

BEHAVIOURAL DRIVERS RELATED TO END-OF-USE SMARTPHONES

Synthesis of a literature review in behavioural sciences

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FOREWORD

This document presents content, scientific experiments and facts that may disturb or confuse the reader. Each theory, statement or practice presented here does not necessarily reflect the views of Ecologic or its employees, nor those of Dr. Dimitri Naczaj, principal author.

The aim of this synthesis of a literature review is to provide a broad and comprehensive view of current multidisciplinary knowledge on the use of economic and psychological levers to change behaviour, with a particular focus on end-of-use smartphones. As a synthesis of a larger and broader document, this one provides scientific references and a short bibliography. An exhaustive list of references is available in the complete version of the literature review. **If you are interested in reading the full literature review, please contact the author (dimitri.naczaj@bellegarde.co).**

Due to the imperfection of the scientific publication system, it is necessary to remain critical toward the studies here mentioned and to take into account the publication bias. Publication bias is the result of an over-representation in the scientific literature of studies that yield significant, positive results and validate the research hypotheses. Consequently, studies that do not provide significant results (on which one cannot reasonably conclude on the presence or absence of an effect of the variables tested) tend to be less published and are therefore under-represented in the scientific literature, artificially inflating the validity of the studied theories.

However, the author of this document developed it with these shortcomings in mind. Only studies that meet the standards of the scientific method (including the number of study participants, significance level, statistical power, and explanation of inclusion criteria in meta-analyses) were considered, and we ensured that none of our conclusions excluded potential alternative hypotheses that have not yet been tested

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This document is the synthesis of a literature review in behavioural sciences on psychological levers and barriers related to end-of-use smartphones. To access the full literature review, please contact the author (dimitri.naczaj@bellegarde.co)

The main objective of the report, to which this synthesis relates, is to review the current knowledge, in behavioural sciences, related to the personal storage, reuse, repair and sorting of end-of-use smartphones, and more specifically to the drivers of these behaviours. The second objective is to highlight these obstacles and motivating factors so that they can be the subject of specific communications and actions relating to waste management, and specifically that of smartphones, in order to improve collection practices and other recovery strategies.

If we were to rank the behaviours associated with smartphones as waste in terms of their social and ecological virtues, we would first have reuse, then repair and finally sorting for recycling. Storage behaviour does not enter this hierarchy, since a smartphone does not pollute when put to sleep in a drawer, although a significant proportion of these smartphones end up in the bin (Nowakowski, 2019). On the other hand, the phenomenon of smartphone hoarding (i.e., taking the smartphone out of the circular economy loop), to which storage contributes, prevents materials from being reused and leads to the need to resort to natural resources. Postponing smartphone renewal is also considered a beneficial behaviour for circular economy (c.f., Wieser & Tröger, 2017), as some suggest that using a smartphone for an extra year would reduce the smartphone-related carbon footprint by 31% (Benton et al., 2015). However, there are currently not enough studies on this behaviour to include it in our state of the art.

1. Figures related to smartphone use

Before smartphones rise (pre-2007), research conducted on feature phones reported average first use durations ranging from 2 and a half to 5 years (Bakker et al., 2014; Murakami et al., 2009, 2010; Oguchi et al., 2006). From 2007 onwards, the duration of first use has fallen, but is now rising slightly each year. A number of studies, covering several countries, show such a trend since 2013 (Kantar World Panel, 2017 in Milanese & Guenveur, 2016; Murakami et al., 2010). Between 2013 and 2016, the average for France rose from 18 months to 22.2 months, and is now (2021) estimated somewhere between 23 and 40 months, attesting to the constant increase in the average duration of first use (CREDOC, 2021; Citizing, 2020; Strategy Analytics, 2020).

