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Article

# How the Dead Storage of Consumer Electronics Creates Consumer Value

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**Abstract:** Consumers across the globe tend to store their small electronic devices when they reach their end of life instead of disposing of them. This is a problem because if end-of-life devices are not recovered from consumers' homes, the devices cannot be re-used or recycled, leading to increased production. We study what motivates consumers to store their end-of-life devices by looking at how storage creates consumer value. Applying a practice-based understanding of value, we find that storage is a social practice that generates value by protecting consumers from four different kinds of risk: practical risks, existential risks, environmental risks, and moral risks. Storage gives consumers a sense of security in their everyday lives and thus generates what we call 'security value'. This notion implies that even though end-of-life devices sit idle in consumers' homes, their value generating capacity remains active. The findings have implications for the role of consumers in reverse logistics strategies for sustainable systems.

**Keywords:** circular economy; storage; consumer electronics; consumer value

## 1. Introduction

Several studies have documented that consumers across the globe tend to store their small electronic devices when they reach their end of life instead of disposing of them [1–8]. This 'dead storage' of devices represents a problem to the transition towards a circular economy, that is, a "regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops" [9] (p. 766). By this definition, dead storage amounts to a serious leak in the material loops of the economy: When end-of-life devices sit idle in consumers' homes, they cannot be re-used or recycled for the production of new devices. This is particularly problematic because many electronic devices contain raw materials in finite supply (such as copper, gold, palladium, and silver). The failure to recover end-of-life devices means that the materials they contain are lost and that new finite-supply materials must be extracted [10]. What is more, recent research suggests that there is significant economic potential in recovering wasted electrical and electronic equipment [11–13]. It is therefore important to understand why consumers choose to keep their end-of-life devices.

A series of studies exploring consumers' rationale for storing end-of-life electronic products attributes this behavior to the residual value electronic products are perceived to possess after they are

retired from use [2,3,5,10,14]. The studies argue that, even after retirement, the products may still fulfil some function to consumers or may be expected to do so in the future. Some phones, for example, function as ‘secondary phones’ [10] to be called into use if consumers lose or break their primary phone. Therefore, even if end-of-life electronics hold no or very little value on the market, consumers may still find them valuable and, consequently, worth retaining. The studies thus suggest that it is this *perceived* value that poses a fundamental barrier to the efficient recovery of electronic waste and the circular flow of the precious resources involved in producing small consumer electronics.

We build on and extend this insight. While previous studies have described the different types of value consumers ascribe to end-of-life electronic products (e.g., the value of having a ‘secondary phone’), no study has so far theorized *how* these products become valuable to consumers. To that end, we draw on recent contributions within consumer research that advocate taking a practice approach to value [15]. In this perspective, value does not solely reside in products themselves (e.g., a fixed external value) nor in the minds of consumers (e.g., an entirely subjective value perception). Rather, the value of products also depends on how the products are used and the kinds of problems they are used to address. Value, put differently, partly arises from practices. Following this line of thinking, we consider storage as a value-creating practice. Hence, our central research question is: How does the storage of end-of-life electronics create consumer value?

The article is structured as follows. First, we conceptualize value and conceptually link it to practices of storage. We then present our methodology—in-depth interviews with 29 consumers conducted in their homes—and proceed with the analysis. In the analysis, we find consumers’ value experiences of storage closely related to perceptions of risk: storage serves as a risk management strategy and provides consumer value by promising security against different types of risks. In this way, storage generates what we term ‘security value’. We identify four discourses of risk that underlie consumers’ value experiences: practical risk, existential risk, environmental risk, and moral risk. Finally, we show how our findings have implications for the conventional understanding of ‘dead storage’ and for practice-informed discussions of value.

## 2. Theory

### 2.1. Value

Discussions of value are central to the concept of circular economy. In Webster’s [16] (p. 16) definition, a circular economy is an economy that “aims to keep products, components and materials at their highest [ . . . ] *value*, at all times” (emphasis added). Despite this centrality, discussions of how value can be conceptualized are lacking in the circular economy literature. Most commonly, the value of resources seems to be determined in relation to the economic potential they hold to companies and economies (i.e., economic prosperity) or the environmental benefits their circulation implies (i.e., environmental quality). As Kirchherr et al. [17] suggest in their comprehensive review of 114 circular economy definitions, there is much less concern with the value the circulation of resources brings to consumers.

Recently, however, there has been increasing interest in consumers within the circular economy literature, as well as multiple calls for more attention to the role of consumers in implementing circular practices [17–23]. Much of this attention has so far been directed at consumers’ acceptance of circular solutions [24–26]. However, as Camacho-Otero et al. [18] (p. 17) argue, “change [towards a circular economy] is not only about acceptance”. Where consumers’ active participation in circular solutions is crucial for these solutions to succeed, consumers need not only to accept them but also to *care* about them. The concept of consumer value holds promise for understanding why consumers care enough about some practices to actively engage in them. For example, as the studies on consumer storage of end-of-life electronics previously cited indicate [10], the value consumers attach to their end-of-life electronics motivates consumers to store them instead of disposing of them for recycling.

Consumer value is thus a key concept for understanding the motivational structures of consumer circular behaviors and misbehaviors.

