domains (e.g., energy-efficiency labels) and have been suggested as a means to extend lifetimes (Bovea et al., 2018; Dalhammar & Richter, 2017; Gnanapragasam et al., 2018; Jacobs & Hörisch,

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TABLE 1 Details of the interview sample

Participant	Gender	Age	Income (€)	WM	VC	TV	SP
P1	Female	67	Unknown	x	x		
P2	Female	56	3750–4500		x		x
P3	Male	61	3750–4500			x	x
P4	Female	50	Unknown		x		x
P5	Male	68	3750–4500			x	x
P6	Male	63	2250–3000	x	x		
P7	Male	50	Unknown			x	x
P8	Female	41	Unknown		x	x	
P9	Male	52	3750–4500		x		x
P10	Male	59	4500 or more			x	
P11	Female	29	750–1500		x		x
P12	Female	56	3750–4500			x	
P13	Female	30	2250–3000				x
P14	Female	73	2250–3000			x	
P15	Female	51	Unknown	x			
P16	Female	55	Unknown		x		
P17	Male	34	750–1500	x			
P18	Female	56	3750–4500	x			
P19	Female	57	3750–4500	x			
P20	Male	66	4500 or more	x			
P21	Male	48	4500 or more			x	
P22	Female	31	3750–4500	x			



FIGURE 1 Illustrated example: Pictures of the new (left) versus replaced (right) TVs and smartphones of participant 3

2021). While the label concerns the purchase phase, the repair aspects cover the use and disposal phases of consumption. This focus thus enabled us to cover multiple consumption phases, where consumers' choices can impact lifetime extension. The question about participants' knowledge of the environmental impacts of products was posed at the end to prevent socially desirable answers.

3.5 | Data analysis

All interviews were fully transcribed. We used inductive data processing to describe the insights that emerged in a detailed manner, while staying close to the raw data (Saldaña, 2013). First, the transcripts were coded using Atlas.ti software. We discussed the initial codes in the research team by clustering overlapping codes. Looking for patterns and themes, we eliminated irrelevant codes during several iterative sessions. This resulted in a total of 101 subcodes. Subsequently, these were grouped in 42 codes. The codes were clustered in 13 categories and 3 themes. Figure 2 displays the steps.

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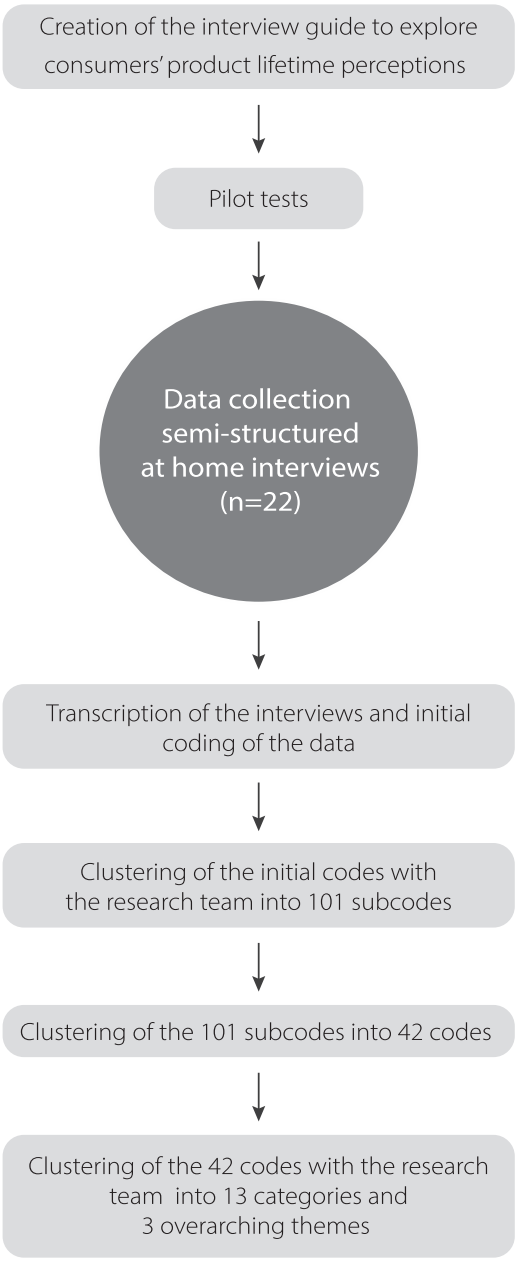


FIGURE 2 The steps of the data analysis

4 | RESULTS

Figure 3 displays the themes and categories showing our main findings. Supporting Information S2 presents an overview of the coding scheme per theme.