The 2021 edition of the digital barometer (CREDOC, 2021) reported that 26% of renewals were due to some constraint that makes it impossible to use the smartphone (partial deterioration, breakage, loss or theft) and 37% were due to malfunction or because the smartphone was no longer being updated. Together, these two categories account for 63% of cases. A third category is made up of individuals who have no need, but rather a desire, to change their smartphone for a latest-generation model (8%) or any other more recent smartphone (11%), or who have had an opportunity or offer to change (6%). These three reasons, labelled as “pleasure purchases”, account for 25% of smartphone renewals. Finally, the study presents a category that includes other reasons whose nature is not explained (5%) and cases of first-time smartphone purchases (7%).

Overall, then, there are two types of reasons given for renewing smartphones:

- Comparison with a new model, giving the desire to change. Some authors refer to this as premature disposal or pleasure purchase, triggered by internal (mainly emotional) and social reasons (Chapman, 2010; Cox et al., 2013; Park, 2010). Renewal can come from a desire to update or from the need for better performance. There is a range of secondary reasons, such as a lack of accessories or the old phone's functions being too limited, when they are not deemed outdated or even obsolete (Afroz et al., 2012; Perez-Belis et al., 2017; Miner et al., 2020; Ongondo & Williams, 2011; Shaikh et al., 2020; Tan et al., 2018). It may also involve external sources of motivation, such as operator renewal subsidies (Martinho et al., 2017), social factors such as fashion effects or social status (Cao et al., 2016; Shaikh et al., 2020; Yin et al., 2014), or, more simply, the introduction of brand-new models (Miner et al., 2020), although this last factor needs to be qualified.
- Partial or total deterioration of the smartphone's capabilities or functions, leaving little choice but to replace it. In this case, this is "constrained" purchase (c.f., CREDOC, 2021). The reasons for this second category are simpler: the smartphone is replaced mainly when the old one is stolen, lost or destroyed (Liu et al., 2019; Tan et al., 2018).

2. Storage behaviour

According to recent studies (e.g., Sofies, see Rochat et al., 2019), storing smartphones as waste is the most widely adopted behaviour in France, with 46 to 50 million mobile phones stored, unused, functional or not (Harris Interactive, 2023). After changing smartphone, around one in two French people keep their old one (53%, c.f., CREDOC, 2021). An emblematic example of this behaviour is the smartphone that ends up in the drawer, because it can "always be used", but this reason, although often put forward, does not explain everything, far from it.

- First, storage seems to be a default behaviour, since keeping the waste does not require any action. This situation can be compared to the status quo bias (c.f., Samuelson & Zeckhauser, 1988), which highlights the tendency of individuals to prefer situations as they are, leading them to opt for choices that limit change. We find this effect of ease of behaviour from the opposite angle, when, in certain studies (e.g. Kurisu et al., 2020), participants highlight the discomfort or effort involved in recycling their electronic waste.
- Then, we can see the lack of information as a major determinant of smartphone storage. The vast majority of articles on the conservation of smartphones or, more generally, electronic waste, recommend increasing and diversifying awareness campaigns, and providing information at the right time (e.g., Poppelaars et al., 2020; Shaikh et al., 2020) in order to prevent hesitations that often lead to smartphones being stored. This lack of information concerns collection programmes, alternatives to storage and collection points (collection centres, in-store collections, etc.). In other words, some people simply won't know what to do with their old smartphone, while others will give up on the idea of reusing or recycling it, because they don't know where to turn. In the 2021 edition of the digital barometer, 16% of people said that they had kept their old smartphone due to

lack of information or indecision, they don't know what to do with their old smartphone (CREDOC, 2021).