But how can we conceive of consumer value? What is it and how does it come about? Graeber [27] (pp. 1–22), in his monumental work on the notion of value across human societal forms, underlines that there are basically three ways in which we have considered value. It has been presented as a sociological concept often termed ‘social value’ and referring to a social norm concerning what is ultimately considered good and desirable in society. It has also been conceived of economically as an ‘exchange value’, indicative of the ‘price’, i.e., the amount of resources that someone is willing to give up in order to acquire something in an exchange process. Finally, it has been considered linguistically as ‘meaningful difference’, i.e., the value of something is what sets it apart from other phenomena (of different value) [27] (pp. 1, 2).

If Graeber paints with a very broad theoretical brush in his quest for an anthropological theory of value, consumer researchers have excelled in micro-distinctions in terms of forms of value underlying consumption practices and choices. Karababa and Kjeldgaard [28] try to bring some order to the plethora of notions of value found in consumer research. They are critical of the axiological approach of Holbrook [29] which gives the impression that “a particular set of values are inherently human values” [28] (p. 123). This axiological approach, like so many other social psychological value schemes, becomes problematic in terms of respecting the multitude of contexts that are found among consumers worldwide. Values in the marketplace, Karababa and Kjeldgaard argue, must rather be “conceptualized as cocreated through the practices of a multiplicity of actors, such as consumers, companies, the media, the state, and brand communities, operating in the marketplace” [28] (p. 124).

This practice-based approach is taken up and developed by Arnould [15], who in his call for a praxeology of value starts out by reminding us that “practices consist of discursive knowledge and tacit knowledge sometimes grouped together as competences, materials and affective engagements” [15] (p. 129). In his insistence on the need for a praxeology, Arnould is aligned with another anthropologist interested in consumption, Daniel Miller, who suggests that value should be considered less as something there “is” or, in other words, an attribute of objects, but rather as something one “does” [30]. This perspective suggests that the value of end-of-life electronics is not fixed and static but rather arises from what consumers do with them—e.g., by storing them. The consumer value of stored devices may very well be linked to the physical and functional condition of the devices, as others have suggested [31]. But rather than assuming this, the practice-based perspective encourages us to consider the value of the stored device in relation to what purposes the practice of storage serves. If a device is not stored for its future functionality, for example, its functional deterioration might have little influence on the value it holds to consumers. So, if the value of end-of-life electronic products does not reside within the products themselves, how may storage transform such products into valuable consumer possessions?

## 2.2. Storage and Value

Drawing on Cwerner and Metcalfe [32], we define storage as a practice of ordering things. Depending on where things are stored, this ordering has implications for the value assigned to them. For example, the same object, say a t-shirt, assumes very different value depending on whether it is placed in the bin or in the drawer. In the bin (a space for transiently storing rejected things, until the arrival of garbage collectors), the t-shirt is temporarily stripped of its value and becomes trash [33] (few would indeed dare to wear a t-shirt straight out of the bin); whereas when in the drawer, the same t-shirt is still assigned potential use value. In this way, storage is essential in maintaining order since, by managing and transforming the value assigned to things, it determines our relation to them and, consequently, the way we act towards them.

The assignment of value through storage goes beyond differentiating things as being waste and non-waste. Studying people’s practices of storing things in the garage, Hirschman et al. [34] explain that the garage bestows a specific value on the items stored there: not valuable, not waste, but

something in between. Many of these mixed-state items are classified as more than halfway-waste (simply waiting for the next occasion to be thrown out). They are items that, although presently useless, are believed to possess “potential” utility for future situations, i.e., “potential value [that] has yet to be proven or accessed” [34] (p. 384). For consumers, items stored in the garage function as a ‘hedge fund’ that secures them against the uncertainties of the future (what if one day I need that?)

Cherrier and Ponnor [35] similarly propose that hoarders store things to protect themselves from future uncertainties. The authors draw on Beck’s [36] notion of ‘risk society’ to explain that rapid technological development and the rise of global capitalism has generated as a series of risks (e.g., the risk of global warming and sudden shortages of critical resources) that consumers face in their daily lives. Hoarding consumers are found to accumulate items in an attempt to cope with the potential materialization of these global risks. In this way, Cherrier and Ponnor [35] emphasize the intimate link between material possessions and *security*, making it apparent that the value of storage (and of stored things) partly derives from the sense of security that storage instills in consumers.

Furthermore, the hoarders of Cherrier and Ponnor saw storage as a way to resist the ‘throwaway society’ they thought themselves to be living in. Storing items instead of disposing of them (even if they had no functional value) was seen as a reflection of the hoarders’ commitment to bringing about a more sustainable society and protecting the environment. Storage, in other words, classified certain items as ‘not-waste’, items not contributive to “the current wasteful society” [35] (p. 19) and therefore valuable.

Finally, consumers even assign identity value to their possessions through the practice of storage. For example, through curatorial practices, such as collecting [37,38], cherishing family heirlooms [39–41] and hoarding [35], consumers cultivate a symbolic connection with their histories, values, and relationships, forging emotional attachment to their possessions and imbuing them with identity value. In all these practices, storage is paramount to the classification of the curated items as valuable extensions of consumers’ identity. The role played by storage in attaching identity value to objects becomes apparent when storage is not or cannot be practiced. Indeed, under conditions of nomadic [42] or access-based consumption [43], which for different reasons limit consumers’ ability to store their items, identity value is absent in objects [44].

