PROMPT

Premature Obsolescence Multi-Stakeholder Product Testing Program

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Association des consommateurs Test-Achats – Belgium

Organización de Consumidores y Usuarios OCU – Spain

Union Fédérale des Consommateurs - France

Disclaimer

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Content

1 Introduction

1.1 Topic

The way we take, make, and dispose of products is damaging our environment. Prolonging product lifetimes has a high potential to lower the environmental impact of electronic (household) products (Den Hollander et al., 2017). However, a lot of products are discarded before they reach the end of their functional life (Harmer et al., 2019; Hennies and Stamminger, 2016; Wieser and Tröger, 2018), which is also in many cases before their 'environmental break-even' point occurs (i.e., the moment where the environmental impacts that result from using a product are equal with impacts of a (more energy efficient) replacement product (Bakker and Schuit, 2017)). The impact of such a replacement was assessed by the EEB (European Environmental Bureau) in the study called Cool Products don't cost the earth (EEB, 2019).

Product lifetimes can be extended by prolonging the product's first life by longer usage or repair activities that restore products initial functionalities. However, earlier research of the PROMPT project (WP2) showed that consumers face a lot of barriers toward product lifetimes extension. For example, the fast-paced development of new technologies and marketing efforts stimulate early replacement of still functioning products. Also, a low consumer repair ability (e.g., knowledge, tools) and motivation (Ackermann et al., 2018) relatively high cost and insufficient repair infrastructures and services discourage repair activities. Earlier research showed that if products are designed to be physically durable, or to be repaired easily, this does not mean consumers will act accordingly (Makov and Fitzpatrick, 2021). For lifetime extension it is therefore crucial to investigate how user and market related aspects can postpone or encourage premature replacement of products

1.2 Scope

The focus of this report is on white goods and consumer electronics. The investigated product category choice for the PROMPT project was made at the start of the project, with the support of a multi-Criteria analysis by the project team. The criteria mainly focused on high market penetration, high environmental impact, high frequency of usage, and a variety in technological advancement were used as selection criteria. The four main product categories investigated in this report are washing machines, vacuum cleaners, (smart) televisions, and smartphones.

1.3 Objective

An overview of the state-of-the-art knowledge from consumer organisations, scientific research and policy about premature replacement was already researched in Task 2.5 of the PROMPT project and reported in Deliverable 2.6. This report was the base used for follow-up research in Work Package 5, in which we focus on the user and market-related aspects of premature obsolescence. Preceding this report, in deliverable 5.1 (p.7-9) first insights obtained for tasks 5.1 (premature replacement of well-functioning products) and task 5.2 (choice for replacement over repair) were reported, as well as published in the Current Opinion in Psychology (van den Berge et al, 2021), in which we explained the consumers' replacement decision- making process in more detail. In this report we build further on these first insights. We will provide insights of consumer studies that were specifically conducted for this deliverable, both qualitative (chapter 2) and quantitative (chapter 3), in which we analysed how a product's design features and/or business model influence people' replacement and repair attitudes and behaviours. We will end with a conclusion in which we reflect upon all insights obtained and how these contribute to previous PROMPT insights and will provide input for future deliverables (Chapter 4); for example, how these insights are useful for the development of the criteria for the testing program to assess the user/market related factors for premature obsolescence. Figure 1 shows a visualisation of the structure of this report and an overview of the conducted studies for this deliverable.

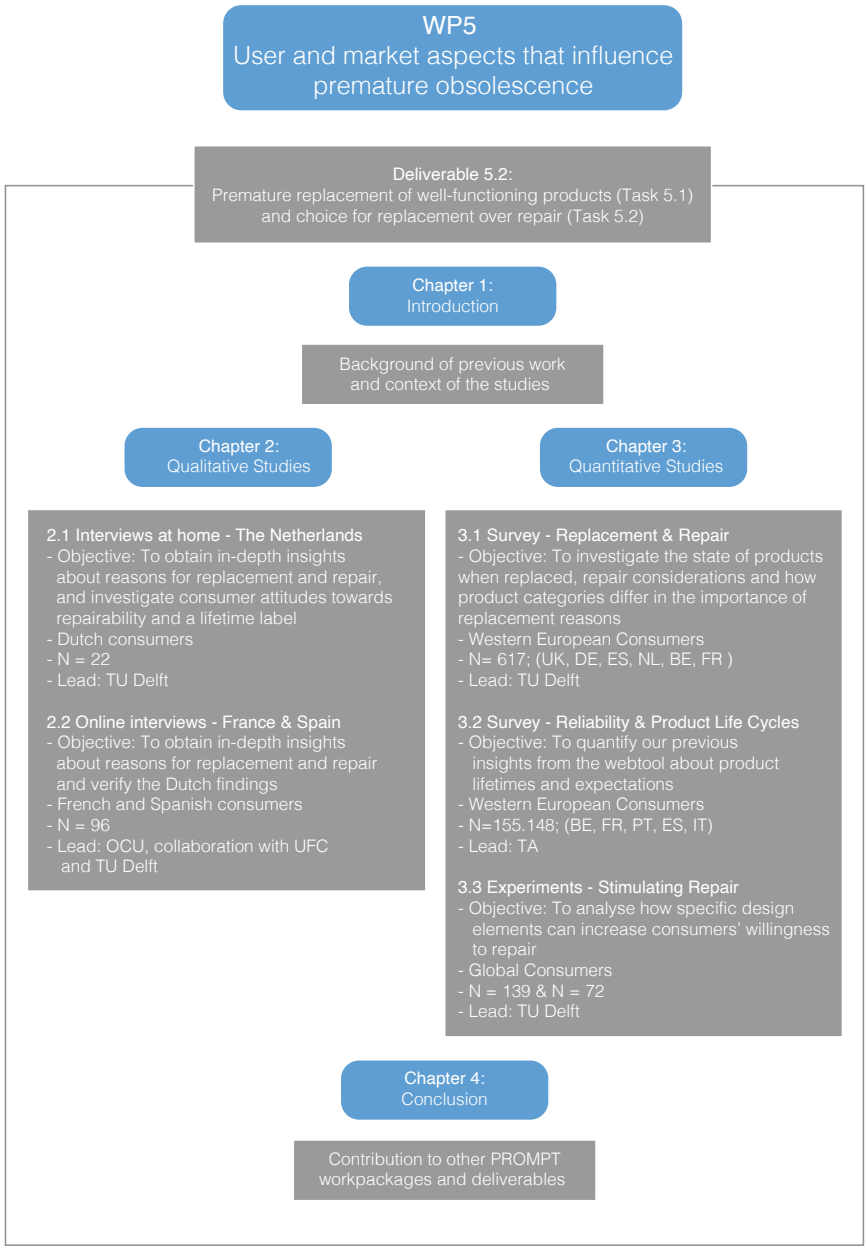


Figure 1 - Visualisation of the report structure

1.4 Partners

TU Delft was as work package 5 leader responsible for the project management of the studies conducted in WP 5, as well as for coordination of the reporting of this deliverable. Additionally, they provided the content for the theoretical background or product replacement, collected qualitative insights among Dutch consumers about replacement and repair, provided support for the follow up study in France and Spain, conducted the quantitative survey study on replacement and repair, and conducted the repair experiments. OCU coordinated the data collection of the qualitative interview studies in France and Spain executed together with UFC and was responsible for the reporting of these insights. TA coordinated the Reliability and Product lifecycle survey across the different European countries and was responsible for the reporting of these insights. In a combined effort, TU Delft, OCU and TA formulated the conclusion of this report while reflecting on earlier PROMPT insights (mostly from WP2) and insights from other consumer organisations /experts that go beyond the PROMPT project.

2 Qualitative insights on product replacement and repair

In addition to making products reliable (WP3) and repairable (WP4) from an engineering perspective, users' attitudes, and behaviours regarding the repair of products should be positive to convince them to do this. To gain knowledge on people's decision processes with respect to product longevity and to the choice to repair or replace, we will build our literature insight from Deliverable 2.6 which showed the state-of-the-art overview, and Deliverable 5.1, which showed the consumer replacement decision-making process.

In this part we investigate more in-depth why people replace products even though these products are functioning well, and why people either repair or replace a product that is malfunctioning. To investigate this on a more detailed level, we focused on the reasoning behind consumers' decision-making process. Therefore, qualitative studies are conducted for the selected four product categories. We collected insights from European consumers in different countries (The Netherlands, France, and Spain) to establish an in-depth insight on the different reasons for people's premature replacement or decision to (not) repair products and why these were made. Also, specific attention is paid to the role of the product, its (service) design features, and business models that either encourage or postpone premature obsolescence.

2.1 Interviews at home – The Netherlands

2.1.1 Objective

Consumers have an important role in product waste reduction (Cooper, 2004). A product can be physically durable or repairable, but this does not mean the consumer will act accordingly and extend its lifetime (Makov & Fitzpatrick, 2021). Current literature lists several reasons for replacements and indicates repair barriers. However, explanations about the reasoning behind consumers' decision to replace or (not) repair are lacking. Understanding consumers' thought processes are valuable when the goal is to get consumers to act and extend the life of products. The aim of this study was to provide in-depth insights about reasons for replacement and why consumers (not) repair products, that explain our previous findings from Deliverable 2.6 and 5.1.

2.1.2 Method

The findings from Deliverable 2.6 and 5.1 served as a basis for this qualitative interview study (n=22). A semi-structured interview guide served as a guidance for the questions. The explorative nature of semi-structured interviews left room for new topics to emerge. Open ended and 'why'-questions were used to gain in-depth insights into the reasoning behind product replacement. All participants replaced one or two of the selected product categories (washing machines: n=8, vacuum cleaners: n=8, TVs; n=8, and smartphones; n=8) within six months preceding the interview. The interviews lasted 30-60 minutes, depending on whether one or two products were discussed, and took place at people's homes to ensure a safe environment for them to share their experiences. This also provided the opportunity for the interviewer to observe the replaced product (if still present) and the new product in its context. The recruited participants showed variety in age (29-72 years), gender (41% male, 59% female) and income, details are shown in table 1.

During the interview, the participants were first asked why they decided to replace the product, and whether they have considered to repair it or have repaired it in the past. We asked about their consideration about repair and their barriers. Consequently, we asked whether the product met their expectations about the product lifetime, and whether they considered the lifetime during replacement decision-making. Also, we asked how they currently would make an estimation about the expected product lifetime. Finally, we asked about their opinions about product repairability in general and a potential product lifetime label. The guide which was used during the interview is shown in Appendix A.

For the analysis, all interviews were recorded, transcribed, and coded using Atlas.ti software. All codes are supported by several quotes from interviewees. From the codes, several categories and overarching themes emerged and represent the main insights. The results are discussed in the next section.

Table 1 - Details of the interview sample

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

2.1.3 Results

To show the context and background of the replaced products, we reported the actual lifetimes, the reasons for replacement and the state of the product when replaced. The actual lifetimes of the replaced products greatly differed within all categories (washing machine: 5-18 years; vacuum cleaner: 5-30 years; TV: 4-25 years; smartphone: 2-9 years). Differences between product categories regarding the physical state of the products during replacement were observed as well. While most washing machines had a defect, most TVs were still working. The reasons for replacement were also diverse, ranging from a defect or decrease in functionality (e.g., a broken drum of a washing machine, or a decrease in battery capacity of a smartphone) to a desire or a good deal for a new product (e.g., a TV with a bigger screen or a good deal for a vacuum cleaner). More specifications about the reasons for replacement of the products can be found in table 1 of Appendix B; in the academic publication of the interview results presented on the PLATE 2021 online conference.

Second, we reported consumers' lifetime estimations. Participants' estimations about the lifetime of their new product (i.e., the product bought as a replacement) were diverse, ranging from 5-12 years for a washing machine, 5-15 years for a vacuum cleaner, 5-15 years for a TV and 2-10 years for a smartphone (see table 1). Considering that there was a large variety in lifetimes between products within each product category (i.e., depending on quality, range, price etc.), the diversity in lifetime expectations is not surprising. The observed spread in consumers' lifetime estimations suggests that the lifetime is very unpredictable for consumers. Deeper insights revealed that participants' lifetime estimations were mainly based on intuition (i.e., instinctive knowing). When we asked what this intuitive estimation was based on, they mentioned personal experiences, recommendations from family or friends, consumer reviews, salesmen, the price, and brand reputations. Also, many participants acknowledged a lack in expertise and knowledge to make a well-informed estimation about the product lifetime and declared themselves unable to make a proper estimation. From the appearance, it is difficult to identify differences between products in

terms of lifetime. Information about the quality and robustness of used materials and components is often not communicated by the manufacturer. Concludingly, estimating the lifetime feels as a guess to many consumers.

Third, we reported consumers' repair considerations. Before replacing the product, only three participants repaired their smartphone, and only one repaired her washing machine. None of the participants repaired a vacuum cleaner or TV (Appendix B; table 1). Our results thus demonstrated that repair was often not considered for the replaced product. Confirming existing literature, the age of the product and cost of repair were mostly mentioned as barriers towards repair activities. We also investigated the repair considerations of participants' new products. Some additional barriers, such as the lack of a convenient repair infrastructure and the availability of spare parts for a reasonable price, emerged that confirmed existing literature. Additionally, consumers also seem to face concerns about the repair outcome. Our results thus revealed the uncertainty of the repair outcome as a hindrance towards executing repair activities.

Furthermore, we measured responses towards product repairability. Most participants answered that they did not take repairability into account when purchasing the new product. They were often surprised or confused by the question and indicated to 'not have thought of it at all'. The participants indicated that manufacturers currently do not communicate about repairability, and some also mentioned that the product did not look like it could be repaired. Additionally, participants questioned if a repairable product could live up to the latest performance standards, as well as it is often the more expensive option compared to similar products. Some participants even perceived repairability as a negative feature for products, because consumers just want a well-functioning product and do not wish to be bothered with potential repairs.

Finally, we reported attitudes towards a product lifetime label. Participants' attitude towards a product lifetime label varied. Often concerns about the trustworthiness of the label were observed when it would be provided by the manufacturer. According to the participants, manufacturers have no interest in selling long-lasting products as this would reduce their sales. Additionally, the continuous development of new models made the participants wonder whether the lifetime of products can be predicted in advance. The speed of new technological developments makes it difficult to include evidence from practice in lifetime estimations. Furthermore, it was questioned how a label can take the influence of (careless) consumer behaviour into account. Current warranty legislations from the European Union require proof that a failure is not due to the consumer. Often this was experienced as a burden, because for some cases it is difficult to provide proper evidence. Participants mentioned that a lifetime expectation expressed in years could affect them, because this would enable them to compare the purchase price to the expected lifetime. On the other hand, there were concerns about a lifetime expectation expressed in years, because the use intensity (i.e., the frequency of usage) and consumer behaviour (i.e., the way the product is handled by the consumer) strongly influence the product lifetime. Especially consumer behaviour is difficult to take into account on a label.

2.1.4 Partners

TU Delft was responsible for the set-up of the study, the data collection of the conducted interviews, as well as the data analysis and reporting of this study.

2.1.5 Academic publication: A poorly educated guess

The results of this study were presented in more detail in a contributions of the PLATE 2021 conference, Appendix B

- Van den Berge, R., Magnier, L., & Mugge, R. (2021). A poorly educated guess: consumers' lifetime estimations, attitudes towards repairability, and a product lifetime label. PLATE 2021 conference contribution

2.2 Online interviews - France and Spain

2.2.1 Objective

This interview study aimed at establishing an overview of French and Spanish consumers' replacement behaviour, focusing on the reasoning behind the decision to replace broken products (instead of repairing them) or still functioning products. The study tried to identify the in-depth insights in the main factors hindering product lifetime extension, as well as gathering consumer expectations regarding products' lifetime and possibilities to prolong it, and seeks to confirm the findings from the Dutch study.