- **The perceived usefulness or value of the smartphone** as waste is another reason for keeping it. One of the reasons often given for this is the fact that it can still be used, in around 25% of cases according to the digital barometer (CREDOC, 2021). It is not unlikely that this perception of usefulness limits the consideration of the old phone as some waste (even if it is, strictly speaking). So there would be no need to throw it away or sort it for recycling, when donation and sale remain an option. This perception of value must be seen in relation to the standard of living of users; the richest populations consider their old smartphone to be waste and seek to dispose of it, whereas the poorest populations consider it more as a resource to be valued (Borthakur & Govind, 2017; Zhang, Qu, Wang et al., 2019). This categorisation upon wealth is built upon different countries, not populations within countries.
- **The confidentiality of personal information** plays a very important role when considering the various options for disposing of smartphones. Some studies report users' fear about what could happen to their personal data (contacts, messages, photos, etc.) when they don't think being able to delete it or when they don't trust the collector. The few studies that have been carried out on the subject are categorical: every question related to the security of personal information in electronic waste, whether destined for destruction or reuse, is a reason for users to keep their old devices. For example, a study on Chinese university students showed that around 20.7% of them said they were worried about the fate of their personal data on the device they would dispose at a collection point, and 19.6% said they kept their e-waste to preserve the valuable personal information it contained. This represents nearly two out of five students who prefer to keep their old smartphone, guided by a fear related to the privacy of their personal information (Zhang, Qu, Sheng et al., 2019). In other studies, it is not uncommon to see a significant proportion of participants considering breaking their phone into pieces before disposing of it, in order to be sure that their personal data will remain unexploited (e.g., Bai et al., 2018).

Even if they are less important, because they are little or indirectly related to smartphones in the scientific literature, the following determinants should be taken into consideration.

- **Bonding to the object** and the anxiety generated by separation. Few studies have focused specifically on smartphone-user bonding (e.g., Martel, 2016); it would seem that the dynamic is the same, whatever the object: a strong attachment favours conservation behaviour, and, only after, the concern to dispose of it in an eco-responsible or sustainable manner (Evers et al., 2018; Trudel et al., 2016). The corollary is also true: individuals who have a general tendency to keep their objects (even waste) tend to report having a stronger attachment to them (Coulter & Ligas, 2003).
- **Separation anxiety** has been studied specifically in relation to smartphones. Overall, it would appear that reducing attachment can reduce separation anxiety (Nie et al., 2020) and thus limit the phenomenon of storage. Nomophobia (no mobile-phone phobia) is a pathological form of the anxiety about no longer having access to one's smartphone. All the studies are broadly unanimous: even if it is often pointed out as a harm arising from unbridled use of smartphones, nomophobia

does not explain the tendency to keep used smartphones, but, on the contrary, the need to change them as soon as the current smartphone no longer provides the desired access to functions deemed essential. It should be borne in mind that this pathology affects a very small proportion of the population, and that nomophobia is not yet recognized as a pathology in the DSM-V (fifth edition of the Diagnostic and Statistical Manual of mental disorders, referencing mental health and brain-related conditions and disorders), even though researchers have published articles in favour of its admission (e.g., Bragazzi & Del Puente, 2014).

- **Loss aversion and endowment effect** could also explain storage behaviour. Loss aversion generates a desire to keep the object (c.f., Dommer & Swaminathan, 2013 ; Maddux et al., 2010), and endowment effect stands that we overvalue an object as soon as it we own it. According to these authors, the compensation offered falls short compared to the perceived value of the item, especially when weighed against the purchase price, which encourages users to keep their old smartphone. This type of situation is particularly common in smartphones buy-back or take-back campaigns.
- Finally, one of the last reasons, put forward by a single study, relates to **people's lack of interest** in the ecological treatment of their smartphones, or in environmental causes more generally (Nowakowski, 2019).

3. Reuse behaviour

Reuse covers two different behaviours: donating or selling a smartphone, and using a second-hand smartphone, sometimes involving a purchase. These two different behaviours have their own dynamics and determinants. There has been very little scientific research into the reuse and reutilisation of smartphones. The data we report concerns electronic waste, including smartphones, but does not come from studies specifically on smartphones, unless otherwise stated.