In sum, we suggest that storage practices serve as conduits [45] for negotiating the value assigned to things. Crucially, storage separates value from waste but also assigns different kinds of value to objects by classifying them in diverse ways (e.g., as security in an uncertain world, the protection of the environment, identity extensions, etc.). In the findings that follow, we explain how our informants classified their stored end-of-life electronics and how storage became a value-generating activity given these classifications.

### 3. Materials and Methods

The study was part of a larger project investigating the flow of electronic products towards disposal within a circular economy framework. The ultimate objective of the project was to understand how to facilitate the circulation and reutilization of such products, which often end up in landfills. More specifically, for this paper we examined consumers’ experiences of storage and disposal practices. As the divestment of things is a reflexive practice reproducing social narratives [46], we based our analysis on in-depth interviews with the aim of understanding consumers’ emic interpretation of those narratives. When convenient to the study participants, we conducted a naturalistic investigation in their homes [39]. In those cases, interviews were supported by the researcher’s observations, written down during the interview, or conveniently right after, in the form of fieldnotes. Fieldnotes captured the researcher’s immediate reflections on the discussion and descriptions of the spatial surroundings of the encounter, especially of those places where consumers kept their used technology. These spatial descriptions focused on the design of the rooms, the objects stored in there and the perceived level of order and clutter, i.e., traces of the circulation of objects within and through the home. Overall, observations enriched our basis for analytical interpretation of the interview data [47].

The final data set amounts to 29 interviews lasting between 45 min and 2 h. The interviews were semi-structured [48], guiding the discussion from a general talk about circular economy to the peculiarities of the informants' everyday disposal behavior of technological objects. Mobile phones were often mentioned during the interviews, yet as we show in the findings, they were not the only type of technological object discussed. The number of collected interviews was decided on following the principle of informational redundancy [49] (Figure 1). During the last interviews, no new information was added to that previously collected, and we hence concluded that informational redundancy had been reached. Furthermore, as data analysis proceeded iteratively and simultaneously with data collection, we made sure that the gathered data were sufficient to reach inductive thematic saturation, i.e., the point where identification of new codes in the data ceases [50]. As no new codes emerged at the end of the preliminary analysis, we deemed the number of interviews to be satisfactory for our research purposes.

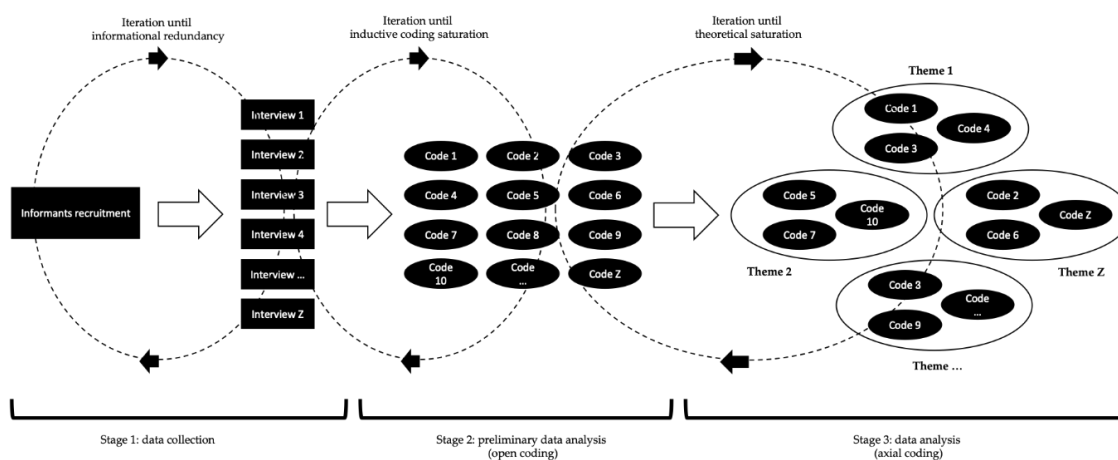


Figure 1. Research process.

The study participants were all Danish citizens between 23 and 82 years old. They were recruited from a pool of survey responses stemming from an earlier phase of the overall project. In the survey, people had the opportunity to leave their email address and state whether they were available for a follow-up interview. As the present research is qualitative and exploratory in nature, it must be noted that our purpose is not to make general statements about a specific (and constructed) sample of a larger population, but “to gain access to the cultural categories and assumptions according to which one culture construes the world” [48] (p. 17). In other words, we are not interested in assessing how many people within a more or less homogeneous group possess certain characteristics that may explain their storage behavior. We are interested in exploring the qualitative relations that characterize storage as a phenomenon of the culture in which it is performed. Therefore, discussions about the “statistical logic” [51] (p. 435) underpinning our “sample” are less relevant. More important than the representativeness of our recruited participants is their “social significance” [51] (p. 435), that is, the fact that informants have “direct and personal knowledge of some event [the storage of unused electronic products, in our case] that they are able and willing to communicate to others” [49] (p. 180).