4.1 | Consumers' considerations about product lifetimes

4.1.1 | Long lifetimes are perceived positively

Participants indicated relatively high satisfaction when the replaced product exceeded lifetime expectations, especially for utilitarian products, such as washing machines and vacuum cleaners. In contrast, satisfaction was relatively low when the actual lifetime underperformed expectations. This

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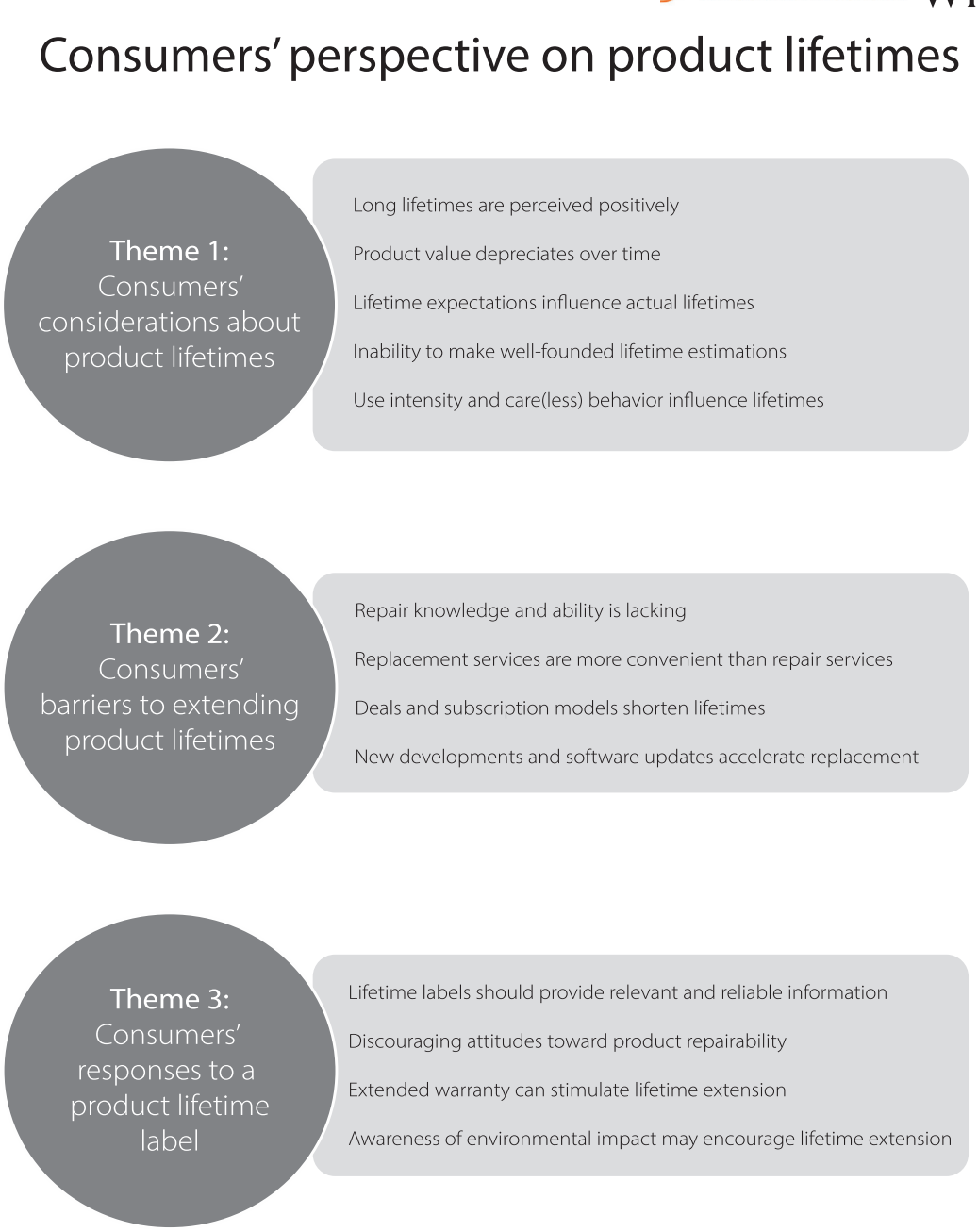