In France, it is estimated that one third of the 46 to 50 million mobile phones kept in drawers, were working when they were being stored (Harris Interactive, 2023) and could potentially be reused, although only between 5.1 and 9 million are actually reused each year (Rochat et al., 2019). In the 2021 edition of the digital barometer (CREDOC, 2021), 28% of those questioned about the fate of their old smartphone, after buying a new one, said they had sold it or given it away to a relative, another individual or a shop. A survey carried out by Kantar on behalf of Recommerce (a company that buys and resells second-hand devices) reveals the growing interest of French people on that matter: 34% have already bought a second-hand mobile phone; however, it would appear that this is not a habit, as 82% want to buy their next phone brand new (Kantar, 2021). These figures seem to vary greatly from one country to another, and to evolve positively over the years. In Germany, Switzerland and Belgium, the proportion of people who have already bought a second-hand smartphone is almost identical to that in France (38%, 38% and 32% respectively). However, other studies report very different figures. Take, for example, the study by Pérez-Belis et al. (2017), carried out among 400 residents of Castellón de Plana, a representative sample of the Spanish population. The researchers explain that only 0.75% of the participants had ever bought a small second-hand electronic device. However, the study does

not specify whether smartphones were included in this particular count of small electronic devices. For the moment, the reports regarding second-hand devices change dramatically from one study to the next.

Drivers of reuse behaviour

- **A need for information on the repairability and durability of products** is reported in several studies as an explanation for the low rates of reuse. This lack of information also concerns systems or companies that allow reusing electronic devices other than the traditional channels of sale between private individuals (Othman et al., 2015; Pérez-Belis et al., 2017). This lack of information targets individuals who wish to buy a second-hand smartphone and those who wish to resell their own, with a greater impact on the latter.
- **Perceived values of the old smartphone**, and, in particular, the price, play a very important role, especially when compared to new models. A significant difference between a more recent or a new model seems to boost motivation to buy a second-hand or refurbished smartphone (e.g., Kantar, 2021; Pérez-Belis et al., 2017), whereas, conversely, the presentation of new, sometimes cheap, models represents a brake. As mentioned above, the endowment effect is an obstacle to the sale and purchase of second-hand smartphones: according to this cognitive bias, the seller will tend to overvalue the smartphone they're offering for sale, while the potential buyer will tend to undervalue it. The seller's overvaluation may discourage him or her from putting his smartphone up for sale, especially if he refers to the average price of other smartphones. The buyer's undervaluation may be reinforced by a comparison with the price of new smartphones. The condition of the second-hand smartphone seems to be the first variable correlated with purchase intention (Thangren & Nastaran, 2017).
- **Lack of trust** is a particularly significant barrier, for both buyers and sellers. This lack of confidence can have several consequences. First, it can result in a perceived lack of reliability of the second-hand model, or a lower reliability compared to new models, perceptions that dampen intentions to buy refurbished or second-hand phones (Ylä-Mella et al., 2015). Lack of trust can also lead to interrogations regarding battery capacity, giving the impression of a shorter lifespan, caused by the speed of technological progress (Pérez-Belis et al., 2017). Lastly, for some buyers, this lack of trust may give rise to doubts about the hygiene of second-hand appliances, especially those sold between private individuals, that are not reconditioned (Bovea et al., 2017; Pérez-Belis et al., 2017).
- **Pro-environmental attitude**, which is strongly correlated with a range of environment-related behaviours, seems to be just as strongly correlated with eco-responsible purchasing. In detail, the more knowledge an individual has and the more favourable their attitude towards environmental issues and the need to take action, the more eco-responsible their purchases will be (e.g. buying bulk products, second-hand appliances, limiting clothing purchases, etc.).
- **Selling the old phone** seems to be particularly popular with younger users, as it enables them to partly finance the purchase of the new one (Wieser & Tröger, 2018). In some countries, such as In-

dia, the second-hand market is highly organised, with shops and even showrooms showcasing recent reconditioned second-hand models (Kumar, 2017).