2.2.2 Method

For collecting information, in-depth interviews were conducted by skilled professionals following a guideline document previously defined among task partners (see Appendix C). The field work was carried out in April and May 2021, first in Spain and then in France. Interviews lasted 40- 60 minutes and most of them were conducted by videoconference due to COVID-19 restrictions. The sample selection was similar to the initial Dutch study (described in point 3.1) with some slight changes to adapt it to the national situation. Participants were selected considering:

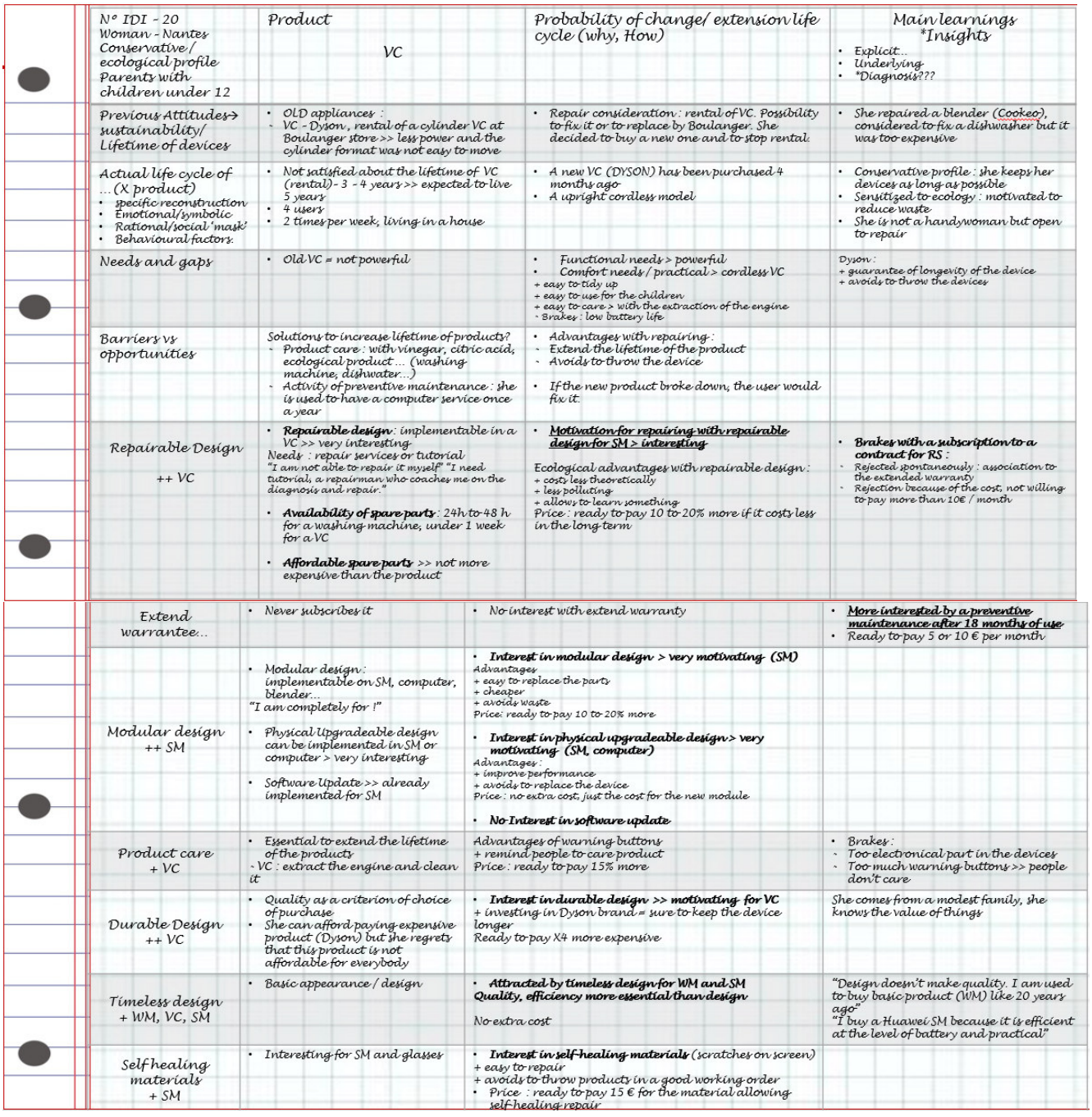
- **Moments in life cycle**
  Our sample include young people that live alone or with flatmates (named singles), persons that live with a partner without children (named dinkies), those who live with a partner and their children (named families or parents) and people over 55 years living with a partner without children (named seniors)
- **Age ranges**
  Participants must be over 22 years and under 65 years.
- **Occupation**
  Some interviewees had full-time jobs, others only a part-time job or where retired and some people were unemployed at that time.
- **Gender**
  We tried to have a balanced sample in both countries.
- **Territories**
  Spanish participants lived in different and distanced areas such Madrid, Catalonia, Basque Country or Andalusia while French participants lived in Paris, Lyon, Lille, Nantes or Bordeaux.

Additionally, all interviewees should have replaced at least one product of the involved categories (washing machines, vacuum cleaners, smartphones, or televisions) in the last 6 months. We provided more detailed information from 96 interviews, 48 per country, with the following distribution in table 2.

Table 2 - An overview of the sample distribution for France and Spain

	Product 1		Product 2		Product 3		Product 4		TOTAL	
	Spain	France	Spain	France	Spain	France	Spain	France	Spain	France
Singles *(Living on their own, friends... 25-30 , 30-40 y.o.)*	2	2	2	2	2	2	2	2	8	8
Dinkies *(double incomes no kids, 25-35 y.o.)*	2	2	2	2	2	2	2	2	8	8
Parents <12 y.o. (32-45 y.o.*)*	3	3	3	3	3	3	3	3	12	12
Parents >12 y.o. (46-58 y.o.*)*	3	3	3	3	3	3	3	3	12	12
Seniors *(55 and over or empty nest)*	2	2	2	2	2	2	2	2	8	8
TOTAL	12	12	12	12	12	12	12	12	48	48

Analyses and conclusions are fully qualitative. All interviews were fully transcribed, and the most relevant data were collected in worksheets (figure 2). Each worksheet shows the result of one participant. All participants were anonymised with an ID code. The worksheets were used for the analysis and enabled to identify significant verbatims and valuable insights per participant, create a consolidated summary per each interesting variable (product category, profile, consumption habits etc.) as well as draw an overall picture of the situation.



N° IDI - 20 Woman - Nantes Conservative/ ecological profile Parents with children under 12	Product VC	Probability of change/ extension life cycle (why, How)	Main learnings *Insights • Explicit… • Underlying • *Diagnosis???
Previous Attitudes→ sustainability/ Lifetime of devices	• OLD appliances : - VC - Dyson , rental of a cylinder VC at Boulanger store >> less power and the cylinder format was not easy to move	• Repair consideration : rental of VC. Possibility to fix it or to replace by Boulanger. She decided to buy a new one and to stop rental.	• She repaired a blender (Cookeo), considered to fix a dishwasher but it was too expensive
Actual life cycle of … (X product) • specific reconstruction • Emotional/symbolic • Rational/social 'mask' • Behavioural factors.	• Not satisfied about the lifetime of VC (rental) - 3 - 4 years >> expected to live 5 years • 4 users • 2 times per week, living in a house	• A new VC (DYSON) has been purchased 4 months ago • A upright cordless model	• Conservative profile : she keeps her devices as long as possible • Sensitized to ecology : motivated to reduce waste • She is not a handywoman but open to repair
Needs and gaps	• Old VC = not powerful	• Functional needs > powerful • Comfort needs / practical > cordless VC + easy to tidy up + easy to use for the children + easy to care > with the extraction of the engine - Brakes : low battery life	Dyson : + guarantee of longevity of the device + avoids to throw the devices
Barriers vs opportunities	Solutions to increase lifetime of products? - Product care : with vinegar, citric acid, ecological product… (washing machine, dishwater…) - Activity of preventive maintenance : she is used to have a computer service once a year	• Advantages with repairing : - Extend the lifetime of the product - Avoids to throw the device • If the new product broke down, the user would fix it.	
Repairable Design ++ VC	• **Repairable design**: implementable in a VC >> very interesting Needs : repair services or tutorial "I am not able to repair it myself" "I need tutorial, a repairman who coaches me on the diagnosis and repair." • **Availability of spare parts**: 24h to 48 h for a washing machine, under 1 week for a VC • **Affordable spare parts** >> not more expensive than the product	• **Motivation for repairing with repairable design for SM > interesting** Ecological advantages with repairable design : + costs less theoretically + less polluting + allows to learn something Price : ready to pay 10 to 20% more if it costs less in the long-term	• **Brakes with a subscription to a contract for RS** : - Rejected spontaneously : association to the extended warranty - Rejection because of the cost, not willing to pay more than 10€ / month
Extend warrantee…	• Never subscribes it	• No interest with extend warranty	• **More interested by a preventive maintenance after 18 months of use** • Ready to pay 5 or 10 € per month
Modular design ++ SM	• Modular design : implementable on SM, computer, blender… "I am completely for !" • Physical Upgradeable design can be implemented in SM or computer > very interesting • Software Update >> already implemented for SM	• **Interest in modular design > very motivating (SM)** Advantages + easy to replace the parts + cheaper + avoids waste Price: ready to pay 10 to 20% more • **Interest in physical upgradeable design > very motivating (SM, computer)** Advantages : + improve performance + avoids to replace the device Price : no extra cost, just the cost for the new module • **No Interest in software update**	
Product care + VC	• Essential to extend the lifetime of the products - VC : extract the engine and clean it	Advantages of warning buttons + remind people to care product Price : ready to pay 15% more	• Brakes : - Too electronical part in the devices - Too much warning buttons >> people don't care
Durable Design ++ VC	• Quality as a criterion of choice of purchase • She can afford paying expensive product (Dyson) but she regrets that this product is not affordable for everybody	• **Interest in durable design >> motivating for VC** + investing in Dyson brand = sure to keep the device longer Ready to pay X4 more expensive	She comes from a modest family, she knows the value of things
Timeless design + WM, VC, SM	• Basic appearance / design	• **Attracted by timeless design for WM and SM** **Quality, efficiency more essential than design** No extra cost	"Design doesn't make quality. I am used to buy basic product (WM) like 20 years ago" "I buy a Huawei SM because it is efficient at the level of battery and practical"
Self healing materials + SM	• Interesting for SM and glasses	• **Interest in self-healing materials** (scratches on screen) + easy to repair + avoids to throw products in a good working order • Price : ready to pay 15 € for the material allowing self-healing repair	

Figure 2 - Example of worksheet to collect interviews' information

2.2.3 Report: Spanish and French consumers

In this part we display the results of the interview study. We first present our main insights in consumers` replacement behaviour. After that we present insights on consumer behaviour per product category. We end with a general conclusion.

Main insights in consumer replacement behaviour

1. *Different level of commitment to sustainable behaviour depending on the country*

Citizens are aware of the importance of moving forward a more sustainable consumption and the key role of enlarging the lifetime in sustainability, but beliefs and behaviours are not enough aligned yet. The study also identified significant differences with this respect between the two tested countries.

French citizens are more committed and active in sustainable behaviour regarding product consumption and replacement than Spaniards. Many replaced products of French participants had already overcome the average lifespan, were second-hand or even refurbished devices. They spontaneously recognize the intention to repair all devices before replacing them. However, most of the Spanish participants recognized not to do much for enlarging product lifetime. They blamed the excessive tolerance to hyper-consumption, the premature obsolescence, business practices that push consumers to replace devices in commercials or the poor quality of current repairing services. In France there is also a certain dissatisfaction with repair services, but the intensity of the associated emotion is much lower.

The study showed that citizen behaviour is moving towards more sustainable patterns. French participants were more committed with enlarging lifetime habits than Spaniards but, even Spaniards are increasingly including some sustainable criteria in their purchasing choices. For instance, participants declared they are already looking at the energy efficiency when buying big household appliances such as washing machines, they take into consideration the online reviews given by other people about efficiency and durability, they like brands with high availability of spare parts and good post-sale & repairing services, as well as models that could be easily upgraded.

2. *The pandemic crisis changed consumer behaviours, particularly in Spain*

The pandemic crisis made a significant influence in consumer behaviours, at least during the time the study was conducted, but much more in Spanish consumers than French ones. More than a third of the Spanish participants declared to have looked recently for replacing well-functioning devices for new models looking for better connectivity, higher performance, technological novelties, etc. to compensate themselves from the COVID-19 restrictions and the anxiety suffered during recent lockdowns (figure 3).

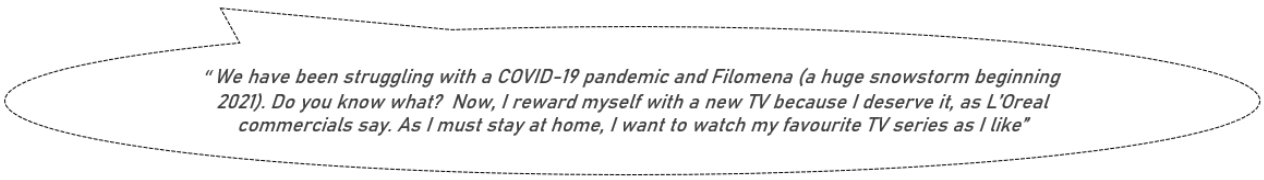


Figure 3 - Verbatim example from a Spanish interview

The attention to technological novelties for smart devices (smartphones or smart TVs) also raised in French interviews but only as a wish, it didn't become true in the majority of the cases.

3. *Demographical factors influencing consumer attitudes towards consumption and replacement of products*

Two psychosocial variables showed to make special influence in consumption and replacement behaviours, the moment of life cycle of the respondent and the citizen profile.

The moment of life cycle is the most relevant factor for Spaniards, where young people and singles are the most hedonistic and impulsive during the product replacement, dinkies are “smart shoppers” who may delay the purchase until they find an interesting offer, parents first try to repair or get the broken product repaired and seniors make more conscious choices and recycle more than the rest.

However, citizen profile seems more relevant than the moment of life cycle In France. Most participants have a conservative profile, it means with a responsible consumption pattern, i.e. they commonly try to repair broken products and they openly criticise hyper consumerism. But, at the same time, there is a minor profile, representing slightly less than a third of the French sample, who can be identified as consumerists. Those citizens are very permeable to novelties, performance-oriented and vulnerable to advertising messages. Both, consumerist and conservative profiles were identified among participants in different moment of their personal life, either in young people, families, or seniors.

As a result, initiatives to enlarge product lifetime should be targeted according to these profiles or moments of life cycle, depending on the country, to maximise their impact.

4. *Other factors influencing product replacement*

- **The increasing DIY trends**
  The DIY lovers try to self-repair their appliances and it implies an increasing interest for manual instructions, the availability or cost of spare parts and everything related to enlarging possibilities. The self-reparation is mostly welcomed by conservative profiles and participants with low incomes. However, it is being progressively taken up by parents, due to the excessive repairing costs and time consuming, or simply as a hobby. It is also well appreciated by participants that use the internet intensively; they usually look for repairing tutorials, manuals, spare parts, reviews... on the Internet. Thus, DIY lovers demand digital adapted services and remote care. The incorporation of DIY habits is often linked during the interviews to the perception of bad quality of repairing services, so people become self-repairers because they can’t find a solution in current repair services.
- **Permeability to technological novelties and the association of smart devices to high social status**
  The technological leap from a conventional device to a smart TV, robot vacuum cleaner or a new smartphone is so intense that consumers feel their house is obsolete if they don’t have them. The attention to technological novelties for smart devices is similar in both countries but it doesn’t lead to real purchases in French interviews, mostly remains a desire while it becomes a real action in one third of the Spanish sample.
- **Time is a key factor**
  Time is a key factor for accepting the repair of essential household appliances such as washing machines. Citizens in both countries can’t do without them and the replacement happens immediately if they must wait for it to be repaired . It must be noted that while the study was conducted, the respond from repair services was rather difficult/slower during COVID lockdowns, and it was a reason of quicker replacement.
- **Possibilities to find good repair services at reasonable price**
  French participants specially complain about the difficulty to find repair services in nearby, rather difficult in big cities such as Paris than in medium-sized ones such as Nantes or Bordeaux. In Spain, additionally, the high cost of the repair and the market facilities such as the frequent price offers of new devices, accelerate the replacement option.

Consumer behaviour regarding washing machines

Influencing factors on replacement decision-making and repair considerations
A washing machine is considered an essential household appliance and consumers need to solve the broke down immediately or they would opt for the replacement. The average service life of this product is over 7 years, and the new model is mostly chosen by the reliability of the brand (reviews, previous experiences, quality assurance…). Other factors such as load capacity or the situation of loading door could also be considered.

There is little experience in self-reparations and professional repair services are commonly requested. The broken appliance is commonly taken to recycling collection points or handed it over to the shop where the new one is purchased, whereas a functioning device ends in second-hand shops or relatives' houses.

Factors that could stimulate product lifetime extension and repair
For enhancing longer lifetime, participants spontaneously suggested having devices with more durable materials (e.g., drum, absorbers, door), a repairable design joined to optimal performance of repair services (e.g., speed, cost, quality of work, advise), good availability of spare parts at reasonable price and access to extended guaranties (at least for higher wearing parts and for all types of breakdowns). Aesthetic design is not important in new acquisitions, but good performance and high energy efficiency are required.

Differences between the two countries
In Spain there is less experience in self-reparations and people totally rely on technical service judgement about the replacement decision. Besides, the old appliance is not taken to recycling collection points or second-hand shops as often as in France. Most of the time the old appliance returned to the shop where the new washing machine was acquired. In France, the main purchasing criteria is the brand, so they tend to choose the model with the optimal performance and features without changing manufacturer, while brand is less important for Spaniards.