FIGURE 3 The themes and categories of the interview data

occasionally provoked feelings of irritation and anger (cf. Table 2, P15) and was perceived as a waste of money and resources. Regarding desired lifetimes, most participants wanted to use products as long as possible, only replacing them when deemed necessary. Investing time and effort in selecting new products was considered bothersome, especially for utilitarian products.

4.1.2 | Product value depreciates over time

Although most participants wanted to use products as long as possible, their products' value also depreciated over time. Decreasing emotional, social, and epistemic value was especially true for trend-sensitive products, such as smartphones and TVs, and played an important role in value depreciation. For example, participant 11 (cf. Table 2) explained that the need to capture life events (emotional value) and the fear of missing out on the latest features adopted by peers (social value) resulted in the early replacement of a smartphone.

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TABLE 2 The categories and example quotes of the theme "Consumers' considerations about product lifetimes"

	Category	Example quotes
4.1.1	Long product lifetimes are perceived positively	"I wanted it to last longer because a washing machine that lasts only five years … I didn't like that. Not only for my own wallet, but also the idea that every five years you take a product to the scrapyard…" P15
4.1.2	Product value depreciates over time	"I was in doubt because it was not really broken yet. Uhm, and costs. It's just really expensive to get a new one […] In theory the old smartphone still works, but then I saw other people taking beautiful photos. I started to realize that my photos are always a bit blurry. Then you start to miss that feature." P11
4.1.3	Lifetime expectations influence actual lifetimes	"I think we owned the old one for 15 years. It probably would have washed for a while longer, but at some point, it started to make noise and move around. Then, you start thinking, when is it going to fail? […] Fifteen years is a good age for a washing machine." P20
4.1.4	Inability to make well-founded lifetime estimations	"I don't know actually … You can kind of get that from reviews now and then … And yes, also from hearsay, from the experiences of people around you." P16
4.1.5	Use intensity and care(less) behavior influence lifetimes	"I think the new washing machine will last at least 10 years… However, you can't express this in years … For a washing machine you have to look at the number of washes. I now have only one child at home, so we will just wash a lot less than we used to." P18

4.1.3 | Lifetime expectations influence actual lifetimes

Next to desired lifetimes, we asked participants about expected lifetimes. For all product categories, we found that when a defect arose, participants considered the product's expected lifetime to evaluate if the time was right for replacement. Also, we found that expected lifetimes can influence actual lifetimes. When consumers felt that the product had fulfilled its duty, they were more comfortable with replacing it. To illustrate, participant 20 (cf. Table 2) stated that after the product met lifetime expectations, the fear of near-future product failure—that is, lack of trust in its reliability—triggered its replacement.

4.1.4 | Inability to make well-founded lifetime estimations

Most participants were unable to make well-founded judgments about their products' expected lifetimes. Their responses varied greatly from 2 to 4 years for smartphones, 4 to 10 years for TVs, 5 to 15 years for vacuum cleaners, and 5 to 30 years for washing machines. Their expectations were guesses, based on their "gut feeling." Therefore, they did not actively consider lifetimes of products at purchase. Participants relied on brand, price, reviews, and previous experiences in making lifetime estimations (cf. Table 2, P16). Some doubted the reliability of reviews posted on producers' and resellers' websites because they believed these mainly serve marketing purposes. They preferred reviews from independent parties (e.g., consumer associations), but also noted that these reviews often only share experiences from the early product lifetime with no information on longevity.