- In 2012, a study pointed out the lack of a second-hand market as a major problem for reuse (Dindarian et al., 2012). Since then, even though this market has expanded, particularly in France, the idea put forward by the authors remains the same: we need a second-hand market with easier take back schemes to resell second-hand smartphones. This market should be well known and appear credible and trustworthy in order to encourage reuse behaviour.
- At last, **technical characteristics of second-hand phones**, which are often inferior to those of the latest models, can act as a barrier, especially for the most tech-savvy audiences (Thungren & Nastaran, 2017). In a study by Ylä-Mella and her colleagues (2015), almost 23% of participants would only buy a second-hand smartphone if it had a subjectively satisfactory number of new technologies. For some buyers, the technical features of the second-hand smartphone will be the second criterion in their purchase decision.

4. Repair behaviour

When a smartphone is broken or malfunctioning, it is also possible either to repair it or have it repaired. In our situation, repair behaviour only consider smartphones being repaired with the aim of continuing to be used by the owner, and not for resale or donation. With an estimated 16 million out-of-service phones kept by private individuals in France (Harris Interactive, 2023), there is significant potential for repair behaviour, even if we don't know the repairable proportion of these phones. Compared with other behaviours, the figures from the digital barometer (CREDOC, 2021) provide little information about smartphone repair. We learn from it that 47% of people would not be against buying a so-called eco-responsible smartphone, allowing parts to be replaced by the user themselves. However, we do not know how many of the people questioned in this French study have had one of their smartphones repaired.

Of all the behaviours we are studying in this literature review, it would appear that repairing is the least done, which may explain why it is also the least studied. Some researchers suggest that, unlike other behaviours, the interest in having one's smartphone repaired diminishes as the smartphone gets older and as new smartphones are released (Makov & Fitzpatrick, 2021).

Drivers of repair behaviour

- **Perceived values** influence the decision to repair in two ways. First, there is the evaluation of the absolute cost of repair, which, according to some studies, is the first and main determinant of repair (Blake et al., 2019). If it is deemed too expensive, repairing a damaged smartphone will not be considered attractive and will be abandoned in favour of renewal. A smartphone repair costs an average of €110 in France (ADEME et al., 2021). It would also appear that users' willingness to pay to have their smartphone repaired is globally falling by 6.7% each year (Sabbaghi & Behdad, 2018). This decrease, which may be explained by the high cost of repairs, does not, however, affect

users' opinion on the usefulness of repairs. The cost and benefits of repair are also assessed in comparison with the price and benefits of a new model. It is not uncommon for some people to opt for renewal, as it may be cheaper or slightly more expensive, but brings more benefits than repairing an old model (c.f., Blake et al., 2019).

- **Lack of knowledge and information** has surfaced in several studies as one of the primary obstacles to an alternative to stockpiling behaviour, in our case, repair (Pérez-Belis et al., 2017). There is a general lack of information about the brands that offer smartphone repairs, about the cost, the timescales or, more simply, the kinds of issues that can be repaired.
- **The difficulty of repair** of small electronic appliance, particularly smartphones, is often put forward by individuals, even those in favour of repair (Bovea et al., 2017; Saritha et al., 2015). This barrier includes the difficulty of carrying out the repair, as well as the difficulty of obtaining replacement parts or tools to carry out the repair.
- **Feeling of programme obsolescence** is reported as blocking the desire to repair a smartphone that could quickly fall into disuse, see its capabilities drastically reduced, or no longer be updated. From this point of view, the cost of repair may not be worth it. The researchers behind this study recommend limiting communication on obsolescence (whether software or hardware, perceived as programmed, deliberate or not), to focus attention on the repairability of smartphones (Makov & Fitzpatrick, 2021).
- **The desire to change smartphone** is also a significant motivating factor. In France, in 20% of cases, smartphone owners prefer not to repair their smartphone, but to replace it directly with a newer, more efficient model (ADEME & Harris Interactive, 2021). The figures for the other electrical and electronic appliances studied by the same survey show that around 20% of the individuals questioned are likely to give in to the desire for a new appliance if there's a special offer (a statement made by 14% of individuals for washing machines or 20% for televisions). This desire seems to stem in part from the perceived obsolescence of smartphones, and to be driven by anything that facilitates renewal, such as price reductions.
- **Attitude toward repair.** We've seen that already, attitudes towards environmental issues seem to be strongly correlated with related behaviour. However, it would appear that smartphone users are less and less interested in repairs, which logically leads to fewer and fewer repairs. Because of the perceived obsolescence and depreciation of smartphones, repair is often seen as pointless. For example, when an individual damages their smartphone or when the device has diminished capabilities, it will not be the actual technical or software obsolescence that will slow down repair intention, but rather the perception of obsolescence (Makov & Fitzpatrick, 2021). This downward trend can be observed in other studies reporting a decrease in the willingness to pay for smartphone repairs, regardless of the amount of the repair, the type of device or the type of fault (e.g., Sabbaghi & Behdad, 2018).