However, we recognize possible limitations related to the sociodemographic composition of the cohort of study participants (summarized in Table 1). We sought to approximate gender equality (the final sample consists of 41% women and 59% men) and covered a range of different educational backgrounds. Yet our sample is still disproportionate in terms of age (the majority are between 20 and 30 years old), education (the majority are students) and housing (the majority live in flats). We are aware that the predominance of these sociodemographic variables may affect our informants' perspectives on and experiences of technology disposal and storage and, with them, the results of our study. But to reiterate the point made above: the present study is exploratory and makes no



claim about the representativeness of the sample, nor the generalizability of the findings in relation to the sample.

**Table 1.** Informant demographics.

Pseudonym	Gender	Age	Education	Occupation	Housing
Andreas	M	27	Master	Clerk	House
Anja	F	30	Bachelor	Unemployed	Flat
Birger	M	67	Primary school	Retired	House
Charlotte	F	30	Bachelor	Nurse	Flat
Claes	M	25	Master	Student	Flat
Dennis	M	23	High school	Unskilled worker	Flat
Dorthe	F	25	High school	Student	Flat
Dagmar	F	28	Bachelor	Unemployed	Flat
Eva	F	63	Bachelor	Librarian	House
Esben	M	24	High school	Student	Flat
Henrik	M	68	Bachelor	Retired	House
Ida	F	24	High school	Student	Flat
Jonas	M	30	Master	Student	House
Juliane	F	26	Bachelor	Student	Flat
Kristian	M	49	Professional bachelor	Unskilled worker	Flat
Leif	M	50	Bachelor	Retired	Flat
Morten	M	27	Bachelor	Unemployed	House
Mathias	M	23	High school	Student	Flat
Maja	F	29	Master	Clerk	Flat
Margrethe	F	28	High school	Student	Flat
Niklas	M	27	High school	Student	Flat
Robert	M	29	High school	Student	Flat
Theis	M	76	Bachelor	Retired	Flat
Tobias	M	30	Master	Unemployed	Flat
Torben	M	29	Bachelor	Student	Flat
Troels	M	24	Bachelor	Student	Flat
Tyra	F	82	Professional bachelor	Retired	House
Wendy	F	24	Professional bachelor	Student	Flat
Xin	F	30	Bachelor	Student	Flat

We conducted a thematic analysis of the data in order to explore consumers' experiences of their disposal practices [52]. The analysis proceeded inductively, as we did not commence with a fixed theoretical agenda in mind, but rather with a commitment to understanding why consumers keep or discard their technology. In the preliminary stage of the analysis, the researchers involved in data collection independently read the transcribed interviews and proceeded with open coding to form initial meaning categories describing informants' reflections on their experiences of technology storage and disposal. These categories were recursively compared and discussed within the research team to ensure inductive thematic saturation, i.e., the point where no new codes emerge [50]. In the later stage of the analysis, we proceeded with axial coding to identify relationships among the preliminary

categories [53]. At this stage, categories were related to each other and to existing theory on the topic, and thus iteratively reinterpreted “in a continuous back and forth process of relating parts to the whole” [54] (p. 141). This hermeneutical, back-and-forth process [55] continued until theoretical saturation [50], i.e., until we reached a comprehensive interpretation of the data in light of existing theory. As a result, we identified the theme of risk as the common underlying framework through which our study participants make sense of the practice of storage of unused technology. The different connotations of this theme (i.e., the different risks) and further explanations of the findings are discussed in the next section.

#### 4. Results

In the findings, we address how storage transforms end-of-life electronics into valuable possessions. We find that this transformation happens because storage serves as a practice of managing four types of risk that consumers experience in their lives: practical risks (i.e., risks to the stability of consumers’ everyday practices), existential risks (i.e., risks to consumers’ sense of self), environmental risks (i.e., risks to the environment), and moral risk (i.e., risks of acting wastefully). This classification should be understood as ‘ideal types’ of risk in the Weberian sense. They are thus not the risk perceptions of any one individual but rather serve to capture the predominant patterns among the risk perceptions our informants articulated.

##### 4.1. Practical Risk

Most of our informants saw storing used electronic devices as a way of insuring themselves against the risks that losing or breaking their devices would pose to the stability of their everyday lives. For modern consumers, electronic devices have become central to carrying out a multitude of daily practices, such as work, study, parenting, banking and leisure practices. If consumers suddenly find themselves without their devices, these practices are at risk of breaking down. For this reason, keeping a “safety stock” of used electronics, as one informant called it (Mathias), is essential for ensuring that consumers can go about their daily business without worrying about the unexpected loss or breakdown of their smartphones, laptops, or tablets.

In line with previous research [10], our findings suggest that the storing of smartphones is particularly pervasive. Smartphones kept for insurance against risks to the stability of everyday life go under various names: ‘emergency phone’, ‘SOS phone’, ‘spare phone’, ‘back-up phone’, or an ‘insurance’. The very naming of these devices—e.g., ‘emergency phone’ and ‘SOS phone’—indicates what is perceived to be at stake: losing one’s phone represents nothing short of an emergency. Consider also Ida, who tells us that she has “her whole life” in the digital calendar on her smartphone. Metaphorically, losing her phone would be equal to the uprooting of her life. Juliane articulates a similar stance:

*“Well, I’ve been down at one of those Apple repair stores, and every time I’m there they say that they have a ton of work and that it [i.e., Juliane’s computer] will be lying on a shelf and they can’t tell me when it’s done. And I can’t . . . I can’t do without my computer. Because we have the desktop computer at home, which you can’t bring anywhere. I mean, I have classes, I have student jobs. So, I can’t do without my computer for like 2 weeks, 3 weeks.”*