4.1.5 | Use intensity and care(less) behavior influence lifetimes

All participants indicated the importance of use intensity and their own behavior on the actual lifetime (cf. Table 2, P18). Several participants engaged in care activities, such as using a smartphone flip cover and running a washing machine empty at a high temperature, while others were unfamiliar with measures to ensure long lifetimes. Our results revealed large differences in care behavior among participants. Some indicated that they handle their possessions with care, whereas others said that their neglect caused a product breakdown.

4.2 | Consumers' barriers to extending product lifetimes

4.2.1 | Repair knowledge and ability is lacking

Most participants considered themselves unable to execute repair activities. Only one participant self-repaired a washing machine (broken door) and three participants repaired their phones (replacing screen/battery). None repaired a vacuum cleaner or TV. Participants often did not know what was wrong with the product (cf. Table 3, P17). The only participant who self-repaired a washing machine consulted an expert beforehand, and professional technicians repaired all broken smartphones. Also, participants did not consider repair a valuable option (cf. Table 3, P5), deeming it

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TABLE 3 The categories and example quotes of the theme "Consumers' barriers to extending product lifetimes"

	Category	Example quotes
4.2.1	Repair knowledge and ability is lacking	"A washing machine is a product too technical for me personally to make a seriously good estimate about repairability. So, if it does not work, yes, then I just cannot estimate whether only the light does not work, or if the whole function is gone." P17 "Indeed, if a defect occurs, you can go back to the store and ask what it will cost to have the TV fixed again. And when they say it will cost 50 percent of the purchase price to have it repaired… then you start thinking is this worth the money?" P5
4.2.2	Replacement services are more convenient than repair services	"I shouldn't have to go all the way into town with a vacuum cleaner, because then I would not do it. But it would be useful if there is such a repair support, that it is a bit close or something. That will encourage, I think." P2
4.2.3	Deals and subscription models shorten lifetimes	"I think there's some sort of idea: every two years I must have a new phone, whether or not it is: because my subscription has expired, and I'm allowed a new subscription, so I want a new phone." P9
4.2.4	New developments and software updates accelerate replacement	"Yes well, I was thinking … I'm sitting here watching a nice television. But are the colors the best? Does it work seamlessly? Then it could always be a little better. So, we [decided to replace] and now have this very luxurious product." P3 "I couldn't download apps anymore, for example [banking smartphone application]. I found that annoying. That was most decisive in the replacement." P13

expensive mainly because they included labor costs in their calculations. Participants also indicated that current products are not designed to be repaired. For example, the absence of screws in a TV made them wonder whether the product was repairable at all.

4.2.2 | Replacement services are more convenient than repair services

Replacement services, such as next-day product deliveries, are a convenient choice. Participants mentioned that the service aspect of replacement was a determining factor in the decision to choose replacement over repair. They suggested that improvement of repair services may encourage repairs—for example, increasing repair service convenience by eliminating physical barriers (e.g., at-home repair) (cf. Table 3, P2), improving service provider findability (e.g., repair platforms on the internet), or providing faster service (e.g., next-day repairs).

4.2.3 | Deals and subscription models shorten lifetimes

Good deals could easily persuade participants to replace well-functioning products. For instance, offering new smartphones with contract renewal (cf. Table 3, P9) accelerated the value depreciation of the owned product and triggered its replacement with a newer higher-performance model. Additionally, some participants justified their replacement because the lifetime expectations of their product were met, and an attractive deal was the final trigger.

4.2.4 | New developments and software updates accelerate replacement

Our results showed that washing machines were mostly replaced because of a defect, while only three TVs were replaced because of defects. Three other TVs still functioned flawlessly, and new functionalities were the main reason for replacement (e.g., bigger screens with higher-quality images) (cf. Table 3, P3). The remaining two were incompatible with the service provider. Especially for TVs, newer models with improved performance accelerated the value depreciation of the owned product. Additionally, software obsolescence caused early replacement. For example, participant 13 replaced his smartphone because he could no longer download (essential) applications (cf. Table 3).