Consumer behaviour regarding vacuum cleaners

Influencing factors on replacement decision-making and repair considerations
A vacuum cleaner is considered a functional appliance, but it becomes essential for families and households with pets. New devices, such as robots or cable-free options, have changed radically consumers' perception because the incorporation of technological novelties and new functionalities made them more attractive for techno- lovers, consumerists, curious dinkies and even families. When something fails in a conventional device, consumers try first to solve the problem themselves. If they fail, new conventional devices are so cheap that many people do not try to get them repaired by professional services.

The old vacuum cleaner is commonly preserved when consumers replace a well-functional hoover with a new smart device. In this case consumers do not replace the current vacuum cleaner but add a new device with new functionalities. Aesthetic design is not required for the new acquisition, but consumers commonly choose it with more emotional than functional criteria (it becomes an impulsive purchase). They want to have new functionalities or features (e.g., using cordless, robot vacuum cleaner), or reaching a higher social status (e.g., by using smart devices). But people recognize the new device can't be so convenient (i.e., robots in two-story houses or it has not as good suction power as the conventional) so keep both. Only houses with pets and families look for functional aspects such as high suction and power products, typical of conventional models, or top brands.

Factors that could stimulate product lifetime extension and repair
For enhancing longer lifetime, participants spontaneously suggested having devices with more durable materials (e.g., motor, handles, wheels, brushes, rotors), easy access to consumable and spare parts (e.g., nearby shops, websites) and at reasonable price, extended guarantee for higher wear parts and for all kind of breakdowns.

Differences between the two countries
In France, where the most frequent profile is conservative, consumers told us they will repeat the vacuum cleaner model in case of replacement. However, in Spain consumers are more sensitive to novelties so, even if the vacuum cleaner is considered a functional or basic domestic appliance, they are looking for access to top technology and "high status" appliances.

Consumer behaviour regarding (smart) TVs

Influencing factors on replacement decision-making and repair considerations
A smart TV is a highly desirable device nowadays, due to the enjoyable experience and the high status that it implies for consumers. The TV is a common device in most houses, but a smart TV is considered close to a luxury. Very often, the purchase does not replace a broken device, it is a self-rewarding purchase, and the old TV is moved to another room, house or it is donated. The main criteria for the purchase of a new smart TV are connectivity, image

and sound quality and maximum size (depending on the room dimensions). Aesthetic design is not required but some top technological features must be visible (e.g., minimalist design, flat screen, touch controls). In case of breakdown, consumers contact immediately repairing services, without self-repairing it because it is considered a sophisticated and complex device. However, the repair expectations are quite low.

Factors that could stimulate product lifetime extension and repair
For enhancing longer lifetime, participants spontaneously suggested the improvement of the long-term availability of parts and spare parts, the optimal performance of technical services (time, advise, price and quality of repairs), the extension of guarantee on higher wear parts and all types of breakdowns and having more durable materials in the display, inner panel, brackets, etc.

Differences between the two countries
No relevant differences were identified.

Consumer behaviour regarding smartphones

Influencing factors on replacement decision-making and repair considerations
A smartphone is the top personal product with the greatest need of customisation, a powerful identifier for young people or dinkies, and a multifunctional device for parents. It has become increasingly important in recent times when the mobile phone started to be used as the main working tool (due to lockdowns and the massive deployment of remote working). It is often acquired for self-premium and status, as emotional purchase, mainly in specific profiles such as novelty-sensitive clusters. Aesthetic design features and top technology such as connectivity, duration of battery, image/sound quality, applications are required in the new purchase. It only remains a functional product for seniors who commonly replaced it only after a fatal failure. The lifetime expectations strongly depend on the profile.

In case of failure (e.g., a screen or battery) this product category has the poorest perception of repair quality. Participants complain about the excessive price, official services force, repetition of failures , fragility of materials. Only top brands or models are taken to official service centres when the device is broken but they do not score better. When the repair process fails the old devices are commonly collected by the shop where the new smartphone is bought or it is given free to relatives, friends, or donated. Interestingly, not many products are discarded. Most people keep it if they don't find any re-use possibility, to have an on-hand alternative in case they encounter problems with the current device.

Factors that could stimulate product lifetime extension and repair
For enhancing longer lifetime, participants spontaneously suggested returning to repairable and modular design as well as using replaceable parts (screens, batteries, casings…), the availability of spare parts at reasonable prices and having software upgrade to have increasingly powerful memory cards that allow expanded functions and capabilities. The main concerns are screen and camera. For Spaniards it is rather more difficult to find solutions to extend the lifetime of smartphones because the main purchasing criteria is still the latest technological novelty, and they are changing continuously so they are waiting for next developments or keeping the current device.

Differences between the two countries
In Spain it is rather difficult for participants to suggest solutions to enlarge the lifetime of smartphones because they like to have the latest technology and the market is launching technological novelties permanently. In case of failure, Spanish consumers use more frequently local and small repairing services than French participants and, if they decide to replace their smartphone, they try to increase the performance or capacity on the new device where this statement is not so important in France.

General conclusions

The study identifies two main barriers for enlarging the lifetime of domestic products:

1. *The need of acquiring the latest technological novelties*

Many consumers believe a house without smart devices is out of date and they need to replace well-functioning devices to get access to these new features and functionalities. More desirable products are smart TVs (for all segments), smartphones (specially for singles and dinkies) and smart vacuum cleaners (for families)

It is not easy to mobilise consumers that are looking for the latest technological novelties because this expectation is only covered by new purchases. Awareness campaigns and education programs are needed to convince people to change their unsustainable behaviour. For future research it would be interesting to investigate whether the relatively higher awareness and commitment of the French consumers towards sustainable behaviour affected the replacement behaviour in a positive way. If so, it would provide good prospects for behaviour change for consumers that currently have low awareness, if more awareness is raised.

2. *Perception of poor quality of repairing services*

People complain loudly and frequently during the interviews about the low quality of current post-sale consumer services. They are discouraged from getting the product repaired because of multiple causes such as the high cost or unavailability of spare parts, the timing needed to find the right place to bring the broken product, the low quality of the work done, the excessive time for getting the product back,… regardless of the service is provided by a manufacturer, retailer or assurance service, the type of contact (by phone, web or face-to-face attention) or the guaranty status (under or overpassed warranty period).

Furthermore, citizens complain about the difficulty of finding repair centres in the neighbourhood. Only big distribution chains and small repair shops are mentioned during the interviews. When a product is broken the first attempt is to contact the repair services from manufacturers or retailers, so they play a very important role for changing consumers' habits.

Nowadays, consumers feel helpless when they need to solve a problem with a product such as a washing machine, fridge, laptop or smartphone. They don't feel properly informed about the legal rights, who must they contact with in case of problems, alternatives to the replacement (figure 4).

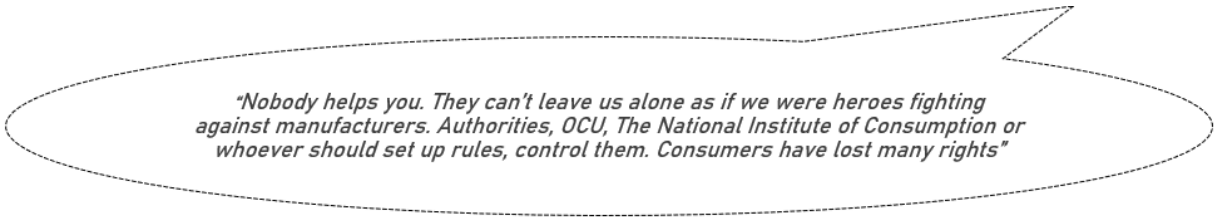


Figure 4 - Verbatim example from a Spanish participant

The repairability would not success only with a good design, consumers ask for a good customer service from the point of sale to the disposal; the whole process must work smoothy, efficiently and agile with good information on new products about replacement parts or modules available in case of problems, who contact with in case of breakdowns, access to tutorial for self-repairing, availability of spare parts or software updates .However, these initiatives could not be accepted by consumers if it implies prices too high. In addition, they would not avoid the purchase of the newly introduced smart appliance because it doesn't make an influence in the wish for technological novelties.

2.2.4 Partners

OCU managed the research for the two countries, Spain and France, and it was responsible for the adaptations needed (i.e., questionnaire, definition of sample) to conduct the qualitative study in Spain. UFC supervised the national adaptations for the French work and collaborated with the set-up of the guideline document, the international questionnaire, and their national report. TUD collaborated in the set-up of the study with the experience obtained in the Dutch study conducted previously. Additionally, the experienced consultancy enterprise *QBO Investigación y Estrategia, S.L.* was engaged in carrying out the interviews and the first data analysis in the two countries. The gathered information of the field work was used by OCU for managing the reporting phase.

3 Quantitative insights on product replacement and repair

In chapter 2 and 3 we found that Individuals may decide to change their products prematurely because they believe (sometimes incorrectly) that they are at the end of their life. In this part we will statistically analyse how often people replace specific products even though these were still functioning and what the general reasons for this premature replacement are for different product categories, and how often European consumers repair specific products. Furthermore, we investigated the expectations that people have with respect to the lifetimes of products. Via quantitative consumer studies, we will analyse how many years consumers in different countries (Belgium, France, Spain, Italy, Portugal) expect the selected product categories to last. Comparisons will be made between different brands, categories, and product variants to support in understanding why people have specific expectations. Specifically, these insights will help us to uncover whether certain products are designed to last for a too short period of time and for which specific products consumers may believe such 'planned obsolescence' to occur. Finally, we performed experiments to analyse how specific design features can change people's attitudes and behaviours regarding repair for the selected product categories.

3.1 Survey – Replacement and repair

3.1.1 Objectives

This survey has been realised to understand better consumers' decisions to replace functioning products in the context of WP 5.1. Expected and actual lifetimes of products have been published in prior literature (cf. WP2.6) but we wanted to get a confirmation with participants having recently replaced the product targeted in the Prompt project.

We contribute to the stream of literature regarding repair from a consumer perspective by quantitatively investigating the state of products when they are replaced, whether consumers consider repair when their product is partly malfunctioning or broken and the type of repair they consider (i.e., self-repair, repair café, professional repair). In addition, we considered repair outcomes for participants having initiated a repair activity. Finally, we test the extent to which the replacement reasons highlighted in Deliverable 2.6 are important in the decision to replace the products. As replacement motives may differ greatly between product categories (Box, 1983), we also contribute by highlighting differences in the importance of these reasons of replacement between different categories of electronic products.

3.1.2 Method

Selection of participants
We conducted a pre-screening study using the Prolific panel with the goal to recruit diverse participants who had recently replaced one of the target product categories. This enabled us to ensure that they still remembered accurately the specific characteristics of their old products, the reasons why and the conditions under which they decided to replace their product.

We sent the pre-screening questionnaires to participants in the United Kingdom, France, Germany, the Netherlands, Belgium and Spain. The pre-screening questionnaire was therefore translated from English to French, Dutch, German and Spanish by native researchers involved in a European project on the topic of premature obsolescence and proposed in Qualtrics. In total, we reached out to 2477 individuals (UK = 513, DE = 478, ES = 500, NL = 412, BE = 238, FR = 336), who were compensated for their time with a small amount of money.

In the pre-screening questionnaire, panellists were presented with a list of products and asked to select the electronic product(s) they had replaced in the last 6 months (*Please indicate for all of the following product categories whether you have replaced these in the last 6 months. With replaced, we mean that you acquired a new*

product that is intended to take over the function of another 'old' product. The 'old' product can be disposed of or kept as a backup product. Multiple answers are possible. Please tick the products that you replaced in the last 6 months). To prevent opportunistic behaviours from panellists who would want to complete the questionnaire and receive the compensation without actually having replaced their product recently, we included our four products in a broader list of 9 electronic products (also including a dishwasher, a laptop, a coffee machine, a camera, a refrigerator). In addition, the option 'None of the above' was available to participants.

In the next phase, we analysed the 2477 responses to our pre-screening questionnaire and defined some criteria to recruit participants for our main questionnaire. First, we recruited in priority participants who indicated that they had only replaced one of our four target products among the 9 products presented in the list. Participants recruited for the main questionnaire about smartphones had only replaced their smartphones in all countries. However, this method did not lead to a satisfactory number of participants to run the statistical analyses in the three other products categories. Consequently, next to participants who only replaced the target product category, we also recruited participants who also had replaced one or two other products in the list.

The participants that were recruited during the pre-screening survey were invited to participate in the main questionnaire using their unique Prolific identifier. Each participant was allocated to the questionnaire regarding the product category that they had replaced.

Final sample

The four main questionnaires were sent to 691 selected panellists with a specific note that they had been selected to participate in an extensive questionnaire about the replacement of their [product] based on their responses to a pre-screening questionnaire. After participants who had failed the attention check were removed from the fully completed questionnaires (N=11), the final sample consisted of 617 participants (response rate 90.9%). Participants received a small compensation of 1.60 GBP for their participation in the study.

Overall the sample was diversified in terms of gender (Female = 314) and age (Min_{age}= 20; Max_{age} = 72, M_{age} =34.64, SD = 9.54).

Questionnaire

Data was gathered in May 2021 through an online questionnaire. This questionnaire was also available in English, French, Dutch, German and Spanish. The purpose of this questionnaire was to uncover the conditions under which participants decided to replace their products. We started with a general question about lifetime expectations, asking participants to determine how long they expected smartphones, vacuum cleaners, televisions and washing machines to last before they would break down. Second, participants were asked questions about their old product, such as the age of the product when it was replaced and how satisfied they were with its lifetime using a 7-point semantic differential scale ranging from dissatisfied to satisfied. They were also asked in what state the product was when it was replaced using multiple-choice questions with the three following options: working well, partly malfunctioning or broken. We asked participants who had answered that their product was partly malfunctioning or broken to the previous question whether they considered repairing their product and the type of repair they performed.

Third, participants were asked questions about the reasons why they replaced their products. Specifically, we asked them to indicate the extent to which the reasons highlighted in the literature review influenced their decision to replace their product on 7-point Likert scales going from 'no influence at all' to 'very much of influence'. The reasons were divided into two categories: reasons related to the decreased perceived value of their old products (in terms of functionality, but also emotionally or socially) and reasons related to the heightened perceived value of a new product (functional or epistemic, emotional, social, or conditional), also including market-related factors (e.g. special price promotions, the launch of a product or a commercial).

3.1.3 Main results

The main results of this study are described in a scientific journal article which is currently under review (2nd round) at Resources, Conservation and Recycling. In order not to interfere with the review process, we do not yet include the

full manuscript and only present the main results. If and as soon as the manuscript gets published, it will be in open-access, and we will publish it on the website of the Prompt project.

Results show that an important proportion of our participants replaced their products before they reached a usage period of 5 years. Most products were replaced while they were still performing their main function but showing a loss in performance. A majority of people (60%) replacing their broken or malfunctioning product did not even consider repair at all and, interestingly, repair was significantly more often considered when the product was broken (58.6%) than when it was partly malfunctioning (30%). Washing machines – a utilitarian product – were replaced for functional reasons while televisions – an up-to-date product - were replaced because the features of new products were attractive. Satiation related to the use of the old product was consistently one of the most important reasons to replace smartphones, vacuum cleaners, and televisions. These results provide insights for designers, companies, government bodies and non-profit organisations to introduce timely initiatives promoting product longevity.

3.1.4 Partners

TU Delft was responsible for the coordination of the study, the creation of the questionnaire, the recruitment of participants, the data analysis, sand the write-up of the results. Inputs for the questionnaire were received from Test Achats, Fraunhofer, and OCU. Similarly, inputs for the translation of the questionnaires were received from OCU and Fraunhofer.

3.2 Survey - Reliability and product life cycles

3.2.1 Objective

This study tries to define "premature" obsolescence from a consumer perspective. We investigated consumers' expectations of the lifecycle of their product, the time they intend to keep using the product which impacts the decision to replace or repair the product when it breaks down and consumers' reasons for premature replacement of functioning products. The aim was to quantify our previous insights from the webtool and investigate influences of brands on the premature replacement of products.