Juliane’s words evoke the phantomic presence of an unbearable risk associated to “make do without a computer” (that is, a portable computer). When asked what she would do in case of a sudden breakdown of her (already malfunctioning) laptop, she expresses risk-related anxiety through a reluctance to even think about such a negative scenario: “I don’t know. I have to figure that out. I don’t hope that that happens”. In this respect, our findings echo and extend Robinson and Arnould’s [56] observation of the ‘hysteresis of the battery’, the ‘unpleasant unpredictability’ and resultant unsettling feelings brought along by battery-based technologies. Robinson and Arnould [56] (p. 13) describe this “discomfort of unpredictability [as] the ‘what’, ‘if’ and ‘might’ of insufficient energy”. Our findings



suggest that such discomfort is not only experienced in relation to depleting energy gauges but also in relation to electronics more generally. That is, our informants articulated feelings of discomfort towards the ‘what if’ of breaking, losing or “having to make do without” electronics. In this way, keeping an insurance device becomes a way of managing the ‘unpleasant unpredictability’ of electronics. It provides consumers with easily accessible replacement devices and thereby reduces the discomfort evoked by the ‘what-if’ scenarios in which a replacement device would be needed.

End-of-life devices are not only kept to *replace* consumers’ primary devices, as described above, but also to *protect* them. For many of our informants, stored devices served, for example, as ‘sacrificial devices’ [10], devices that can be used for occasions where the devices are at augmented risk of getting lost or breaking (e.g., at festivals or during traveling). Typically (but not exclusively), phones are at the center of this narrative. As Dorthe puts it, she stores her old phone “if I were to need one that could take a beating”. Though intended for future use, sacrificial devices typically remain in storage and only, if at all, leave storage for very brief periods. Put simply, their functionality is potential, not realized. Thus, akin to what Hirschman et al. [34] (p. 372) write of many items consumers store in their garages, a sacrificial device “may be kept and stored ‘just in case’ the opportunity arises for its use in the future”.

To summarize, the storage of end-of-life devices helps consumers manage the practical risks brought about by the entrenchment of electronic devices in their daily practices. In this way, storage creates value as a form of contingency planning: It is in part some imagined future emergency (e.g., the loss of a phone) or exacting event (e.g., a festival) that makes end-of-life electronics valuable to the consumer.

#### 4.2. Existential Risk

Consumers do not only store their devices to manage risks related to their everyday practices. They also store devices as a way of protecting themselves against the loss of identity that losing control of their electronic belongings might entail. Storage helps consumers create a sense of existential security by managing two types of existential risks. First, storing helps consumers maintain a connection with material memories (e.g., pictures) or material extensions of themselves (e.g., an old, beloved phone), and second, storing helps consumers shield themselves from the misuse and manipulation of sensitive, identity-defining data.

##### 4.2.1. Forgetting the Self

For some consumers, storing old electronics is a way of holding on to some memory that is important to their sense of self. Storing these devices keeps their memories safe and their identities intact. An extreme example of this is Jonas, who, by his own initiative, has made a document listing all the smartphones he has ever owned. The document contains pictures of the phones accompanied by small anecdotes recounting the memorable experiences Jonas has had with his phones. Jonas’s commemorating of his devices reflects his deep emotional bond to them. Storing these treasured phones is a way for Jonas to remember and commemorate important periods of his life. Speaking of another kind of device, one of his old computers, Jonas explains:

*“Hell, you build an emotional relationship to these things. That’s probably also one of the reasons that I don’t get rid of it. I have an old Macintosh 3G I remember playing with when I was little. I mean, I can’t get rid of that. I’ve just acquired an old Mac Classic from 1986, it’s actually a Macintosh SE from 1986, and I did that because it was the first computer I used as a child. Then I could sit in my room and play Shuffle Pops. It’s nostalgia. It’s love for the machine. So I had to have it. And it now sits in my house.”*

Wendy provides another, albeit somewhat different, example of storing a device as a way of memorializing one’s past self. Wendy holds onto an old Nokia phone to maintain a connection with a lifestyle she once led and even keep the option of reverting back to this lifestyle open:

*“And the other one [i.e., the other phone Wendy stores] is a Nokia push-button mobile phone, which I have a dream of one day using for going ‘off the grid’. But, well, it’s not going to happen, but I keep it if I one day feel like doing that.”*

Both Jonas and Wendy exemplify how storage can transform stored possessions into “personal memorabilia” [37] (p. 149) or “memorials to self-history” [34] (p. 377). The stored electronics may in this way be viewed as “a personal archive or museum that allows [consumers] to reflect on [their] histories and how [they] have changed” [37] (p. 159).

Where the value of end-of-life electronics to manage practical risks derives in part from their future functionality (e.g., to act as a replacement phone), the value of storing devices as personal memorabilia is disconnected from the functionality of the stored devices. As Cherrier and Ponnor [35] (p. 14) write in their study on hoarding behavior, “[a]s objects are found to serve as vessels for memories, they are removed from the bounds of functionality”. Except for cases (like that of Wendy) in which the devices are stored to allow our informants to return to some nostalgized period of their life, our informants did not expect their electronic memorabilia to return to active use and their functionality was therefore largely irrelevant. For owners of such devices, there may not be an ‘optimal’ time to discard them, as conceived by Fang and Rau [31], as the consumer value of these devices does not decrease as their functional and physical properties deteriorate.