5. Sorting behaviour and voluntary recycling disposal

Before a smartphone can be recycled, it must first be selectively set aside so that it can be taken back to a collection site, a shop or a waste collection centre. According to the 2019 Sofres study, only 300,000 to 500,000 phones are recycled each year in France, and 200,000 to 400,000 are thrown away (Rochat et al., 2019). The 2021 digital barometer (CREDOC, 2021) reports that this voluntary option concerns only 14% of individuals when they replace their smartphone. The intention to recycle only concerns 9% of people whose old smartphone is stored (CREDOC, 2021).

Overall, all the factors that determine whether or not people keep their smartphones act as a brake on other behaviours. Consequently, removing these brakes motivates people to adopt an alternative behaviour, primarily sorting for recycling.

- Once again, the biggest obstacle is the **lack of information** on a range of issues relating to the sorting and recycling of smartphones. Communicating about collections, take-back schemes and drop-off procedures at collection centres or shops, seems to be one of the most important strategies yet (Arain et al., 2020; Borthakur & Singh, 2020). It is also advisable to provide information about the product itself, its design, and the importance of recycling it in order to limit its environmental impact (Arain et al., 2020).
- **Ease of the behaviour**, in particular through proximity to collection points or recycling centres, is also one of the major factors encouraging the sorting and recycling of electronic waste and smartphones in particular. Studies carried out in developing countries report that some residents do not hesitate to dispose of their electronic waste (including smartphones) with household waste if the infrastructure is inaccessible to them (Ardi et al., 2020; Shaikh et al., 2020). Proximity to a collection point for recycling is not the only condition; this point must also be able to offer practical and accessible collection conditions (Arain et al., 2020; Araujo et al., 2017).
- Although not necessarily a primary determinant, **overall attitude and sensitivity to environmental issues** remain strongly correlated with the sorting and recycling behaviour of electronic waste, including smartphones. Studies show that sorting habits for all waste combined, reflecting both good knowledge of and sensitivity to environmental issues, are good indicators of intentions to recycle smartphones (Casey et al., 2019).
- **Habit and previous behaviour** also play a major role. Smartphones-related behaviours are not frequent enough to make it a habit; it is more a question of behaviour related to all electronic wastes, or indeed any type of waste, which can constitute a habit. Scientists have shown that the more carefully household waste is sorted, the more other waste is also sorted. According to this logic, individuals who are in the habit of sorting their waste should therefore also be the most likely to have their smartphones recycled (Favot & Grassetti, 2017).
- **The confidentiality of personal information** is an area of concern that hinders the sorting of smartphones for recycling. This is the fear linked to fraudulent use or theft of personal data, or simply a lack of confidentiality. Of the French people surveyed in the digital barometer (Rochat, 2019), 12% wanted explanations for deleting their personal data from their smartphone before

disposing of it. In another study (Kurusu et al., 2020), 45% of respondents explained that a collection service, which guaranteed the effective deletion of their data, would encourage them to hand in their computer for recycling. These results are echoed in other studies, all of which conclude that it is necessary to provide information about data deletion processes and to communicate more clearly in order to increase confidence in the organisation in charge of recycling.