3.2.2 Method

The survey covers five countries: Belgium (BEL), France (FRA), Italy (ITA), Portugal (POR) and Spain (SPA). Sampling was done randomly among members of different consumer organizations in the selected countries; data were collected through online questionnaires addressed to product magazine subscribers (Test Achats, UFC-Que Choisir, Altroconsumo, Deco-Proteste, OCU) during **April 2019** for washing machines (large household appliances survey), **November 2019** for smartphones and TV's (high-tech devices survey) and in both **June 2019 and June 2020** for vacuum cleaners (small household appliances survey). Respondents assessed their products by answering a unique link sent to their email addresses. The overview in table 3 summarizes the number of valid answers collected for these surveys

Table 3 – An overview of the survey sample

	Large household appliances	**High-tech devices**	**Small household appliances**	
	2019	**2019**	**2019**	**2020**
Belgium	7687	6204	5163	7283
France	9932	10595	10392	10813
Italy	11584	10395	8851	5924
Portugal	5661	3612	4410	5988
Spain	6868	6344	4141	13301
Total	41732	37150	32957	43309

The survey focused on the following dimensions**:**

Foreseen duration of use and expected minimum lifecycle of current devices
In this section, people reported how long they expected to keep using their current device at the time of purchase, and how long they expected to be its minimum lifecycle.

Real lifecycle of previous devices
In this section, people reported for how long they kept their previous device, and what was the reason for replacing it. Average life cycle durations by brand have been compared through One Way ANOVA to distinguish above-average, average and below-average groups.

By analysing the differences between the expected minimum lifecycle and the real lifecycle (reliability-related reasons for being replaced), the report, presented in section 4.2.4, summarizes whether consumer expectations about the lifetime are met by the manufacturers.

3.2.3 Report: Life Cycle assessment

Owners of four categories of products (washing machines, smartphones, TV's and vacuum cleaners) answered questions about their expectations at the time of purchase/acquiring these products, their reasons for replacing their previous appliances and the lifecycle of their previous appliances. Below, we provide a summary of the main results of the study. For more in-depth insights, we refer the full report available in Appendix E.

Expected use of an appliance
"At the moment of buying/getting this [product], how long do you expect to keep using it before buying a new one?"

Four out of 10 (40%, Chart 4.1, p53) respondents expect to use their vacuum cleaner for more than 10 years from the moment of acquiring it, for washing machines this is almost half (47%, Chart 1.1, p14). The expected time of use is lower for high tech products: 38% of respondents (Chart 3.1, p40) expect to use their TV for 8-10 years, and 45% of respondents (see Chart 2.1, p27) expect to use their smartphone for 4-5 years (both measured from the moment of acquiring).

Expected minimum lifecycle of an appliance
"At the moment of buying/getting this [product], how long do you expect to be the minimum lifecycle duration?"

For both washing machines (Chart 1.2, p16) and vacuum cleaners (Chart 4.2, p55), respondents expect their product to keep functioning for more than 10 years from the moment of acquiring.
Four out of 10 respondents (41%, Chart 3.2, p42) expect their TV to last for more than 10 years from the moment of acquisition. For smartphones, 42% of respondents (Chart 2.2, p29) expect their smartphone to remain in working order for 4-5 years from the moment they acquired it.

Comparison between expected use and minimum lifecycle
Most consumers differentiate between their expected duration length to keep the appliance and their minimum expected life cycle of the appliance. However, there was a difference detected between household appliances (both small and large) and high-tech devices.

- Close to one out of three respondents (30%, Chart 2.3.1, p31) expect to keep using their smartphone **shorter** than its expected minimum lifecycle. For televisions, this is the case for one out of five respondents (20%, Chart 3.3.1, p44).

- For washing machines, however, one out of five respondents (20%, Chart 1.3.1, p18) expect to keep using it **longer** than its expected minimum lifecycle. 8% of respondents (Chart 4.3.1, p57) expect to keep using their vacuum cleaner **longer** than its expected minimum lifecycle.

The respondents thus expect to keep their high-tech devices shorter than its expected minimum lifecycle. For household appliances this is the other way around. They expect to keep it longer than its expected minimum lifecycle.

Brand comparison of expected use and minimum lifecycle
Differences in expected use and minimum lifecycle can also be observed between the owners of products of different brands.

- A large majority (79%) of Miele owners (versus 19% of Haier owners) expect to keep using their **washing machine** for more than 10 years. 75% of Miele owners (19% of Haier owners) expect their washing machine to have a minimum life cycle of more than 10 years (Chart 15, p95).
- In **smartphones**, 39% of Doro owners (versus 14% of Google owners) expect to keep using their device for more than 5 years. 52% of Doro owners (versus 23% of both Honor and Xiaomi owners) expect their smartphone to have a minimum life cycle of more than 5 years (Chart 16, p97).
- In **TV's**, 47% of Loewe owners (versus 23% of Haier owners) expect to keep using their television for more than 10 years. 60% of Loewe owners (28% of Haier owners) expect their TV to have a minimum life cycle of more than 10 years (Chart 17, p99).
- Finally, in **vacuum cleaners**, 76% of Kirby owners (versus 15% of Domo owners) expect to keep using their vacuum cleaner for more than 10 years. 81% of Kirby owners (versus 19% of Ariete owners) expect their vacuum cleaner to have a minimum life cycle of more than 10 years (Chart 18, p101).

These results imply that brands have an impact on the expectations of the minimum lifecycle of products.

Reasons for replacing an appliance

"What was the type and brand of the appliance, the age at which you replaced it and the main reason to replace it?"

Seven main reasons for replacing an appliance could be discerned:

1. Completely out of use
2. Not working well anymore (and didn't want to repair it)
3. Repair costs too high
4. No spare parts available anymore

5. Out of date (but still functioning well)
6. Because of my misuse (just for smartphones and TV's) and
7. Another reason (gift, moving, family needs, …).

The first four reasons have been considered as reliability-related reasons for replacing the previous appliances. The results of the respondents showed the following:

- 75% of previously owned **washing machines** (Tables 6.x, p66-70) were replaced because of reliability-related reasons.
- 36% of previously owned **Smartphones** (Tables 8.x, p73-77) were replaced because of reliability-related reasons.
- 34% of previously owned **TV's** (Tables 10.x, p80-84) were replaced because of reliability-related reasons.
- 64 % of previously owned **Vacuum cleaners** (Tables 12.x, p87-91) were replaced because of reliability-related reasons.

These results imply that high-tech devices are more often replaced for reasons other than the product's reliability, compared to small and large household appliances.

Brand comparison of average real lifecycles

- In **washing machines**, Miele stands alone with the highest average age (15y 10m) (Table 7, p72).
- In **smartphones**, Blackberry (5y), Nokia (4y 9m), Apple (4y 4m) and HTC (4y 2m) are the brands with the highest average age (Table 9, p79).
- In **TV's**, Thomson (9y 6m), Grundig (9y 3m), Sony (8y 10m) and Philips (8y 8m) are the brands with the highest average age (Table 11, p86).
- In **vacuum cleaners**, Vorwerk (13,7y), Panasonic (12,6y), Nilfisk (12,1y), Miele (11,6y) and Kirby (11,5y) are the brands with the highest average age (Table 13, p93).

The results show that, depending on the brand of the appliance, there are significant differences between the life cycle durations.

Difference between expected minimum lifecycle and real lifecycle

Differences between the expected minimum lifecycle duration of the current device and the real lifecycle duration of the previous device were also analyzed for this report.

To ensure reliability of this analysis, only brands having enough cases in both categories (current and previous appliance) were considered. To compare the real life cycle durations, only appliances replaced for reliability-related reasons were considered for analysis. Results of this analysis should however not be understood as an intrinsic quality of the devices. They only indicate the difference between what people expect to be the minimum lifecycle, and what they experienced to be the real lifecycle.

- In **washing machines**, most brands had a higher proportion of appliances with a real lifecycle of more than 10 years than the proportion of consumers who expected their washing machine to last for more than 10 years.
- In **smartphones**, most brands had a shorter real lifecycle duration than the minimum lifecycle duration expected by consumers. Only Oneplus' real lifecycle duration meets consumers' expectations.
- In **tv's**, only Thomson devices' real lifecycle duration was higher than the expectations.
- In **vacuum cleaners,** only Nilfisk, Tornado, Panasonic and Miele performed better in real life cycle duration than the expectations.

To conclude, the expected minimum life cycles and real life cycles differ among product categories. Also, differences are detected among brands and thus seems to be of influence.

General conclusions

Reflecting on our survey among European consumers concerning reliability and product lifetimes, most consumers don't make a difference between their expected duration to keep the appliance and their minimum expected life cycle of the appliance. Those who do, expect to keep using their household appliances longer than what they expect their minimum lifecycle to be, for high tech products it is rather the opposite.

Additionally, the time consumers expect to keep using their products also differs depending on the product category and brand. In general, consumers expect to keep using their household appliances for longer than the expected minimum lifecycle, while they expect to replace their high-tech products before they reach their minimum expected lifecycle. Differences can also be observed between products of a different price range: the expected lifecycle as well as the expected use of products from a higher price range is higher than for products of a lower price range, except for smartphones, where the expected use of products from the higher price range is lower than for cheaper products. Reasons for this can be sought with the fact that tv's and smartphones in particular are very much seen and treated as fashion items and status symbols rather than purely functional objects. Also, there are significant differences for expected life cycle duration depending on the brand of the appliance. This was the case for smartphones, televisions, washing machines and vacuum cleaners.

Finally, a large majority of household appliances are replaced for reliability-related reasons, for high-tech products it is the opposite. Like the findings from WP2, within the reliability-related reasons, cost-related reasons for not repairing their product are reported by the largest proportion of respondents.

3.2.4 Partners

TA had the lead in the setup of the survey and the analysis of the results. The survey was conducted by consumer organisations in five countries, amongst which project partners Test Achats in Belgium, OCU in Spain and UFC Que Choisir in France. Surveys in Italy and Portugal were handled respectively by Altroconsumo, which is part of the PROMPT advisory board and Deco Proteste, which is part of the PROMPT supporting board.

3.3 Experiments – Stimulating repair

3.3.1 Objective

The aim of this study was to analyse how specific design elements can increase repair activities among consumers. Earlier studies about consumer behaviour (researched in Task 2.5) showed that increased level of self-efficacy supports in performing certain targeted behaviour. To translate this to stimulating repair activities among consumers, we tested whether an increased level of self-efficacy of consumers influences their willingness to repair. We did so in an experimental set-up, allowing us to compare different scenarios. More specifically, we investigated the effects of a fault indication on the willingness to repair washing machines, vacuum cleaners and stick vacuum cleaners and explored if an increased willingness to repair can be explained by an increased level of self-efficacy.

3.3.2 Method

For this research, we used an experimental set up and performed 2 rounds of experimental studies. Both studies had a between-subjects design. Study 1 had a 2 (fault indication: absent vs. present) x 2 (product's likelihood to be repaired professionally: low vs. high) between-subject experimental design. Each participant was presented with one of four conditions in a scenario, which consisted of a picture and a short text. We chose washing machines (WM) and vacuum cleaners (VC) because these products are used frequently and are considered important to consumers. The described failure in each scenario ensured that the main function of the product could no longer be performed. When the fault indication was absent, only information about the observed failure was presented. The participant was 'not able to activate the wash programs' of the washing machine, and the vacuum cleaner had 'lost its suction power'. When a fault indication was present, the scenario provided additional textual and visual information about the cause of the failure. For the washing machine, an error code showed 'damaged drum bearings', and for the vacuum cleaner a red light indicated a 'damaged filter'. Additionally, the text referred to information on a (online) manual indicating that the specific damaged part needs to be replaced. An example of one of the scenarios is shown in figure 5.

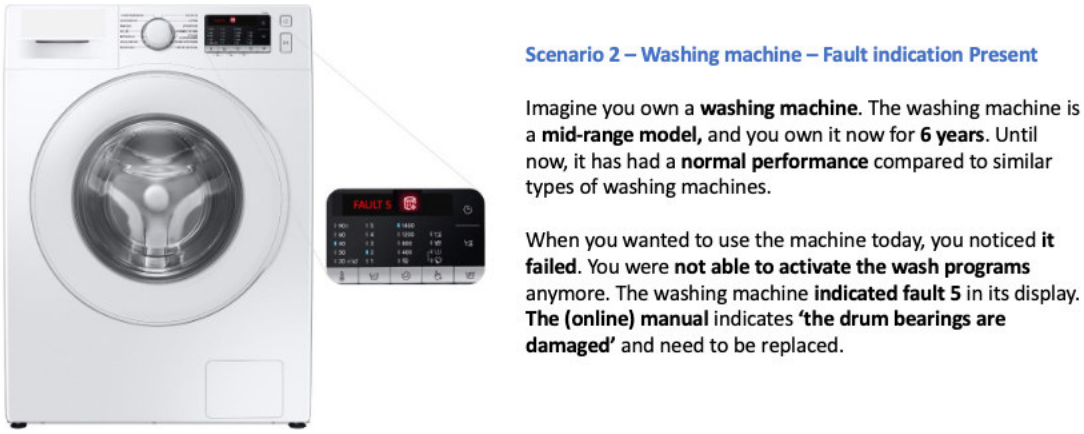


Figure 5 - An example of one of the 4 scenarios shown to the participants in study 1: a washing machine with a fault indication present.

For study 2, the main purpose was to validate the findings of study 1 for a different type of failure. We chose a stick vacuum cleaner (SVC) as a comparable product to a vacuum cleaner in terms of a low probability to be professionally repaired. This resulted in a 2 (fault indication: present vs. absent) x 1 (SVC) between-subject experimental design, which equals 2 scenarios that were compared. The conditions presented in the two scenarios of the stick vacuum cleaner were similar to those in study 1. The product was introduced as being a 'mid-range model' and having a 'normal performance', and the time of ownership was 3 years which is in line with the vacuum cleaner of study 1. We chose a malfunctioning battery as a failure, ensuring that the essential function of the product could no longer

be performed. In the condition where the fault indication was absent, the stick vacuum cleaner 'failed' and was 'not able to function anymore'. When a fault indication was present, a red light was shown on the product. The text referred to information in the (online) manual indicating that the battery was damaged and needed to be replaced, an example of one of the two scenarios is shown in figure 6.

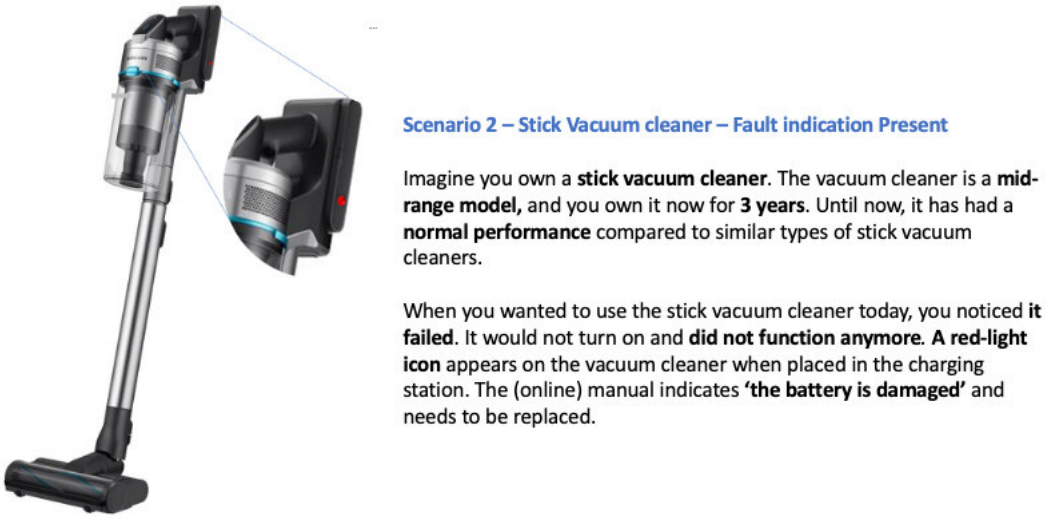


Figure 6 - An example of one of the two scenarios shown to the participants in study 2: a stick vacuum cleaner with a fault indication present.

Participants were recruited using Prolific, which is an online database representing participants from all over the world. The selected participants were equally presented across gender. The mean age of the participants was around 40 years and set to a minimum of 25 years. In study 1 a total of 139 consumers participated (Age: Mean=41.10, SD=10.61; Gender: Male=54.0%, Female=46.0%, Other=0%). In study 2 a total of 72 consumers participated (Age: Mean=38.11, SD=8.69; Gender: Male=47,2%, Female=52.8%, Other=0%).

The two studies were conducted online using Qualtrics (Qualtrics. XM, 2022) software, which allows for online data collections. The studies had a between subject-design, so each participant was presented only one of the scenarios. The measures of both studies were identical, which means all participants evaluated the scenarios on the same multi-item scales for their 'willingness to repair', level of 'self-efficacy', the 'likelihood of professional repair', 'level of repair knowledge'. The participants also completed the manipulation check to differences between the scenarios was clear enough for the participants. More details about these scales are shown in the academic publication about this study in Appendix D. The dataset was analysed using SPSS and results are presented in the next section.