Sometimes, it is not the stored device itself that is linked to consumers’ identities but rather the content of the devices. The devices that our informants kept in storage would often be regarded as storage units. They held photos, videos, and old school papers, and other digital artefacts that hold and express our informants’ selves. Ida, for example, keeps a total of three devices—two old computers and an old phone—because they all contain photos that are valuable to her. While Ida wants to dispose of these devices eventually, she is in no rush to do so. For now, the devices serve as a functional way of storing her photos as the devices are not in the way and do not take up much space:

*“Well, I don’t want to throw them out because I know that there are images on them. And then it’s just something that I don’t get around to doing because, well, they don’t take up a lot of space and they are just in my closet.”*

Losing these devices would mean the loss of artefacts that might be important for consumers’ self-concept. Our findings thereby corroborate previous studies that suggest that consumers store their devices because of their emotional attachment to them [10] (p. 530) [57]. However, we also move beyond these studies in showing that sometimes the attachment is to the device itself and not only to the personal data it stores. Our study thus evidences Ylä-Mella et al.’s [8] (p. 381) speculation that old devices may acquire value as a “representation of [consumers’] personality”. In this way, storing the devices represents a way for consumers to manage the risk of forgetting themselves.

#### 4.2.2. Manipulating the Self

Our informants also expressed concerns in relation to other risks to the self. Many were concerned about what would happen to the sensitive data on their devices if they were to dispose of the devices. Our informants thought that this data posed an existential risk because it, in the wrong hands, would mean a lack of control of how one’s self was projected to others (e.g., having photos shared against one’s will) or result in the misuse of one’s identity (e.g., stealing one’s personal information and selling or using it for financial gain). Eva, for example, sums up her reasons for storing multiple phones in her home: “I guess it’s because I don’t know if there’s data on them that should be deleted”. Another example is Jonas, who is only willing to pass devices on to people he knows personally:

*“[E]ven if they [i.e., Jonas’ friends] recovered some images of me or my girlfriend, I would know that they wouldn’t misuse them, because they have, like, respect for me. I can trust them. Therefore, I wouldn’t sell it [i.e., Jonas’ phone] to people I don’t know.”*

Interestingly, Jonas, as a computer science graduate and technology enthusiast, is extremely technically knowledgeable. But rather than granting Jonas a sense of control of his data and making him feel more at ease with disposing his devices, his technical knowledge alerts him to the risks of doing so:

*Interviewer: But would you feel safe that they [Jonas' private images] would be gone if you deleted them?*

*Interviewee: No. Because they aren't [safe]. Unless you uninstalled your entire disc. Then I would have to install programs [to uninstall the disc] and then I would also have to trust those programs. And suddenly, I would have to write the software myself and I'm too lazy to do that.*

For consumers concerned about these existential risks, storage represents a technique for maintaining a sense of complete control over what happens to their data. Storage, in other words, ensures that the data is not used for identity-destabilizing uses.

Whether used as a way of remembering one's identity or making sure it is not wrongfully manipulated, storage provides value to consumers by granting them a sense of existential control and security.

#### 4.3. Environmental Risk

Storing electronic devices also provides value by giving consumers a way to manage the environmental risks perceived to be associated with disposal. In line with the findings of other studies [2], our informants were worried that their disposed of devices were not processed properly and therefore might end up in places where they would have a detrimental effect on their surroundings. Storing their devices was seen as a technique for making sure this did not happen. Morten makes this view explicit when he explains why he keeps over 10 phones in storage:

*"Over 10 phones, yes. [...] I don't use them for anything, so I guess I could just throw them out. But—I've heard that if the phones go to the recycling center, it's not certain that they end up being recycled. They can also end up in Africa or some place and just become scraps. That was just too much to take, not knowing where they actually ended up and if they were recycled properly. In any case, that's the problem for me—not knowing where they actually end up and if it is taken care of properly. So now they are just in my drawer."*

Ida articulates a very similar view in relation to two computers she keeps stored:

*"[...] that's also one of the reasons I haven't thrown out those computers. It's because I don't know how to throw them out. I don't want to throw them somewhere where they are going to pollute and stuff seeps into the groundwater or is burnt. I don't want to be a part of that, I feel they pollute less in my closet. [emphasis added]"*

Storage becomes a practice of controlling and containing the environmentally harmful effects that might follow from disposing of one's devices—even if the devices are disposed of for recycling, as Morten stresses. Like the hoarders studied by Cherrier and Ponnor [35] (p. 18, 19), our informants felt responsible towards the environment and storage allowed them to live up to this responsibility.

This finding shows that some consumers perceive it to be more sustainable to store one's devices than to dispose of them for recycling. By keeping their devices in storage, consumers are in control and do not risk making themselves complicit to putting a strain on the planet. Interestingly, this view stands in complete contrast to the literature on the role of dead storage in the transition towards a more circular economy. This literature emphasizes the importance of minimizing the amount of hibernating electronic devices and portrays storage as a barrier to efficient electronic waste recovery [10].