- Depending on the infrastructure available, **attitudes and subjective norms** related to recycling influence the intention to recycle. If they have the opportunity to recycle, the more positive individuals feel about recycling and the more widely they perceive this behaviour to be adopted by others, the more likely they are to intend to do the same, particularly with their smartphones (Nduneseokwu et al., 2017; Pandebesie et al., 2019).
- Some studies have shown that in addition to the practical aspect, **the collection system and its procedures** are also very important. In China, for example, the youngest members of the population seem to appreciate take-back systems for recycling on the internet, unless they present a risk, while young adults prefer the safety of depositing their waste with a student association or in their university library (Ramzan et al., 2020).
- **Knowledge of technology** (mainly computers) is, according to some researchers, a driver for sorting behaviour. Yet, this is an indirect one: thanks to this knowledge, individuals would be more aware of the environmental stakes involved in recycling and would fear less for the security of their personal data (Jayaraman et al., 2019). These results are in line with those concerning the lack of information.
- **Perceived values** also play a role in recycling behaviour. First of all, it has been shown that financial incentives can eventually help to recycle WEEE, except for individuals who are already used to the exercise (Darby & Obara, 2015). The value of this option remains fairly limited: the best application solution would be a voucher for a new product when the old one is returned to the shop, along the lines of take-back schemes (Martinho et al., 2017). In countries where recycling is subject to a fee (i.e. not in France), the pay-per-waste system seems to be popular, especially if it can be combined with an e-waste deposit scheme (Nixon et al., 2009).
- Finally, a number of studies have highlighted the socio-economic characteristics related to intention and behaviour with regard to the recycling of electronic waste, including, in some cases, smartphones. It is important to bear in mind three facts. First, these characteristics are not drivers, they are correlated with intentions or behaviours related to recycling, but they are not the reason why those people do it. Then, these characteristics are specific to some populations under study, which often differ from the French population. Finally, the mentioned studies focus on the recycling of electronic waste and not exclusively to that of smartphones. Among these socio-economic characteristics, large families (as opposed to single-parent families, couples without children and single people), women and individuals living in houses (rather than apartments) seem to recycle more of their e-waste, including their smartphones (Dagiliūtė et al., 2019; Darby & Obara, 2005; Nowakowski, 2019; Ongondo & Williams, 2011; Pérez-Belis et al., 2015). Professional income and

level of education also appear to play a role by being positively correlated with intention to recycle (Dagiliūtė et al., 2019).

6. A few recommendations

The main drivers of the behaviours we are studying are: information, ease of behaviour and perceptions of utility or value. Used skilfully and coupled with classic behavioural levers from behavioural sciences, it is possible to create engaging and effective behaviour-change campaigns.

Inform, educate and persuade

- **Bring the information**, is the first and most important thing. In a 2021 survey, 73% of French people said that they felt well informed about how they could recycle or give a second life to objects they no longer use. However, the survey points out that this feeling could be greatly improved, specifically improving the transmission of information. The authors also suggest that the difficulty of sorting (especially on packaging) is primarily explained by the lack of information and the multiplication of sorting rules (Harris Interactive survey, carried out for the French Ministry of Ecological Transition, on a sample of 1,051 people, representative of the adult French population: Potéreau et al., 2021).
- **Target different populations at the right moment**. Spreading a campaign at the right time for a given population could be more effective than a bigger, large-scale awareness campaigns. In particular, it is advisable to adapt communications to different key moments during life transitions (such as a birth, entering a new home, or a renovation), which we have known, for a long time now, have the potential to change these kinds of habits (c.f., Andreasen 1984; McAlexander 1991; Ozanne, 1991; Price et al., 2000).
- **Use tailored persuasive arguments**, as it remains a key element in changing or reinforcing attitudes. Communication campaigns should certainly target the recycling, reuse or repair of smartphones, but they should also raise awareness of the environmental impact of smartphones more widely, and focus on different issues depending on the situation. Persuasive arguments could also be deployed to counter fears related the confidentiality of personal data, raised by a number of studies, which inhibit reuse, repair and even deposits for recycling.