3.3.3 Results

Manipulation checks

There was a significant main effect of the presence of a fault indication on the understanding of the product failure for both the washing machine and vacuum cleaner of study 1 and the stick vacuum cleaner of study 2. This means that the results of the manipulation check showed the participants had a better understanding of the failure when a fault indication was present, and thus our manipulations were successful. We also tested our manipulations concerning the probability to make use of professional repair for different product categories. The results showed that participants were significantly more likely to have a washing machine repaired by a professional repairer than a vacuum cleaner and our manipulations were therefore successful. When looking at the means of the stick vacuum cleaner and compare them to those of the washing machine and vacuum cleaner, the results showed that the probability of having a stick vacuum cleaner repaired by a repair professional was comparable to the vacuum cleaner. Therefore, we can assume that the vacuum cleaner of study 1 and stick vacuum cleaner of study 2 are comparable in terms of probability to be professionally repaired. The results of the study are shown in table 4.

*Table 4 - The means, standard deviations and significance levels (p-value: *= p<0.05; **= p<0.01; ***= p<0.001); a= nonparametric test result; p= one tailed) of the variables used study 1 and study 2.*

	Study 1						Study 2		
	Washing machine			Vacuum cleaner			Stick vacuum cleaner		
Fault indication	**Absent (n=34)**	**Present (n=35)**	**p-value**	**Absent (n=35)**	**Present (n=35)**	**p-value**	**Absent (n=37)**	**Present (n=35)**	***p*-value**
Manipulation check	3.39 (1.59)	5.42 (1.16)	<0.001 ***	4.01 (1.69)	5.86 (0.94)	<0.001 ***	2.80 (1.58)	5.70 (1.67)	<0.001[a] ***
Willingness to repair	5.10 (1.67)	5.22 (1.69)	0.763	4.17 (1.69)	5.49(1.55)	0.001 ***	4.38 (2.04)	5.19 (1.85)	0.045[a] *
Level of Self -efficacy	3.45 (1.43)	3.96 (1.58)	0.577	3.77 (1.83)	4.87 (1.35)	<0.001 ***	3.36 (1.64)	4.67 (1.67)	0.012 *
Likelihood for Professional repair	5.97 (1.75)	5.49(1.84)	0.048[a] *	3.83 (2.02)	3.89 (2.32)	0.479[a]	4.46 (2.13)	4.40 (2.40)	0.471[a]
Level of repair knowledge	3.43 (1.29)	3.98 (1.62)	0.124	3.77 (1.53)	3.83 (1.43)	0.872	3.39 (1.51)	4.02 (1.62)	0.087
Level of environmental concern	5.98 (1.00)	5.83 (0.98)	0.541	5.87 (1.21)	5.66 (1.10)	0.462	5.85 (1.10)	6.15 (0.82)	0.193
Level of technological innovativeness	4.66 (1.13)	4.55 (1.47)	0.723	4.91 (1.28)	4.54 (1.10)	0.203	4.74 (1.25)	4.99 (1.18)	0.387

The effect of a fault indication on the willingness to repair

An important factor that prohibits consumers from starting repair activities in the first place, is that consumers are often not aware of what is causing the product failure. Recent research on increasing product reparability emphasized the importance of including fault indications as design interventions supporting repair. A fault indication is a signal (e.g., code, text, icon, light) appearing on a product when it is malfunctioning. An example is an error code on a washing machine's display. This signal can provide information about the cause of the failure and consumers can use this information to identify the steps that need to be taken for repair. If consumers know what is wrong with the product, their ability to find out what needs to be done for a successful repair is thus increased.

In our analyses, a main effect was found for the fault indication in study 1, demonstrating that participants were more willing to repair a product with a fault indication (M_{absent}=4.70 vs. $M_{present}$ =5.29; F(1,132)=6.16; p<0.05). More importantly, the results showed a significant interaction effect of the fault indication and product category on the willingness to repair (F(1,132) =4.78; p<0.05). Looking at the product categories separately, for the vacuum cleaner the willingness to repair was significantly higher when a fault indication was present ($M_{VC\ absent}$=4.25 vs. $M_{vc\ present}$ = 5.42, F(1,65)=11.72; p<0.001). However, for the washing machine this effect was non-significant (Mwm_{absent}=5.12 vs. $M_{WMpresent}$=5.21, F(1,64)=0.09; p>0.50). For study 2 the results also showed a significant main effect on the 'willingness to repair' a stick vacuum cleaner when a fault indication was present (Mdn_{absent}=4.67 vs. $Mdn_{present}$= 5.67; U=798.00, p<0.05). Concluding, a fault indication significantly increased the willingness to repair a vacuum cleaner, but this was not true for a washing machine. Therefore, a fault indication will only positively influence consumers' willingness to repair if it is employed on a product that is unlikely to be professionally repaired. Study 2 provides further evidence for these results. Descriptive statistics are shown in table 4.

The mediating effect of self-efficacy on the willingness to repair

To explain the underlying process for consumers' increased willingness to repair, we argue that when the failure is known, the consumer feels more competent in defining the steps needed for a successful repair. Literature has shown that when consumers believe in their ability to make sound evaluations, in this case about a potential repair, it results in an increased level of self-efficacy. The perceived self- efficacy is defined as a 'can-do' attitude and depends on a persons' level of knowledge and expertise, competence, and difficulty to make sound evaluations

about the related topic. It is likely that when the failure of a product is known, the level of self-efficacy concerning repair of the consumer increases. In the presence of a fault indication, a high level of perceived self-efficacy may thus explain an increased willingness to repair.

For study 1, the aim was to check if self-efficacy mediated the relationship between the presence of a fault indication and willingness to repair and was moderated by the product category, figure 7. The results indeed revealed the presence of a moderated mediation (b=0.92; SE=0.41; 95%CI: [0.12;1.74]; p<0.05). When the probability for professional repair was low (i.e., in the case of the vacuum cleaner), there was a positive indirect effect of a fault indication on the willingness to repair through the level of self-efficacy (b=0.30; SE=0.17; 95% CI:[0.03;0.69]). When the probability for professional repair was high (i.e., in the case of the washing machine) the positive effect of a fault indication on the willingness to repair through the level of self-efficacy was weakened (b=0.04; SE=0.09; 95% CI:[-0.15;0.22]). For study 2 the results also revealed that self-efficacy mediated the relationship between the fault indication and the willingness to repair (b=0.55; SE=0.27; 95% CI:[0.11, 1.18]). The fault indication positively influenced the level of self-efficacy (b=1.01; SE=0.39; 95% CI:[0.23, 1.78]); p<0.05) and self-efficacy, in turn, positively influenced the willingness to repair (b=0.55; SE=0.12; CI:[0.29, 0.80]; p<0.001).

The mediating effect of self-efficacy showed that fault indications can make consumers feel more competent and knowledgeable to select relevant repair actions. Thereby, self-efficacy is positively influencing the willingness to repair a product. The results of study 2 further demonstrated that for product categories for which consumers are unlikely to go to repair professionals, a failure indication can increase consumers' willingness to repair, also for a variety of failures. Summarizing, we conclude that fault indications are successful in increasing self-efficacy for repair for products that are less likely to be repaired professionally. A more detailed discussion about the results and implications for design can be found in the academic publication about this study in Appendix D.

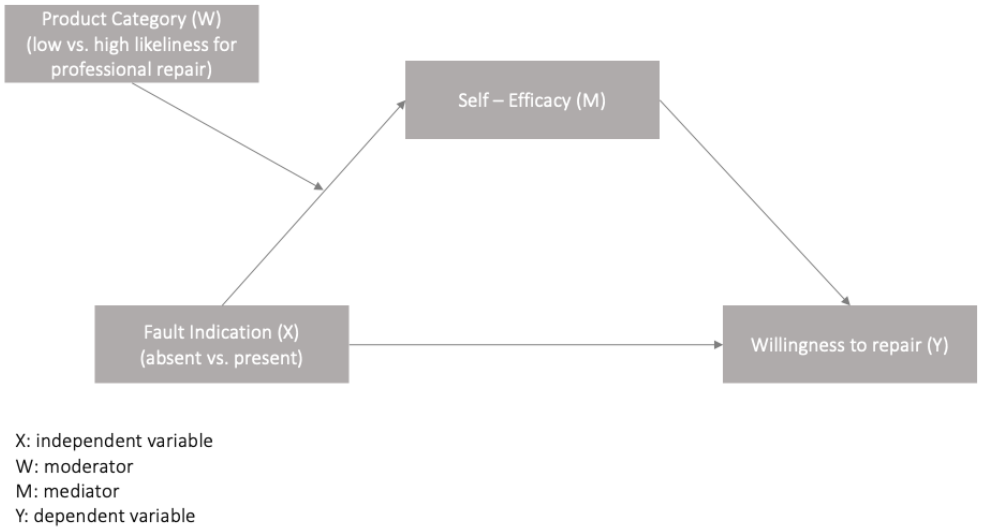


Figure 7 - Moderated mediation model used for study 1 and 2 based on Hayes (2013).

3.3.4 Partners

TU Delft was responsible for the set-up of the study, the data collection, as well as the data analyses and reporting of this study.

3.3.5 Academic Publication: Enhancing consumers' willingness to repair electronic products

The results of the experiments are presented in a contribution of the DRS 2022 conference, Appendix D.

- Van den Berge, R., Magnier, L., & Mugge, R. (2021). Enhancing consumers' willingness to repair electronic products: how design can nudge sustainable behaviour. DRS 2022 Conference contribution

4 Conclusion

In this chapter we reflect on the findings of task 5.1 and 5.2 that are documented in chapter 2, 3 and 4 of this report. These findings are compared with earlier insights obtained from WP2 and WP5 (i.e., deliverables and webtool), from experts of consumer organizations, and from experts in the Advisory Board and supporting partners. Also, we also reflect on insights gained from WP4.

The findings presented in Deliverable 2.6 and Deliverable 5.1 were based on state-of-the art literature. For this deliverable, we aimed to not only confirm but also provide more in-depth insight in the reasoning behind premature replacement and is therefore complementary to earlier WP2 and WP5 findings. For this reason, the results presented in chapter 2 go beyond earlier literature findings, and have a more qualitative, descriptive nature. In this way, we were able to provide a complete overview of the processes behind premature replacement of well-functioning products and choice for replacement over repair for this deliverable. The results of the Spanish and French interviews, which had the same approach of the Dutch interview study, expose several differences and similarities of consumer replacement behaviour, providing more reliability of our results.

The survey study with consumers from Western Europe brings additional empirical insights to elements regarding product replacement highlighted in D2.6 regarding the state-of-the-art literature of the user and market-related factors of obsolescence. Additionally, the results of the study can be used by consumer associations in our consortium to raise awareness among consumers regarding issues to satiation that influence the early replacement of many electronic products and can also be applied in D7.4. Consolidated policy recommendations will be formed based on the project results.

Whereas the results of the WP2 web tools rather suggest that consumers mostly expect their products to last a bit longer than the legal guarantee, results of the survey among European consumers shows that expectations about the minimum lifecycle of a product go well beyond the guarantee period and differ between different product categories as well as between brands. However, for all product categories, consumers underestimate the real average lifecycle. This could be explained by the question's phrasing and the spontaneous character of the webtool which requires consumers to be motivated to take the effort to go to the webtool and fill out the questionnaire. This motivation is often frustration or even anger, both of which are the highest if the product broke down just after the end of its legal warranty, even if consumers expect the minimum lifecycle duration to be higher. To summarize, the results or our survey underline earlier research insights (WP2) that improving products' reliability and repairability can only have a limited effect on the generation of WEEE if no measures are taken to change consumers' expectations about product lifecycles and their attitudes and preconceptions regarding product replacement and repair.

In our experiments about product repair, we built further on insights in WP4, which showed that fault diagnosis is an important aspect in consumers' repair behaviour. The findings from WP4 were merely focused on the products' physical design interventions facilitating repair activities. However, earlier studies resulting from Deliverable 2.6 showed that many consumers do not repair their product, as they face a lot of barriers, among some were that repair would not be possible, or would take a lot of time and effort. In our experiments, we complement these findings, investigating how design interventions can successfully increase consumers' willingness to repair. We showed an increased level of self-efficacy (i.e., 'a can-do attitude') increases consumers' willingness to repair. Physical repairable designs should therefore also focus on increasing consumers' level of self-efficacy to successfully stimulate consumers' repair behaviour. Our findings therefore complement WP4, in which mostly the technical aspect of product repairability is accessed.

In this deliverable, we aimed to provide a complete picture of the premature replacement of well-functioning products and choice for replacement over repair. We built further on WP2 insights and provided more depth by qualitative and quantitative findings that were obtained for the deliverable. Furthermore, our insights about repair attitudes from the interviews and repair experiments provide guidance for WP4, in which the technical product repairability is accessed, to increase the consumer acceptance of repairable products.

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Appendix A: Interview guide: Consumers' Product replacement Behaviour

Discovering the underlying reasons of consumers to replace a product instead of prolonging the lifetime or repairing a product.

The replacement of 'X' (X = WM, SM, VC or TV)

[Description of present and old 'X']
Goal: Introductory question to become acquainted with the topic of product replacement

In this first part of the interview, I would like to discuss with you your replacement of 'X'

by purchasing or acquiring a new/other 'X'.

1. Can you please describe the new 'X'?
    a. What does it look like?
    b. What kind of functions does it have?
    c. Could you show a the product to me?
    d. When did you purchase it?

Before you bought your 'x', you had another 'x'

2. Can you describe the 'x' you previously owned?
    a. What did it look like?
    b. What kind of functions does it had?
    c. Could you show the product to me? (If you still own it)
    d. How long did you use this product?

[Reasons for replacement 'X']
Goal: Understanding of the different reasons for replacement

Can you please think back of the moment in time when you decided to replace 'X'?

3. What was the reasons for you to replace 'X'?
    a. When did this happen?
    b. Can you explain what triggered your replacement?
    c. Did you miss things from your old 'x' that triggered your replacement?
    d. Are there things you miss from your old 'x' that you do not have in you new 'x'?
4. You just told me that …., and …., [listing the reasons for replacement] were the reasons for you to replace your product
    a. Is it correct that these were the most important reasons to replace your 'x'?
    b. Can you indicate the order of importance of these reasons? (Most to least important?)
5. How much time was there between the first idea to replace 'x' and the final decision?
    a. Can you describe why this did (not) take time?
    b. Did you have doubts to replace the product? Why did you have doubts?

[Product, Consumer and Context Characteristics]

6. Did the following factors had influence on the longer use on the choice to replace the product?
    a. Have there been context related changes in your environment? Why?
    b. Have there been product related changes (functionalities)? Why?
    c. Have there been changes in personal needs? Why?
    d. (if not mentioned yet) Was marketing of influence in your decision making?

[Personal evaluation]

7. When you look back on the process replacing your ‘x’:
    a. Are you satisfied with the new ‘x’ in comparison with you old ‘x’? Why (not)?
    b. Are you satisfied with the aspects of your new ‘x’ that you took into account while replacing the product? Why (not)?

[Lifetime]

8. When you consider the lifetime of the new ‘x’
    a. How long do you think it should last?
    b. How long do you think it will actually last?
9. You just told me your previous ‘x’ lasted … years/months
    a. Were you satisfied with this? Why (not)?
    b. What could have convinced you to use the product for a longer amount of time?

Possibility to repair ‘X’

In the next section, I would like to discuss with you your considerations to decide for either replacement or repair.

[Possible repair old ‘X’]
Goal: Understanding of the different reasons to (not) have a product repaired

1. Was the old ‘X’ still functioning completely well when you decided to replace it?
    a. If no, can you please explain what was wrong?
        i. Did you consider the possibility to repair the old ‘X’? Why (not)?
        ii. What were the reasons for choosing for replacement over repair? (Barrier)
    b. If yes, next question
2. Did you repair the old ‘x’ before you replaced it?
    a. If yes
        i. what did you repair?
        ii. Can you describe this process step by step?
        iii. Were you satisfied with the result? Why (not)?
        iv. Would you recommend others to repair products?
    b. If no, repairing a product can also be considered to give a product an upgrade, to improve functionalities
        i. Did you execute something like this?
        ii. What would be a required to make upgrading interesting for you?

[Future repair of new ‘X’]
Goal: Understanding of the different reasons to (not) have a product repaired

3. If your new ‘X’ would malfunction, would you consider repair?
    a. Why or why not? (barriers) Multiple reasons are possible
        i. What could encourage you to repair it? (enablers)
        ii. Are there concrete design elements that would stimulate repair?
    b. Till when would you consider repairing your product? (Till what time?)

[Repairability as a purchase factor]

4. Did you consider the repairability of the product when buying your new ‘x’?
    a. Why did you (not) take this into account?

Closing

[Lifetime]
Goal: Understanding of participants' evaluation of the lifetime as a purchase factor

1. When you bought your 'x', did you take lifetime into account? Why (not)?
2. What would you convince you of a product having a long lifetime?