#### 4.4. Moral Risk

A final type of risk experienced by our informants relates to a concern with needlessly letting things go to waste. This risk of being wasteful we term “moral risk”, knowing well that morality is also involved in the other types of risk discussed here, in particular in the environmental risk. However, as noted by economic anthropology, frugality is a fundamental moral part of our joint human past [58] and a central element in the moral foundation of all major religions, e.g., [59]. Even in what might arguably be one of the most “wasteful” of contemporary consumer societies, the United States, frugality runs like a red thread through its historical moral discourses [60]. Hence, we find the term ‘moral risk’ appropriate due to its deep anthropological and sociological roots.

Boucher [61] identified fourteen different logics of frugality. For example, thrift is suggested as one such logic of frugality, nostalgia as another. As one informant describes, these logics may be intertwined:

*“We have a radio in the basement, which I think is really nice, so I don’t want to throw it out. But it doesn’t work very well.” (Charlotte)*

While the fourteen logics certainly point to a multifaceted phenomenon, they also carry a risk of lumping together different types of logics and behavioral frameworks that differ quite a lot, not least in terms of their conduciveness to sustainable behavior. As pointed out by Evans [62], when it comes to sustainability issues it is important to distinguish between frugality and thrift, since thrift is basically saving economic resources in order to be able to spend it elsewhere or, in other words, the art of doing more consumption with less money [62] (p. 551). In contrast, frugality is a direct moral restraint on consumption and as such much more in line with the ethical demands of sustainability. The notion of moral risk attached to violating principles of frugality suggested here corresponds roughly to what Boucher [61] called moral, idealist, and waste-not logics of frugality.

Consequently, and contrary to environmental risk, the concern here is not related to the generation of waste but rather to a concern of acting wastefully. Put differently, whereas environmental risk reflects our informants’ perceived responsibility to the environment, this type of moral risk reflects on the one hand our informants’ responsibility to the stored device itself (a responsibility that has also been recorded in hoarders [35]). On the other hand, this moral risk has roots in a deeper, cultural heritage of frugality that operates as a social imaginary [63], instituting an anti-wasteful ethos in society in general.

Our informants felt anxious about carelessly disposing of a device that they felt had some kind of value—even if they themselves did not have any current use for the devices. Xin provides a good example of this deepfelt aversion towards wastefulness:

*Interviewer: You mentioned [storing] your iPhone. Do you have many of those at home?*

*Interviewee: I have one that I’ve tried to sell. But now it’s just at home. It’s too old to sell anyway. It’s still functional. So now I’m keeping it for our son if he one day wants a phone to play with. I would rather keep things if they have value.*

Here, Xin recognizes that the phone has no financial value, yet keeps the phone because it still has ‘value’. Thus, throwing away something that still has value would be seen as wasteful. This reluctance to discharge for no apparent reason, we suggest, has roots in an inherited ethos of frugality and the ensuing principles of “not throwing away things that work”. This ethos explains the “sense of guilt [consumers feel] about throwing [their] old phone away” [64] (p. 30), which other studies have suggested to be a motivation for storage. In our context, the moral risk of acting wastefully paradoxically may lead to a behavior that is not conducive to improving sustainability, since it impedes the entry of the material object into the circular economy. Our case thus provides a qualification of Evans’ [62] general observation that frugality (unlike thrift) can reduce environmental impact.

## 5. Discussion

As explained in the introduction, studies have previously argued that end-of-life electronics possess residual value for consumers and that this value makes consumers store their electronics instead of disposing of them. Our analysis qualifies this conclusion. Taking a practice-based approach to value, we argue that the residual value is not only an attribute of electronics but rather also arises from the practice of storage. Storage serves as an important practice for consumers living in a society increasingly preoccupied with risk and the uncertainty of the future [65]. Our analysis shows that, in the case of end-of-life electronics, storage provides a sense of security to consumers facing four different kinds of risk: practical risk, existential risk, environmental risk, and moral risk. Thus, we show that consumers sometimes prefer storage over disposal because storage provides them with what we call ‘security value’. These findings have implications for how we think of ‘secondary devices’ and the practice of ‘dead storage’.

5.1. Secondary Devices and Differentiated Storage.

The first practical implication amounts to a rethinking of the notion of ‘secondary devices’. Wilson et al. [10] (p. 521) offer the term ‘secondary phone’ to avoid thinking of stored end-of-life phones as redundant: “secondary phone [ . . . ] holds a different function for the user than their primary phone but is still valued and intentionally retained by the user”. Our findings support this classification. However, Wilson et al. [10] further suggest that phones tend to become redundant when they are pushed from the status of a secondary device to that of a tertiary device, as consumers only need one ‘spare phone’. In making this argument, Wilson et al. [10] assume that all stored phones fulfil the same function (i.e., providing a spare), which obviates the need to store multiple phones.

However, as Wilson et al. [10] note and our findings corroborate, consumers tend to store far more than just one end-of-life phone. Our findings suggest that this is in part because consumers’ storage of end-of-life devices is not one homogenous stock of devices. They do not all serve as spare devices. Rather, stored devices tend to fulfil different functions and therefore hold different kinds of value to consumers. For example, our informant Wendy stores both an iPhone 5 and an old Nokia phone. Wendy stores the iPhone as a spare device (i.e., it is kept to manage practical risks) while she stores the Nokia phone as a memorial to her former lifestyle (i.e., it is kept to manage existential risks). Another example is Esben, who stores both a phone as a backup device (i.e., a traditional spare phone) and a phone to bring to festivals (i.e., a sacrificial device). Our findings thus suggest to think of the collection of end-of-life devices consumers store as differentiated storages, consisting of differently valued devices. While it may not make sense for consumers to store two spare devices to manage the same kind of risk, as Wilson et al. [10] correctly argue, it may make perfect sense to store multiple devices to manage different kinds of risks. Public and corporate actors should take these differentiated functions of end-of-life electronics into account in developing their reverse logistics strategies.