Facilitating desired behaviours

- **Favouring proximity, multiplying collection methods**: research is almost unanimous on this point, the primary factor in facilitating collection is the distance between the place of residence and the collection point. This means either building more waste collection centres or increasing the number of temporary collection points. Whatever the technical solution, the aim must be to improve the accessibility of collection, take-back or repair systems, reduce distances and physical and financial costs, and make the inherent procedures more flexible.

- **Diversifying the operators involved in collection and repair**, with the aim of responding to the different constraints and expectations of the population. For example, we need to take into account the dematerialisation of the collection process, which, by making it easier, would encourage the most reluctant customers and those who have less time or resources to go to a collection point. With regard to repairs, Houston and Jackson (2016) recommend diversifying repair businesses, for example by authorising more individuals to carry out these repairs, which are often controlled by sometimes restrictive certifications of manufacturers.

Engage to bring about behavioural change

Engagement is a paradigm that enables behavioural change, and it would be advisable to implement it in order to change the behaviours related to end-of-use smartphones (c.f., Girandola & Roussiau, 2003). In this respect, some studies report the creation of serious games that allow players to learn something serious in a fun way. Most of these serious games are reported to provide the motivation we lack in traditional communications, while at the same time being engaging thanks to their interactivity, which enables important information or gestures to be learned. Serious games are a good way of promoting sorting and recycling, raising awareness of the environmental cause and, in addition to providing information, teaching both concepts and actions. However, these games are not an alternative to traditional communication; they should complement it. As Fourquet and Courbet (2015) point out, they have their place at special events or locations (e.g. museums, exhibitions, shops, collections, etc.). On the other hand, it seems more difficult to use this form of awareness raising as a form of long-term communication.

In addition to serious games, there are also smartphone applications designed to target the youngest, to provide them with appropriate arguments and encourage them to adopt a more responsible behaviour, in particular by recycling their WEEE.

Taking into consideration perceived values

Holders often choose to keep their smartphones if they cannot receive anything in return for the value they place on them, in which case the scales would tip in favour of keeping them as waste. On the other hand, if the holder receives a financial or symbolic incentive when recycling, repairing, donation or sale, then he or she will choose the option that seems most appropriate. The way in which a collection scheme takes into consideration the perceived value of waste, and communicates on this matter seems crucial, as it plays an important role in people's decision-making process. However, not all kinds of incentives are recommended.

- **Directly incentivizing the behaviour** is a first option. However, a system of financial incentives alone is not enough on a large scale to change behaviour related to e-waste sorting, even if it is properly set up and well presented, and if it meets strict ethical criteria. A system of this kind only makes sense if it is part of a wider campaign that includes other major levers for changing behaviour; and even if it can bring about a one-off change, it will have very little influence over time. It

does have the advantage of offsetting the problems associated with the perceived value or usefulness of end-of-use smartphones.

- **Charging the owner for recycling** is, in a way, the opposite of financial reward. Although studies in countries such as China (e.g. Song et al., 2012; Nguyen et al., 2021) have highlighted this solution, it seems difficult to implement it in France, as it could be perceived as duplicating the eco-participation applied to the purchase of electrical and electronic appliances.
- **Introducing a deposit for smartphones** seems to work, according to some studies carried out in China (e.g., Nguyen et al., 2021). Once again, there is a downside: introducing a deposit for smartphones would require a great deal of planning and structural changes, and therefore seems to be a difficult solution.

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