[Labels]

3. Do you think a label about the expected lifetime of the product would be useful?
4. What should be on this label to convince you of a long lifetime?
5. Did you take the environmental impact into account when buying your new 'x'?
    a. If yes, what aspects did you take along? Why these ones?
    b. If not, why not?
    c. Are you aware of the impact of products/ goods we own on the environment?
    d. Are you aware long-lasting products decrease the environmental impact?

[Closing]

6. Can you sign the consent form?
7. Thank you for your participation [hand over the debriefing and voucher].

Appendix B: PLATE 2021 Contribution

4th PLATE 2021 Virtual Conference
Limerick, Ireland - 26-28 May 2021

A poorly educated guess: consumers' lifetime estimations, attitudes towards repairability, and a product lifetime label

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Keywords: Product lifetime; Consumer attitudes; Repairability; Product Lifetime Label.

Abstract: Consumers' expectations about product lifetimes have an influence on the actual lifetimes. Promoting repairability and a product lifetime label can potentially encourage consumers to extend product lifetimes. In this paper, we present in-depth insights in how consumers make estimations about product lifetimes, and their attitudes towards repairability and a product lifetime label. Our results reveal that consumers feel unable to make a well-informed estimation about the product lifetime, have negative associations with product repairability, and have concerns about how use intensity and use behavior can be taken into account on a label. Additionally, displaying a minimum number of years on a label may cause unintentional rebound effects.

Introduction

Prolonging product lifetimes of consumer electronics lowers their environmental impact. Longer product use decreases the need for new products, which in turn lowers the released CO2 emissions, the amount of critical raw materials needed for production processes, and the number of products ending up in landfills. Product lifetime extension is therefore desirable for the environment (Bakker et al., 2014). Consumers and their behavior have an important role in product waste reduction (Cooper, 2004), however, a lot of nowadays products are disposed of for other reasons than being broken 'beyond' repair (Harmer et al., 2019; Hennies & Stamminger, 2016; Wieser & Tröger, 2016). When aiming to prolong product lifetimes, it is thus important to consider the consumer perspective on product lifetimes.

Consumers generally have certain expectations regarding the lifetimes of their products. Research suggested that low lifetime expectations may lead to shorter use times and replacement cycles (Wieser et al., 2015). When aiming to increase product lifetimes, it is important to be aware that the replacement of a product is in most cases not only based on rational decision-making (Guiltinan, 2010). During its lifetime, a product is mentally written off by the consumer. This mental value depreciation is influenced by both economical (e.g., low price of new product compared to costs of possible repair) and psychological factors (e.g., the desire for a new feature) (Okada, 2001). If consumers expect a product to be relatively short-lived, this mental accounting goes faster, and the product is more likely to be prematurely replaced because it has made its money worth (van den Berge et al., 2021). To understand how consumers form lifetime expectations is therefore key. It can provide insights on how to lengthen lifetime estimations, and hereby potentially increase actual lifetimes.

Product repairability (i.e., the extent to which a product is able to be repaired) has been indicated as a potential way to increase product lifetimes (Bocken et al., 2016). It seems likely that providing repair possibilities could thus lengthen consumers' lifetime expectations as well. Previous research indicated that even though consumers may prefer repair over disposal, they currently do not look for repairability in products (Sabbaghi et al., 2016). Furthermore, consumers' face a lot of barriers towards repair (Tecchio et al., 2019). To lengthen product lifetimes, it is thus important to explore consumers' attitudes towards repairability.

Consumers currently lack information in making product lifetime estimations (Cox et al., 2013). To support consumers in making more well-informed estimations, a lifetime label can

potentially bring the longevity of the product more on top of mind during decision-making (Braithwaite et al., 2015; Gnanapragasam et al., 2018). However, it is unclear how consumers would respond toward such a label.

This paper contributes to the literature on product lifetimes. It provides in-depth insights on how consumers make estimations about product lifetimes, how consumers perceive product repairability, and how a product lifetime label could support consumers in making more informed estimations about the lifetime.

Method

The explorative nature of semi-structured interviews (n=22) left room for new insights to emerge and supported in obtaining in-depth insights (Patton, 2002). The recruited participants showed variety in age (29-72 years), gender (41% male, 59% female) and income. All participants replaced one or two of the selected products (washing machines: n=8, vacuum cleaners: n=8, TVs; n=8 and smartphones; n=8) within six months preceding the interview, to make sure the replacement decision was fresh in their memories. For the selection of the products that were discussed in the interview, a high market penetration, high environmental impact, high frequency of usage and a variety in technological advancement (high for smartphones and TVs, medium for vacuum cleaners and low for washing machines) were used as selection criteria.

During the interviews we asked how the participants estimated lifetimes, whether the lifetime and repairability were considered at purchase, and what their opinion was about a product lifetime label. To identify the context of the replacement, we asked the participants about the actual product lifetime and the physical state of the old product when replaced, as well as the reason(s) for replacement. The interviews lasted 30-60 minutes and took place at people's homes (November 2019). All interviews were audiotaped and fully transcribed. For this paper only the data on lifetimes, repairability and lifetime labelling were reported. The data was analyzed using Atlas.ti software, and coded in-vivo in the first round in order to stay close to the raw data (Saldaña, 2013). The in-vivo codes were clustered into sub-codes (50) and codes (22), which were iteratively formulated, discussed and refined within the research team.

Results and Discussion

The actual lifetimes of the replaced products greatly differed within all categories (washing machine: 5-18 years; vacuum cleaner: 5-30 years; TV: 4-25 years; smartphone: 2-9 years). This indicates a large variation in lifetimes of products analyzed in this study. Differences between product categories regarding the physical state of the products during replacement were observed as well. While most washing machines had a defect, most TVs were still working. The reasons for replacement were diverse as well, ranging from a defect or decrease in functionality (e.g., a broken drum of a washing machine, or a decrease in battery capacity of a smartphone) to a desire or a good deal for a new product (e.g., a TV with a bigger screen or a good deal for a vacuum cleaner). The insights related to the context of the replacement are presented in table 1. Below, we further elaborate on consumers' lifetime estimations, responses towards repairability, and attitudes towards a product lifetime label.

Consumers' lack the ability to make well-informed product lifetime estimations

Participants' estimations about the lifetime of their new product (i.e., the product bought as a replacement) were diverse, ranging from 5-12 years for a washing machine, 5-15 years for a vacuum cleaner, 5-15 years for a TV and 2-10 years for a smartphone (see table 1). Assuming that there is a large variety in lifetimes between products within each product category (i.e., depending on quality, range, price etc.), the diversity in lifetime expectations is not surprising. The observed spread in consumers' lifetime estimations suggests there is a possibility to influence currently fluctuating lifetime estimations, because they currently seem to be very unpredictable for consumers. This is promising when aiming to extend undesirable short product lifetimes estimations.

Initially, consumers either confirmed or denied that the product lifetime played a role in their purchase decision-making. More in-depth insights revealed that most of the participants did actually took the lifetime into account, but not always consciously.

P16 – Vacuum cleaner: 'No I do not think I took lifetime into account. Not consciously at least, but it might be something kind of self-evident. A thought of what you can expect from such a device.'

Participant number – Product category	Actual lifetime replaced product	Physical state replaced product	Replacement reason replaced product	Repair attempt replaced product	Lifetime expectation new product	Considered lifetime new product	Considered repairability new product	Interest Product lifetime label
P1 - WM	15	Defect	Unknown defect	No	10	Yes	No	Yes
P6 - WM	10	Defect	Electronical defect	No	5-10	Yes	No	No
P15 - WM	5	Defect	Unknown defect	No	10	Yes	No	Yes, but concerns
P17 - WM	13	Defect	Unknown defect	No	10	N.a.	No	N.a.
P18 - WM	10	Defect	Broken door	Yes, new door	10	No	No	No
P19 - WM	18	Defect	Broken drum	Yes, but failed	10	No	No	Yes, but concerns
P20 - WM	15	Working, but decrease in functionality	Wear of drum bearings	No	10-12	Yes	No	Yes
P22 - WM	15	Decrease in functionality	No clean wash	No	10	Not consciously	No	Yes
P1 - VC	17	Working, but decrease in functionality	Noise and smell	No	15	Not consciously	No	Yes
P2 - VC	30	Damaged	Power plug felt unsafe	No	10	Not consciously	No	Yes, but concerns
P4 - VC	25	Working	New product less noise, more energy efficient	No	10 - 15	No	No	Yes, but concerns
P6 - VC	10-15	Defect	Unknown defect	No	5	N.a.	No	N.a.
P8 - VC	10	Defect	Unknown defect	No	N.a.	No	No	No
P9 - VC	10	Working	New product was a good deal	No	10	Yes	No	Yes
P11 - VC	6-7	Defect	Unknown defect	No	7-12	Yes	No	Yes
P16 - VC	5-6	Defect	Electronical defect	No	5	Not consciously	No	Yes
P3 - TV	5	Working	New technological desires	No	15	No	No	N.a.
P5 - TV	7	Working	Screen too small	No	15	No	No	No
P7 - TV	10	Damaged and decrease in functionality	Damaged screen and decrease function	No	10-12	Yes	No	Yes, but concerns
P8 - TV	2-3	Damaged	Stroke through screen	No	5-6	No	No	Yes
P10 - TV	10	Working	Stain in screen and new technological desires	No	6	No	No	Unsure
P12 - TV	25	Working	Analog TV incompatible with service provider	No	10	No	No	Unsure
P13 - TV	10	Working	Analog TV incompatible with service provider	No	10	No	No	Yes
P21 - TV	4	Working	Screen too small	No	10	No	No	No
P2 - SP	4	Working, but decrease in functionality	Battery malfunctioning	No	4	Yes	No	Yes
P3 - SP	2	Working	Subscription ending and brand reputation	No	2	Yes	No	No
P4 - SP	3	Working	New desired, old product to family member		2 - 2,5	No	No	Yes, but concerns
P5 - SP	3	Damaged	Broken screen	No	5 - 6	No	No	No
P7 - SP	8-9	Working	No available software updates	no	7-8	Yes	No	Yes, but concerns
P9 - SP	4	Decrease in functionality	Decrease of function, low quality camera	Yes, replaced screen 2 times	4	Not consciously	Yes, ability to repair screen	Unsure
P11 - SP	3-4	Decrease in functionality	Low memory capacity, low quality camera	Yes, replaced screen 2 times	4	N.a.	No	Yes
P13 - SP	6	Working	No available software updates	Yes, replaced button	10	Yes	Yes, modular phone	Unsure

Table 1. Overview of the interview data presented per product category.

Participants' lifetime estimations were mainly based on intuition (i.e., instinctive knowing). When we asked what this intuitive estimation was based on, they mentioned personal experiences, recommendations from family or friends, consumer reviews, salesmen, the price and brand reputations.

P1 – Washing machine: '[When making a lifetime estimation] you consider the price and the brand. It is based on instinctive feelings, but also on experiences from the past. Seeing products in the store or on the internet, you don't see the difference at all, and really have to read into it. If you see them in the store, you really need someone to tell you about the product.'

Consumers seem to lack expertise and knowledge to make a well-informed estimation about the product lifetime. Many participants acknowledge this and even declared themselves unable to make an estimation. From the appearance, it is difficult to identify differences between products in terms of lifetime. Information about the quality and robustness of used materials and components is often not communicated by the manufacturer. Estimating the lifetime feels as a guess to many consumers. To make the product lifetime a more prominent aspect in consumers' purchase decision-making, it is thus important to better support them in making lifetime estimations.

Consumers have a negative attitude towards product repairability

Before replacing the product, three participants repaired their smartphone, and only one repaired her washing machine. None of the participants repaired a vacuum cleaner or TV (see table 1). Our results thus demonstrated that repair was often not considered for the replaced product, and thus was unable to lengthen the lifetimes of the investigated products. Confirming existing literature, the age of the product and cost of repair were mostly mentioned as barriers towards repair activities (Laitala et al., 2021; Tecchio et al., 2019). Interestingly, product defects that did result in repair all had a visible effect on the product appearance (e.g., broken door of a washing machine, a broken screen and button of smartphone, see table 1). This suggests that a know-how of what is wrong, either by visual or technical indication (supporting in the notion of what is wrong) may stimulate product repair.

We also investigated the repair considerations of participants' new products. Some additional barriers, such as the lack of a convenient repair infrastructure (Jaeger-Erben et al., 2021) and the availability of spare parts for a reasonable price (Sabbaghi et al., 2017), emerged that confirmed existing literature. Additionally, consumers also seem to face concerns about the repair outcome.

P3 -TV: 'How do you get an appliance like that safely and securely to a place you get offered a repair? And does it pay off to repair it? […] Are there any replacement parts available for a fair price? And after repair, do you really have a working device again that will have the life you hoped for?'

Our results revealed the uncertainty of the repair outcome as a hindrance towards executing repair activities. We believe that the prospect of a sound repair outcome may support in lengthening lifetimes expectations from consumers. It is interesting to investigate what design, service or business model elements (e.g., repair guarantee services) can take away this experienced hindrance, and consequently increase consumers' confidence in repair.

Finally, most participants responded that they did not take repairability into account when purchasing the new product. They were often surprised or confused by the question and indicated to 'not have thought of it at all'. The participants also indicated that manufacturers currently do not communicate about repairability, and therefore, they could not have taken it into account. Additionally, some participants mentioned that the product did not look like it could be repaired.

P 9 – Vacuum cleaner: No, not at all [considered the repairability]. I just did not think about it […] To me, this vacuum cleaner looks very closed as well... It doesn't look like I could open it up myself to replace something.

Participants associated a repairable product with a performance that does not live up to the latest standards, as well as the more expensive option compared to similar products. Some participants even perceived repairability as a negative feature for products, because consumers just want a well-functioning product and do not wish to be bothered with potential repairs.

P15 – Washing machine: 'No, I haven't thought about that… Well, it's not really promoted, that it's easy repairable [...]. You hope that it will last a very long time. It is a negative thing if someone would promote that it is easy repairable. Then you think; does it break down that often?'

The discouraging attitude towards repairability can be attributed to consumers' unfamiliarity with the topic and may change when more awareness is raised. Governmental parties should focus on promoting repairability and making policies for manufacturers that stimulate the promotion of repairs. For example, a policy obliging companies to share information about repairability may also change consumers' current negative attitudes because repairability then becomes a more commonly considered attribute for products (such as the European Union energy label).

Consumers' varying attitude towards a product lifetime label

Participants' attitude towards a product lifetime label varied. Often concerns about the trustworthiness of the label were observed when it would be provided by the manufacturer. According to the participants, manufacturers have no interest in selling long-lasting products as this would reduce their sales. Additionally, the continuous development of new models made the participants wonder whether the lifetime of products can be predicted in advance. The speed of new technological developments makes it difficult to include evidence from practice in lifetime estimations.

P16 – Vacuum cleaner: 'I don't know if a lifetime label is reliable when it is provided by the manufacturer. They obviously commit to the mandatory warranty duration but have no interest in making the device last a lot longer […]. It also has to do with the fact that they keep renewing the devices and changing things. How can you predict anything about that?'

Furthermore, it was questioned how a label can take the influence of (careless) consumer behavior into account. Current warranty legislations from the European Union require proof that a failure is not due to the consumer. Often this was experienced as a burden, because for some cases it is difficult to provide proper evidence. On the one hand, participants mentioned that a lifetime expectation expressed in years could affect them, because this would enable them to compare the purchase price to the expected lifetime. On the other hand, there were concerns about a lifetime expectation expressed in years, because the use intensity (i.e., the frequency of usage) and consumer behavior (i.e., the way the product is handled by the consumer) strongly influence the product lifetime. Especially consumer behavior is difficult to take into account on a label.

P4 – Smartphone: 'I think that's very difficult for smartphones because it depends so much on individual usage. I think it is more important whether you have a good case around it protecting the phone, than the brand.'

Reflecting on these results, displaying a minimum number of years on the label may have undesirable rebound effects. Firstly, because consumers indicated that the lifetime of a product strongly depends on the products' use intensity and consumers' behavior, and therefore cannot be guaranteed. Additionally, research suggested that consumers' lifetime expectations potentially affects the replacement decision (van den Berge et al., 2021). Displaying a minimum number of years may unintentionally encourage consumers to replace a still functioning product when these indicated years are exceeded. They may feel the product has made its money worth.

Conclusions

Our findings suggest that consumers do not feel confident in making accurate lifetime estimations. They need support in making more well-informed decisions with regards to product lifetimes. A product lifetime label potentially not only supports consumers in making better estimation, but it may also incentivize manufacturers to design products with a longer lifetime. When aiming to extend product lifetimes by a product lifetime label, it is important to alleviate consumers' concerns. Special attention should be focused on the current negative attitude towards repair and repairability. Only then consumers will have confidence in the label and use it in their decision-making at purchase.