4.3 | Consumers' responses to a product lifetime label

4.3.1 | Lifetime labels should provide relevant and reliable information

We asked participants whether labels with lifetime information would be useful to them. Responses were diverse; participants tended to respond positively to being better informed about product reliability and expected lifetime. However, they also had doubts. First, labels should be objectively

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TABLE 4 The categories and exemplary quotes of the theme "Consumers' responses toward a product lifetime label"

	Category	Example quotes
4.3.1	Lifetime labels should provide relevant and reliable information	"Uhm yes, I think that [a lifetime label] is very difficult with smartphones because it depends so much also on your individual use, and whether you put a case on it and so on. I think that's even more important." P4
4.3.2	Discouraging attitudes toward product repairability	"No, I did not consider the repairability of this vacuum cleaner […] Repairable parts make you wonder, oh, will that be necessary? Will it break down?" P11
4.3.3	Extended warranty can stimulate lifetime extension	"No, I would not repair this device. If it is within the warranty period, then of course I would. Then you're just throwing money out of the window if you do not make use of that. However, if I'm past that …. The new things are usually a lot cheaper." P6
4.3.4	Environmental impact awareness may encourage lifetime extension	"Well, I don't know how harmful it is that I bought a new washing machine […] I can't say what that really does for the environment, the future emissions […]. Maybe you could be more aware of that. If you know what the consequences are [of replacement]." P22

monitored by independent parties to be reliable. Second, participants mentioned the difficulty of predicting lifetime in years, because it strongly depends on use intensity and behavior (e.g., misuse or carelessness) (cf. Table 4, P4). They indicated that one or more use scenarios (e.g., weekly use frequency of washing machines) could help.

4.3.2 | Discouraging attitudes toward product repairability

Overall, participants were unlikely to take the product's repairability into account during purchase. Some were even surprised or confused by this question. They believed manufacturers would not benefit from improving repairability. Many manufacturers do not communicate information about repairability, and therefore participants could not have considered repairability. Some participants even suggested that promoting repairability could trigger worries about possible breakdowns when acquiring a product (cf. Table 4, P11). Considering that repair information is not generally available in the Netherlands, receiving such information for one specific product at purchase would trigger associations with repair that consumers would otherwise not have. Participants inferred that breakdowns should be expected, and this repair information was provided because the product would need more repairs than other products. If repair information is only given for a specific product in a category, participants may thus question its quality and durability.

4.3.3 | Extended warranty can stimulate lifetime extension

While asking about repair considerations, many participants spontaneously answered that they would use their warranty rights if their new product broke down during the warranty period (cf. Table 4, P6). Beyond the warranty period, the product's age, repair costs, and the price of a new device become more prominent in the repair-versus-replacement decision. Participants also indicated doubts about manufacturers' intentions in offering extended warranties, because they think manufacturers have little interest in repairing broken products and would rather sell new ones.

4.3.4 | Awareness of environmental impact may encourage lifetime extension

Finally, we asked participants about their awareness of the environmental impact of products. Participants primarily mentioned that the energy efficiency and recycling of products contribute to a better environment. However, they rarely spontaneously mentioned the negative environmental impact of short product lifetimes. When we introduced them to this topic, many participants said they were not fully aware about the consequences of early replacement (cf. Table 4, P22) and currently lacked information to judge products on their environmental impact in relation to the expected lifetime.

5 | GENERAL DISCUSSION

This research contributes to the literature by providing in-depth insights into consumers' perspectives on product lifetimes. We found that consumers have positive attitudes toward product longevity, and confirm that early product replacement can lead to dissatisfaction and feelings of guilt

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(Wilhelm et al., 2011). This provides promising opportunities for reducing the environmental impact of consumption via the inner loops in a circular economy. Consumers prefer products, particularly utilitarian ones, to be long-lasting mostly because this is convenient. Convenience appears to be key in the decision to either retain or replace a product, which extends earlier research on consumers' need for convenience in services (Berry et al., 2002). However, our results also confirm that consumers mentally write off the value of products as these age (Okada, 2001; Van den Berge et al., 2021). Attention should be paid to decreasing the pace of value depreciation, especially for trend-sensitive products (Korhonen et al., 2018). Additionally, our participants confirm the disbelief that products are designed to last (Echegaray, 2016; Wieser et al., 2015). Our results confirm there is great variety in lifetime expectations within the categories (EEB, 2019; Jaeger-Erben & Hipp, 2018). We show that many consumers are clueless about their lifetime estimations, which can explain this variation. Furthermore, the fact that consumers' lifetime expectations may influence actual lifetimes is problematic, especially because lifetime expectations are generally decreasing (Kumar et al., 2017). To lengthen actual lifetimes, it is important to increase expectations and support consumers to consistently include expected lifetimes in their purchase decision.