### *How Dead Is Dead Storage?*

Our findings also problematize labelling consumers’ storage of end-of-life electronics ‘dead storage’. This label carries connotations of inefficiency and passivity; if the stored device is ‘dead’, it serves no function and should therefore be put to better use through recycling or refurbishment. Our study finds that the storage of end-of-life devices *does* serve a function, as it helps consumers manage risk. Wilson et al. [10] (p. 522) in part address the inappropriateness of the dead-storage label when they qualify the dead-storage period devices go through as a period of ‘hibernation’: “hibernation [ . . . ] suggests a latent value that although steadily reducing, could be ‘reawakened’ and recaptured.” But our findings suggest that this qualification does not go far enough. While the use value of stored devices may be ‘latent’, the security value is not. Security value is actively captured through storage. Thus, even when devices are not in use, their security-generating capacity is alive and wide awake, which the concept of ‘hibernation’ fails to recognize.

This value-generating capacity of ‘dead storage’ also implies that the current problem of ‘dead storage’ is not likely to be fixed through a top-down, purely technical approach. It might for example not be enough to simply inform consumers of the need to dispose of their electronics and then expect



them to follow suit. As other studies have pointed out, many consumers are aware of the importance of waste recovery, but this “awareness has not translated to recycling behavior” [8] (p. 374). Put differently, problem awareness constitutes but one of the criteria for the effective collection of end-of-life electronics [66]. Yet, discussions of how to solve the problem of dead storage have often centered around awareness-raising campaigns [1,14]. We suggest that proposals to manage ‘dead storage’ must move beyond an understanding of consumers as “passive and rational recipients that will follow [ . . . ] production-side signals when making decisions” [18] (p. 2), the way much circular economy literature treats consumers. Our findings show that consumers might very well be rational, but that they do not always follow a rationality of resource efficiency. For example, as storing end-of-life devices provided our informants with security value, storage seemed perfectly rational to them, even if they were aware that they were engaging in resource-inefficient behavior. Attempts to minimize ‘dead storage’ must therefore seek to ‘speak’ to this rationality and provide security value in other ways if they are to be successful in convincing consumers to dispose of their stored devices (Table 2).

**Table 2.** Overview of risks and possible routes for managing them.

Ideal Type of Risk	Description	Alternative Route to Security Value
Practical risk	Perceived risks to the stability of consumers’ everyday practices	Collectivize the stock of end-of-life devices (e.g., by developing an infrastructure for renting spare and sacrificial devices)
Existential risk	Perceived risks to consumers’ sense of self	Offer data securement services upon recovering end-of-life devices
Sustainability risk	Perceived risks to the environment	Give consumers a sense of control over the fate of their end-of-life devices (e.g., through a certification scheme ensuring responsible e-waste management)
Moral risk	Perceived risks of acting wastefully	Make the disposal of end-of-life devices feel less wasteful (e.g., by redesigning the recycling center)

So how might we go about compensating consumers for the security value they lose upon letting go of their stored devices? How can consumers feel protected from practical, existential, environmental, and moral risks without resorting to storage? We offer a few proposals for alternative routes of risk mitigation. To mitigate practical risks, it might be beneficial to develop an infrastructure for the easy and expedient rental of spare devices. Collectivizing the stock of spare devices would mean that fewer devices would have to be stored and would at the same time make consumers more comfortable with disposing of their own safety stock. To mitigate existential risks, it is essential to help consumers retrieve the identity resources (images, videos, and other files) their old devices contain. Refurbishment stores could for example offer this as a service whenever they acquire consumers’ old devices. To mitigate environmental risks, the challenge is to give consumers a sense of control over what happens to their devices after disposal. This might be done by introducing a certification scheme that e-waste management agencies can apply for to ensure consumers that they are handling e-waste in a responsible fashion. Finally, to mitigate moral risks, consumers must be made to feel like they are not letting valuable resources go to waste when they are throwing out their electronics. One proposal would be to design recycling centers so that it is clear to consumers that the electronic items they leave behind there are handled differently from other trash. A designated area for delivering e-waste in which items are neatly arranged would tell consumers that these items are handled with care, that they have a future, and that they are thus wasted.

These are some of the proposals that arise from taking seriously the security value that consumers experience through storage. We have not, however, tested the effectiveness and economic feasibility of the proposals above, and we call for future research to address this task. Future research should furthermore investigate the degree to which each of our identified risks motivates the storage of *specific*



electronic devices. In our interviews, we took a general approach towards talking about consumers' storage practices without focusing on what motivated the storage of any specific device. Our findings therefore reveal little about whether environmental risk, for example, is a stronger motivator for storing phones than for storing televisions, remote controls, laptops, tablets, printers, scanners, etc. Research addressing this question would help us to develop risk-mitigation strategies that are tailored to specific devices.

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