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Appendix C: Interview guide OCU and UFC – interview study France and Spain

Main aim: Which design features or business models can postpone consumers' replacement of washing machines (WM), smartphones (SM), vacuum cleaners (VC) and TVs?

In order to have an actual replacement situation 'fresh' in their minds, participants are needed who replaced their WM, SM, VC or TV during the last 6 months.

7-8 participants per product category, resulting in a total of 25-30 participants

For in-depth interviews it is important that participants expound on the topic, so it is important to ask them to explain their answers.

Interview guide for online interviews

Introduction

- Interview on replacement behavior of consumers
- Aim is to explore different possible solutions in either the product and the business model whether these could have postponed your replacement decision and the underlying reasons why or why not
- We will present new solutions, but please try to imagine what you would do if this would have been available during your replacement decision
- Please take your time to think it through and try to be comprehensive in your answer, thereby explaining all the things that you are considering
- It is important to understand that we are interested in your personal experience, there are no right or wrong answers
- The interview is expected to last 30-45 minutes

Data interview

- Interview is confidential
- Data will be anonymized for the analysis
- Data will be used for European project PROMPT to develop a testing program
- We will record this interview to be able to transcribe it, but we will destroy these recordings after the research

The replacement of 'X' (X = WM, SM, VC or TV)

[Description of present and old 'X']

Goal: Introductory question to become acquainted with the topic of product replacement

In this first part of the interview, I would like to discuss with you your replacement of 'X' by purchasing or acquiring a new/other 'X'.

1. Can you please describe the new 'X'?
    a. What does it look like?
    b. What kind of functions does it have?
    c. When did you purchase it?

[Reasons for replacement 'X']

Goal: Understanding of the different reasons for replacement (replication of Dutch data)

Can you please think back of the moment in time when you decided to replace 'X'?

2. What were the reasons for you to replace 'X'? Multiple reasons are possible
    a. Can you explain for each reason why this triggered your replacement?
    b. What was the role of the performance and appearance of the old 'X' in your decision to replace it?
    c. To what extend did the COVID-19 situation influence your decision to replace the product?
        i. Did the situation result in faster replacement or in delayed replacement? Can you explain why?

Possibility to repair 'X'

In the next section, I would like to discuss with you your considerations to decide for either replacement or repair.
[Possible repair old 'X']

Goal: Understanding of the different reasons to (not) have a product repaired

1. Was the old 'X' still functioning completely well when you decided to replace it?
    a. If no, can you please explain what was wrong?
        i. Did you consider the possibility to repair the old 'X'? Why (not)?
        ii. What were the reasons for choosing for replacement over repair? Multiple reasons are possible
    b. If yes, next question

[Future repair of new 'X']
Goal: Understanding of the different reasons to (not) have a product repaired

2. If your new 'X' would malfunction, would you consider repair?
    a. Why or why not? (barriers) Multiple reasons are possible
    b. What could encourage you to repair it? (enablers)

Lifetime evaluation

[Lifetime]

Goal: Understanding of participants' evaluation of the lifetime

The next questions concern the lifetime of the old 'X'.

1. How long did you use the old 'X'?
    a. Were you satisfied with this lifetime? Why (not)?
    b. Can you think of certain factors in either the design of 'X' or in related services that could have extended the lifetime of 'X' and thereby postponed your replacement?

Appendix D: DRS 2022 Conference Contribution

DRS 2022
Bilbao 25th June — 3rd July

Enhancing consumers' willingness to repair electronic products: how design can nudge sustainable behaviour

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Abstract: Product repair can decrease the ecological burden of consumer electronics by lengthening their lifetimes, but it is still too rarely practised by consumers. Design for behaviour change can motivate consumers to undertake repair activities. An increased level of repair self-efficacy can nudge consumers towards repair. In two experiments, we tested the effects of a fault indication on consumers' willingness to repair washing machines, vacuum cleaners and stick vacuum cleaners. A fault indication is a signal appearing on a product providing information about the occurring failure. For products that are relatively less likely to be repaired by a repair professional, the willingness to repair increased significantly when a fault indication was present. The perceived level of self-efficacy mediated these results. These results remained consistent among different types of product failures. Finally, we provide implications for designers and future opportunities on how to further stimulate consumers' willingness to repair electronic products.

Keywords: Design for Repair; Sustainable Consumer Behaviour; Product Lifetime; Circular Economy

1. Introduction

The way we produce, use, and dispose of products has a damaging impact on our environment. Production processes do not only result in large amounts of CO2 emissions, but they also cause social and health-related issues(Heacock et al., 2016). Moreover, because of the growing demand for electronic products, e-waste is one of the fastest growing waste streams. Future scenarios studies prospect that the amount of e-waste will be doubled in 2050 when no serious action is undertaken to reverse this growth(Parajuly et al., 2019).

The Circular Economy has been proposed as a solution to lower the environmental impact of products. It aims to restore and recover materials used in the production and use cycles to keep the value of products and materials high across all stages of its lifetime (Ellen

MacArthur, 2013). Past research showed that prolonging product lifetimes enables to retain products' initial value more than, for example, product recycling and is therefore the preferred route in a Circular Economy (McCollough, 2009).

By repairing, a product's functional value is recovered, and it can perform its initial utility again. The product is not discarded, and its lifetime is prolonged. Therefore, design for repair has an important role in product lifetime extension to lower the impact of consumption on the environment (Bocken et al., 2014). However, research shows that consumers often have low ability (e.g., time, skills, tools, knowledge) and motivation (e.g., financial, pleasure) to repair whilst both are needed to initiate repair activities (Ackermann et al., 2021; Jaeger-Erben et al., 2021). Consumer studies endorse a lack of repair behaviour and demonstrate that most discarded products were never repaired during their lives (Harmer et al., 2019; Hennies and Stamminger, 2016; Wieser and Tröger, 2018). Inconvenient repair support (e.g., instructions, services) may impede the performance repair activities (Jaeger-Erben et al., 2021). Also, consumers who do not feel able to repair the product themselves, will include labour costs from involving repair professionals in the estimated repair costs. Including these costs makes the repair option appear expensive, especially in comparison to new products with a relatively low purchase price (Brusselaers et al., 2019). These barriers are expected to have a negative impact on consumers' willingness to repair.

Research has proposed several ways to facilitate product repair by design (e.g., Raihanian Mashhadi et al., 2016; Sabbaghi et al., 2016). However, focus has been on a design engineering perspective mostly, demonstrating the technical opportunities of repairable designs. Yet, the fact that a product can be repaired physically, does not mean that consumers will act accordingly (Makov and Fitzpatrick, 2021). In other words, it is essential to investigate factors that increase consumers' willingness to repair. The Theory of Planned Behaviour (Azjen, 1991) concluded that perceived control (i.e., ease or difficulty of performing a behaviour) can influence the intention to execute this behaviour. Perceived control is conceptually related to perceived self-efficacy (i.e., 'can do' attitude (Fuchs et al., 2010)). For repair behaviour, this would imply that if consumers have more repair self-efficacy, they expect to have sufficient capabilities to repair their product, which will increase consumers' willingness to execute repair activities.

This research contributes to the literature by investigating the impact of diagnosing the cause of the failure on consumers' willingness to repair. Specifically, we used a fault indication as an example of a design intervention that can help consumers diagnose what is wrong with the product, thereby increasing their repair knowledge. The proposed hypotheses are tested in two experiments using different electronic products.

The effect of a fault indication on consumers' willingness to repair

An important factor that prohibits consumers from starting repair activities in the first place, is that consumers are often not aware of what is causing the product failure (Bovea et al., 2017). Research investigating consumers' ability to repair showed that product designs do

not support consumers in understanding and diagnosing the cause of the failure or facilitate repair activities (Pozo Arcos et al., 2021; Rosborou, 2020; Svensson-Hoglund et al., 2021). To counter this low level of ability to repair, behaviour change research has indicated the value of nudging. A nudge can be a design intervention that persuades or encourages someone to behave in a specific direction (Thaler and Sunstein, 2008). Recent research on increasing product reparability emphasized the importance of including fault indications as design interventions supporting repair (Tecchio et al., 2016). A fault indication is a signal (e.g., code, text, icon, light) appearing on a product when it is malfunctioning. An example is an error code on a washing machine's display. This signal can provide information about the cause of the failure and consumers can use this information to identify the steps that need to be taken for repair. If consumers know what is wrong with the product, their ability to find out what needs to be done for a successful repair is thus increased. Therefore, it is likely that by providing information about the failure, consumers' willingness to repair will increase. In this way, the fault indication acts as a nudge which enhances consumer ability to repair and consequently, increases their intention to perform repair activities.

Even though fault indications can help consumers to understand the cause of the failure, it is unlikely that fault indications will encourage consumers to repair all sorts of products. In some situations, consumers would be more likely to turn to repair professionals for repair, for example because the product is technically complex or relatively expensive (Sabbaghi et al., 2016). When a professional repairer is contacted to execute repair, there is less need for consumers to know the exact product failure because consumers trust the professional repairer to diagnose the cause of the failure. However, some products are less likely to be repaired by repair professionals. For instance, products that have a relatively low purchase price repair will be relatively costly to repair (Rogers et al., 2021). For these types of products, a fault indication may lower the barrier towards repair. Knowing the cause of the failure, repair actions may seem less challenging because the steps towards repair are easier to define. We therefore hypothesize the following:

> **Hypothesis 1:** The positive influence of a fault indication on consumers' willingness to repair is moderated by the probability to make use of professional repairers. Specifically, if the product is less likely to be repaired professionally, the fault indication has a positive effect on consumers' willingness to repair (H1a). If the product is more likely to be repaired professionally, the presence of a fault indication will not have an effect (H1b).

To explain the underlying process for consumers' increased willingness to repair, we argue that when the failure is known, the consumer feels more competent in defining the steps needed for a successful repair. Literature has shown that when consumers believe in their ability to make sound evaluations, in this case about a potential repair, it results in an

increased level of self-efficacy. The perceived self- efficacy is defined as a 'can-do' attitude and depends on a persons' level of knowledge and expertise, competence, and difficulty to make sound evaluations about the related topic (Fuchs et al., 2010; White et al., 2011). It is likely that when the failure of a product is known, the level of self-efficacy concerning repair of the consumer increases. In the presence of a fault indication, a high level of perceived self-efficacy may thus explain an increased willingness to repair. Reflecting on our first hypothesis, this specifically applies to products for which consumers have a low tendency to consult a professional repairer. Therefore, we hypothesize the following:

> **Hypothesis 2:** The perceived level of self-efficacy mediates the relationship between the presence of a fault indication and consumers' willingness to repair (H2).

2. Study 1

2.1 Method

Study 1 aims to test whether a fault indication on a malfunctioning product stimulates consumers to repair it. To do so, we empirically tested the willingness to repair of two different product categories. The two categories represent products of which consumers are expected to have either a low or high tendency for professional repair. We used an experimental set-up because it allows to isolate and test the specific effects of a chosen intervention (i.e., fault indication). Moreover, it enables to uncover mainstream effects (rather than unique, individual cases) and that are therefore especially interesting for designers.

Study design and development of the stimuli

Study 1 had a 2 (fault indication: absent vs. present) × 2 (product's likelihood to be repaired professionally: low vs. high) between-subject experimental design. Each participant was presented with one of four conditions in a scenario, which consisted of a picture and a short text (figure 1). We chose washing machines (WM) and vacuum cleaners (VC) because these products are used frequently and are considered important to consumers. Also, the market sales and environmental footprint are substantial. The impact of these products can be lowered when lifetime is prolonged by repair if the repair takes place before 'the environmental break-even point' arrives. This is the point in time where the environmental impacts that result from using a product are equal with impacts of a (more energy efficient) replacement product. For WM this is estimated to be around 10 years, and for VC around 6 years (UN environment, 2017).

We chose a washing machine as a product that is more likely to be professionally repaired, because of its high technical complexity in its design and its relatively high purchase price. We chose a vacuum cleaner as a product category that is less likely to be professionally repaired because the purchase price of a new vacuum cleaner is relatively low, making

replacement of a vacuum cleaner more likely when the product starts to malfunction. Therefore, the probability for consumers to turn to a professional repairer is expected to be lower for a vacuum cleaner compared to a washing machine.

The described failure in each scenario ensured that the main function of the product could no longer be performed. When the fault indication was absent, only information about the observed failure was presented. The participant was 'not able to activate the wash programs' of the washing machine, and the vacuum cleaner had 'lost its suction power'. When a fault indication was present, the scenario provided additional textual and visual information about the cause of the failure. For the washing machine, an error code showed 'damaged drum bearings', and for the vacuum cleaner a red light indicated a 'damaged filter'. Additionally, the text referred to information on a (online) manual indicating that the specific damaged part needs to be replaced.

To create the pictorial stimuli, we used examples from existing products. Brand names and logos were erased to prevent participants' associations unrelated to the topic of our study. To reduce the possibility that different associations regarding the product's initial functionality would influence the results, all products were introduced as 'mid-range models' and having 'normal performance' compared to similar products. Earlier research showed that the age of the product is an important factor in the decision to repair (Makov and Fitzpatrick, 2021). A product's value depreciates over time, meaning it becomes worth less and less (Van den Berge et al., 2021). Therefore, the time of ownership was included in the scenario as well. We chose a time of ownership situated between the legal warrantee period of two years, the average use time of the product types (i.e., 8.3 years for washing machine and 6.0 years for vacuum cleaner (Wieser et al., 2015)), and the earlier indicated 'environmental break-even points', in which lifetime extension is a preferred option. Accordingly, we assumed repair could still be a viable and preferred option for a 6-year-old washing machine and 4-year-old vacuum cleaner. An example of one of the scenarios is shown in figure 1.

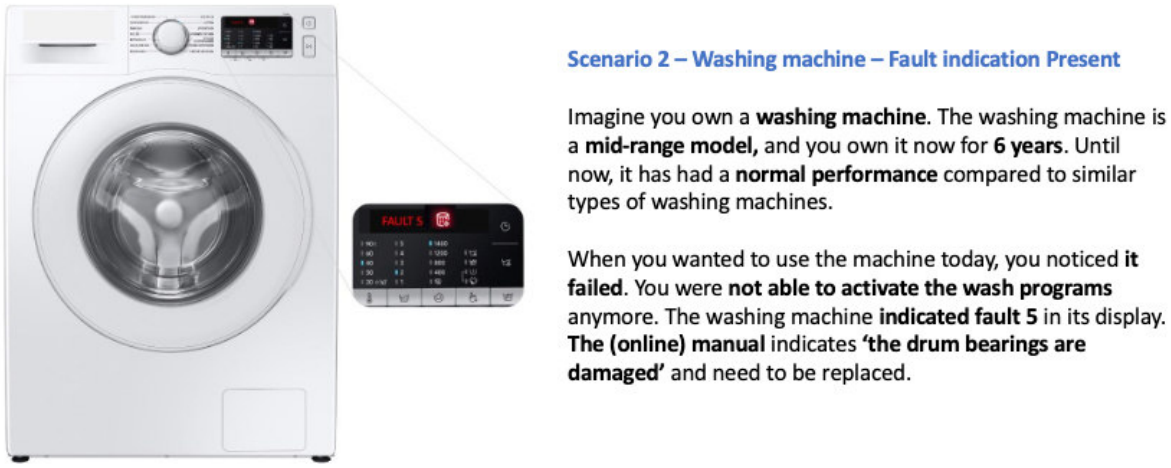

Figure 1 *An example of one of the 4 scenarios shown to the participants in study 1: a washing machine with a fault indication present.*

Participants, procedure, and measures

The study was conducted online using Qualtrics software (Qualtrics.XM, 2022). Participants who did not own the product category under investigation were excluded from the dataset (WM: n=4; VC: n=3). Two participants failed the attention check and were also excluded. This resulted in a total of 139 participants (Age: Mean=41.10, SD=10.61; Gender: Male=54.0%, Female=46.0%, Other=0%). Participants were recruited via Prolific which is an online database representing participants from different nationalities (Prolific, 2022). The minimum age requirement was set to twenty-five years because this made it more likely that participants had bought these products themselves and had possessed them for several years, making a possible repair need a realistic scenario.