As barriers to extending lifetimes, we confirm a lack of repair knowledge (Jaeger-Erben et al., 2021) and high (estimated) costs (Brusselaers et al., 2019; Sabbaghi & Behdad, 2018; Tecchio et al., 2019). Consumers may be quite willing to extend product lifetimes. However, our results imply that to compete with relatively cheap and swiftly delivered replacement alternatives, product lifetime extension possibilities (e.g., repair services) should be designed to be more convenient for consumers. Additionally, our results validate that deals and subscription models can trigger the replacement of still-functioning products (Van den Berge et al., 2021). We show that their influence becomes increasingly prevalent when lifetime expectations are met, which highlights the importance of extending expectations. Also, our results confirm that new developments influence the replacement tendency (Jensen et al., 2021), especially for hedonic products, where feelings of satiation have a strong influence (Hou et al., 2020; Magnier & Mugge, 2022).

Regarding the potential of lifetime labels to better inform consumers about the expected lifetime (Braithwaite et al., 2015; Gnanapragasam et al., 2018; Jacobs & Hörisch, 2021), our findings contribute by demonstrating that such labels can only support consumers if they provide relevant and reliable information. Although improved product repairability has been proposed as a solution to extend product lifetimes (Bovea et al., 2018; Den Hollander, 2018), our findings suggest that incorporating repairability into lifetime labels could cause worries among consumers regarding products' durability. However, consumers might become more willing to consider repairability if a repairability index provided by a reliable institution is displayed on all products. Such an index would normalize repair and give a more accurate representation of devices in terms of life cycle costing or expectations about product care at purchase.

Also, lowering the threshold of repair costs to the price of new products by providing extended warranties may help (Brusselaers et al., 2019). However, the confirmed lack of understanding of the differences between manufacturers' extended warranties and legal guarantees (Maronick, 2007; Svensson-Hoglund et al., 2021) may cause issues. Finally, our results confirm the low consumers' awareness of the environmental impact of short lifetimes of electronic products (Islam et al., 2021). Making this relation more obvious can potentially trigger consumers to retain their products longer.

5.1 | Practical implications

Taking the consumers' perspective on product lifetimes into account is crucial for practitioners who aim to lengthen lifetimes and reduce the negative environmental impact of electronic products. We found that long lifetimes are perceived positively, which yields an interesting opportunity for manufacturers to enhance consumers' image of the brand. To lengthen product lifetimes, industry should focus on preventing value depreciation by sustaining product value. For example, functional and emotional value can be preserved by using scratch- and damage-resistant materials and epistemic value can be preserved by making products more resistant or adaptable to future developments. Finally, to help consumers make well-founded lifetime estimations, independent organizations (e.g., consumer associations) may consider assessing expected lifetimes in their product reviews. Then, consumers may prioritize products' longevity in their purchase decisions.

To alleviate barriers to extending product lifetimes, manufacturers should consider not only long-term software support but also adjust current designs. For instance, product developers could incorporate "cues for repair" (e.g., fault indications). These cues can increase consumers' ability to repair by supporting them in the different repair steps. Manufacturers could also focus on making lifetime extension more economically viable by reconsidering business models (Bocken et al., 2016). For example, manufacturers can offer repair services for a monthly fee or lease agreements where the manufacturer retains ownership of the product and is therefore intrinsically motivated to develop products that last.

For lifetime labels to be successful, practitioners should consider potential rebound effects. For instance, displaying a minimum number of years (Marcus, 2020) may unintentionally give consumers "permission" to replace well-functioning products when these years have passed. Therefore, specific criteria underlying lifetimes, such as reliability of critical parts or repairability (e.g., ease of battery/screen replacement) may be preferred. To improve consumers' attitudes toward repairability, raising awareness about the potential benefits of repair (e.g., saving costs, reduced environmental impacts) should be explored. Also, independent organizations (e.g., consumer associations) could launch awareness campaigns to enhance repair adoption. Furthermore, offering extended warranties may increase consumers' trust that the product is designed to last, enhancing the company's brand image. However, the warranty terms and conditions should be clear regarding coverage, how to sign up for it and whom to contact

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when a failure occurs. Finally, information about products' environmental impact provided on lifetime labels may encourage consumers to consider additional environmental consequences (next to energy efficiency) at purchase.

Finally, policymakers could consider legislation for industry to communicate information about the lifetime via labels. This may make the expected lifetime a more common choice criterion for consumers and incentivize manufacturers to design long-lasting products to score high on this label. Furthermore, stimulating repair activities via legislation could make repair a more worthwhile option for consumers; however, lower repair taxes may not be sufficient (Svensson-Hoglund et al., 2021). A focus on implementing policies that require manufacturers to design consumer-repairable products (e.g., accessibility of critical parts, standardization of spare parts), increasing the proximity and number of approved repairers, and providing repair support (e.g., repair cafes) are therefore also necessary. Finally, the extension of legal warranties may stimulate consumers' repair activities, and in turn, trigger manufacturers to design long-lasting products.

5.2 | Limitations and avenues for future research

Research on ecolabels demonstrated that consumer responses may vary across countries (Peschel et al., 2016). Our results represent a developed country's perspective on lifetimes and understanding the Dutch context may be relevant to other comparable countries (e.g., France, Belgium, Germany, and Spain). Notably, within Western European countries, Dutch consumers are fairly environmentally conscious, but less willing to bear personal costs compared to French and German consumers (Golob & Kronegger, 2019). Therefore, our sample may have been critical toward lifetime extension strategies, such as repair investments. Verifying these insights in different countries is recommended to generalize our results.

Our research focused on investigating four different electronic products regarding lifetime extension. Consumers' replacement behavior differs between product categories (Cox et al., 2013) and different products may thus need different lifetime extension strategies. Also, some existing design strategies (e.g., modularity or upgradeability) were not mentioned by our participants. We recommend future research to focus on investigating other lifetime extension opportunities to extend our findings and identify the optimal strategy for specific product categories. Also, future studies could investigate the factors that influence the market success of repair services (e.g., repair at home, temporary loan device) and if these can improve repairability perceptions.

Regarding lifetime labels, more research is needed to understand how lifetime-related information should be presented to be relevant and reliable for consumers (e.g., by showing numbers, percentages, and ratings of environmental impacts) and influence choice most effectively. Additionally, future studies could investigate how lifetime labels can better inform warranty rights. Finally, communicating information about the expected lifetime of products would enable consumers to have a fairer idea of their relative price over the full lifetime—which may make them more inclined to choose a product that is more expensive but lasts longer. Future research could therefore focus on measuring the effect of communicating the expected lifetime compared to other factors, such as price and brand, in purchase decision-making.

6 | CONCLUSION

Lengthening product lifetimes is necessary to reduce human ecological impact, and studying this topic is therefore of great relevance for the field of industrial ecology. Our findings show the potential of extending product lifetimes as consumers desire long-lasting products, and well-designed lifetime labels can guide them in their decision-making. Extending product lifetimes can thus play an important role in realizing a circular economy and making more efficient use of our scarce resources. We want to stress that a systemic approach is required to catalyze a change in our current way of production and consumption. To extend product lifetimes, governmental bodies play a key role both top-down (in developing legislation) and bottom-up (in creating consumers' awareness). However, to avoid resistance to change, it is essential to profoundly understand both consumers' and manufacturers' perspectives. Taking their perspectives into account may accelerate a change in mindset and adoption of legislation, thereby smoothening the transition toward a circular economy. Ultimately, this shift will only succeed if all parties (government, consumers, and industry) are enabled to contribute toward a more sustainable society.

ACKNOWLEDGMENT

This research was part of the PROMPT (Premature Obsolescense Multi-stakeholder Testing program) and has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement no. 820331.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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How to cite this article: Van den Berge, R., Magnier, L., & Mugge, R. (2022). Until death do us part? In-depth insights into Dutch consumers' considerations about product lifetimes and lifetime extension. *Journal of Industrial Ecology*, 1–15. https://doi.org/10.1111/jiec.13372

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