After being presented with the scenario, the participants were first asked to evaluate their willingness to repair the product using three items *('How likely/inclined/willing are you to have this product repaired?*' (White et al 2011)) on a seven-point scale (1= 'not at all'; 7= 'very much'). Additionally, the level of self-efficacy was assessed on three seven-point Likert scales (1='strongly disagree'; 7='strongly agree') using the items: *'I feel competent enough to select the best repair actions needed for this product'*, *'I feel that I have the relevant knowledge and expertise to make sound evaluations about the repair actions needed for this product*' and *'I had difficulties evaluating the repair actions needed for this product (r)'* (Fuchs et al 2010). Participants also responded to a three-item seven-point Likert scale to check the manipulation of the fault indication: *'The fault was clear to me'*, *'I would be able to identify the type of failure'* and *'I have had enough information to know the type of failure'* (1= 'strongly disagree'; 7= 'strongly agree'). To check the probability of the product to be repaired professionally, we asked participants how likely they were to have the product repaired by a professional repairer (1= 'not at all'; 7= 'very much').

Finally, we included three covariates in our analysis that may have influenced participants level of willingness to repair. For example, it may be that some participants are more knowledgeable about repair than others. Despite the absence or presence of a fault indication, a high level of repair knowledge may lead to an increased willingness to repair. To measure the level of repair knowledge, the participants ranked themselves on three seven-point semantic differential scale (Lakshmanan and Shanker Krishnan, 2011). Also, on the one hand it is likely that a high level of environmental concern also influences consumption patterns because participants are more aware of their impact on the environment. Consequently, this may have led to an increased willingness to repair. We measured the level of environmental concern on an existing six-item Likert scale (Kilbourne and Pickett, 2008). On the other hand, a high level of technological interest may increase the demand for new products. When a product breaks down, this may lead to a higher replacement tendency because the participant is keen to have a new product. Therefore, we included this factor using an existing seven-item Likert scale (Parasuraman, 2000). The scales and items used can be found in appendix A. The collective means of the multiple item scales were calculated in SPSS and used for the analyses.

2.2 Results and Discussion

Manipulation checks

We first checked if the presence of a fault indication had the intended effect on participants' understanding of the failure. We performed analyses of variance (ANOVAs) to test the effect of the fault indication. We used the fault indication as the independent variable and the collective mean of the three-item scale to check the manipulation as the dependent variable. As intended, there was a significant main effect of the presence of a fault indication on the understanding of the product failure for both the washing machine ($M_{\text{WM absent}}$=3.39 vs. $M_{\text{WM present}}$=5.42; $F(1,67)=36.65$; $p<0.001$) and vacuum cleaner ($M_{\text{VC absent}}$=4.02 vs. $M_{\text{VC present}}$=5.86; $F(1,68)=31.67$; $p<0.001$). These results showed that participants had a better understanding of the failure when a fault indication was present, and thus the manipulation was successful. We also tested our manipulations concerning the probability to make use of professional repair for different product categories. The assumptions of normality of variances were not met for this variable. Therefore, we used non-parametric one-tailed independent-samples Mann-Whitney U tests for the analyses. The results showed that participants were significantly more likely to have a washing machine repaired by a professional repairer than a vacuum cleaner (Mdn_{WM}=6.00, Mdn_{VC}=3.00, U=1286.00, $p<0.001$), cf. table 1, and our manipulations were therefore successful.

The effect of a fault indication on the willingness to repair

To test H1, we used analyses of covariance (ANCOVAs) with the fault indication and product category as independent variables, the level of repair knowledge, level of environmental concern and technological innovativeness as covariates, and willingness to repair as the dependent variable. The results of the covariates did not significantly differ across conditions, cf. table 1. Therefore, we can assume that the different groups represent a comparable sample in terms of personality traits. Continuing our analyses, a main effect was found for the fault indication. This demonstrates that participants were more willing to repair a product with a fault indication (M_{absent}=4.70 vs. M_{present} =5.29; $F(1,132)=6.16$; $p<0.05$). There was no main effect for the product category. More importantly, the results showed a significant interaction effect of the fault indication and product category on the willingness to repair ($F(1,132)=4.78$; $p<0.05$). Looking at the product categories separately, for the vacuum cleaner the willingness to repair was significantly higher when a fault indication was present ($M_{\text{VC absent}}$=4.25 vs. $M_{\text{VC present}}$=5.42, $F(1,65)=11.72$; $p<0.001$). However, for the washing machine this effect was non-significant ($M_{\text{WM absent}}$=5.12 vs. $M_{\text{WM present}}$=5.21, $F(1,64)=0.09$; $p>0.50$), shown in figure 2. These findings provide support for both H1a and H1b. Descriptive statistics are displayed in table 1.

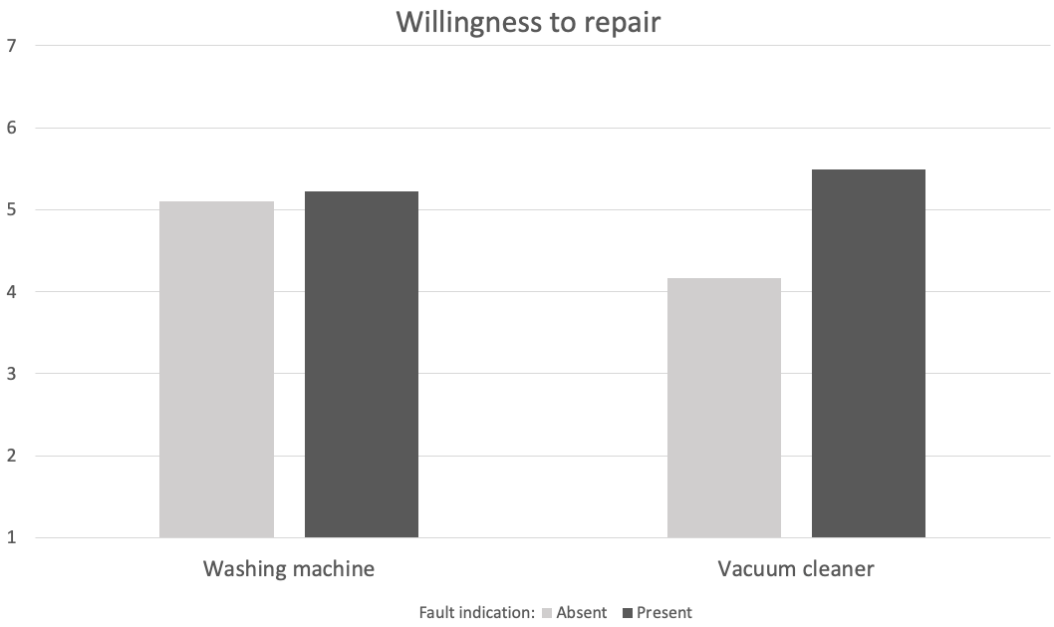

Figure 2 *Bar chart showing the differences in the willingness to repair for the washing machine and vacuum cleaner if the fault indication was absent or present.*

The mediating effect of self-efficacy on the willingness to repair

To test for H2, we first performed ANOVAs with fault indication and product category as independent variables and the level of self-efficacy as a dependent variable. Our results showed a significant main effect for both the fault indication ($M_{\text{FI absent}}$=3.61 vs. $M_{\text{FI present}}$ =4.42; $F(1,135)=9.34$; $p<0.01$) as the product category (M_{WM}=3.71 vs. M_{VC} =4.32; $F(1,135)=5,45$; $p<0.05$) on the level of self-efficacy. No significant interaction effect between the fault indication and product category was found. When looking at the product categories separately, the results showed a significant higher level of self-efficacy for a vacuum cleaner when the fault indication was present ($M_{\text{VC absent}}$=3.77 vs. $M_{\text{VC present}}$=4.88; F(1,68) =8.29; p<0.01), however, this result was not shown for the washing machine ($M_{\text{WM absent}}$=3.45 vs. $M_{\text{VC present}}$=3.96; $F(1,67)$ =1.97; $p>0.10$).

To confirm H2, we performed a moderated mediation analysis using model 7 of the PROCESS macro for SPSS (Hayes, 2013). The aim was to check if self-efficacy mediated the relationship between the presence of a fault indication and willingness to repair and was moderated by the product category, figure 3. The PROCESS results indeed revealed the presence of a moderated mediation (b=0.92; SE=0.41; 95%CI: [0.12;1.74]; $p<0.05$). When the probability for professional repair was low (i.e., in the case of the vacuum cleaner), there was a positive indirect effect of a fault indication on the willingness to repair through the level of self-efficacy (b=0.30; SE=0.17; 95% CI:[0.03;0.69]). When the probability for professional repair was high (i.e., in the case of the washing machine) the positive effect of a fault indication on the willingness to repair through the level of self-efficacy was weakened (b=0.04; SE=0.09; 95% CI:[-0.15;0.22]). Therefore, hypothesis 2 is confirmed.

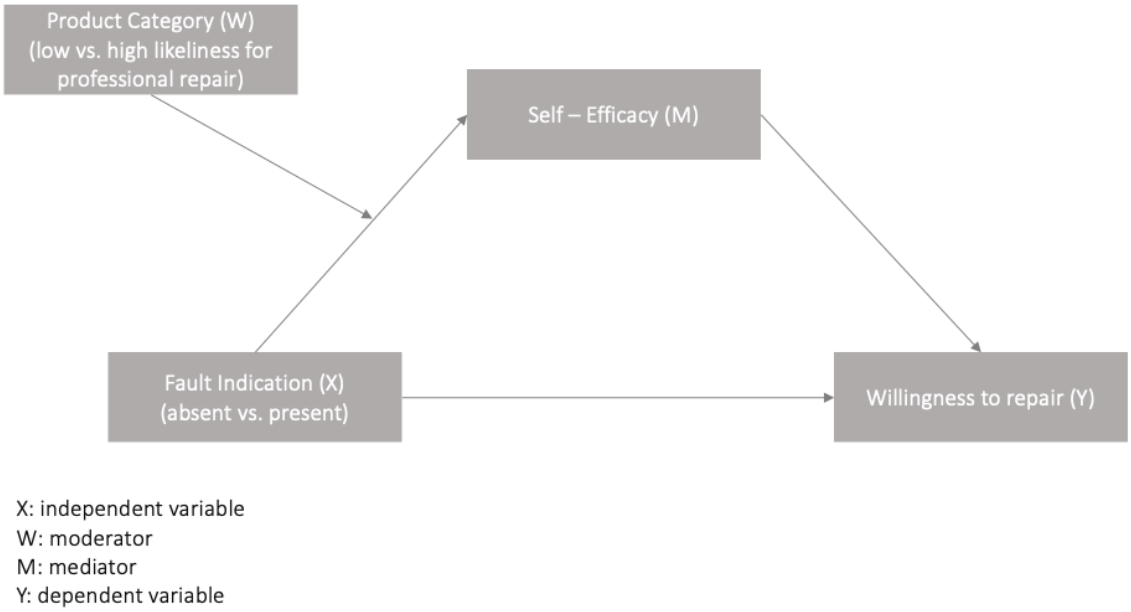

Figure 3 Moderated mediation model of study 1 based on Hayes (2013).

When reflecting on our study, a limitation could be that a 'damaged filter' of a vacuum cleaner was perceived more as a maintenance activity, rather than a pure repair activity by the participants. The 'damaged filter' of a vacuum cleaner may therefore have been perceived as a relatively easy task, that will not take too much time and effort. To validate if fault indications can also be beneficial for other, more complicated failures and repair activities of similar types of products, we chose to replicate the positive effects of failure indication in study 2 using a different type of failure.

3. Study 2

3.1. Method

The main purpose was to validate the findings of study 1 for a different type of failure. We chose a stick vacuum cleaner (SVC) as a comparable product to a vacuum cleaner in terms of a low probability to be professionally repaired. This resulted in a 2 (fault indication: present vs. absent) × 1 (SVC) between-subject experimental design.

Development of the Stimuli

The conditions presented in the two scenarios of the stick vacuum cleaner were similar to those in study 1. The product was introduced as being a 'mid-range model' and having a 'normal performance', and the time of ownership was 3 years which is in line with the vacuum cleaner of study 1. We chose a malfunctioning battery as a failure, ensuring that the essential function of the product could no longer be performed. Desk research on the internet showed that a malfunctioning battery is considered a commonly occurring failure for a stick vacuum cleaner. Additionally, a failing battery is less susceptible to be considered

a maintenance activity and would require more time and effort from the consumer to repair compared to the damaged filter of a vacuum cleaner in study 1. In the condition where the fault indication was absent, the stick vacuum cleaner 'failed' and was 'not able to function anymore'. When a fault indication was present, a red light was shown on the product. The text referred to information in the (online) manual indicating that the battery was damaged and needed to be replaced, figure 4.

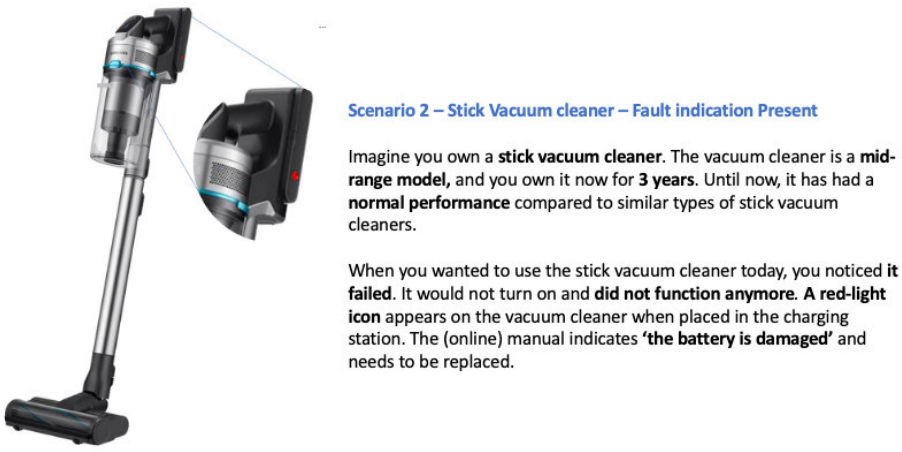

Figure 4 *An example of one of the two scenarios shown to the participants in study 1: a stick vacuum cleaner with a fault indication present.*

Participants, procedure, and measures

Seventy-two respondents (Age: Mean=38.11, SD=8.69; Gender: Male=47,2%, Female=52.8%, Other=0%) participated in this online study. The participants were recruited via Prolific under the same conditions as study 1. Five participants who failed the attention check were excluded from the dataset. As expected, owning a stick vacuum cleaner was less common than owning a vacuum cleaner (55.6% indicated to own a stick vacuum cleaner). As study 1 showed most participants owned a vacuum cleaner, and a stick vacuum cleaner is similar in terms of functionality, we assumed this will not influence our results. Participants evaluated the scenarios on multi-item scales for their 'willingness to repair', level of 'self-efficacy', the 'likelihood of professional repair', 'level of repair knowledge' and completed the manipulation check, cf. appendix A. The measures were identical to those in study 1.

3.2 Results and Discussion

Manipulation checks

The data of the manipulation check was not normally distributed; therefore, a nonparametric test was used for the analysis. The manipulation was successful (Mdn_{Absent}=2.33 vs. $Mdn_{Present}$=6.33, U=1152.50, p<0.001) and confirmed that consumers were significantly more able to identify the failure of the stick vacuum cleaner when a fault indication was present. Furthermore, we compared the results of the stick vacuum cleaner

on the probability to be professionally repaired to the products from study 1. When looking at the means of the stick vacuum cleaner and compare them to those of the washing machine and vacuum cleaner, the results showed that the probability of having a stick vacuum cleaner repaired by a repair professional was comparable to the vacuum cleaner (M_{SVC} =4.43; M_{VC}= 3.86 vs. M_{WM}=5.72). Therefore, we can assume that the vacuum cleaner of study 1 and stick vacuum cleaner of study 2 are comparable in terms of probability to be professionally repaired.

Table 1 *The means, standard deviations and significance levels (p-value: *= p<0.05; **= p<0.01; ***= p<0.001); a= nonparametric test result; p= one tailed) of the variables used study 1 and study 2.*

	Study 1						**Study 2**		
	Washing machine			**Vacuum cleaner**			**Stick vacuum cleaner**		
Fault indication	**Absent (n=34)**	**Present (n=35)**	**p-value**	**Absent (n=35)**	**Present (n=35)**	**p-value**	**Absent (n=37)**	**Present (n=35)**	***p*-value**
Manipulation check	3.39 (1.59)	5.42 (1.16)	<0.001 ***	4.01 (1.69)	5.86 (0.94)	<0.001 ***	2.80 (1.58)	5.70 (1.67)	<0.001[a] ***
Willingness to repair	5.10 (1.67)	5.22 (1.69)	0.763	4.17 (1.69)	5.49(1.55)	0.001 ***	4.38 (2.04)	5.19 (1.85)	0.045[a] *
Level of Self -efficacy	3.45 (1.43)	3.96 (1.58)	0.577	3.77 (1.83)	4.87 (1.35)	<0.001 ***	3.36 (1.64)	4.67 (1.67)	0.012 *
Likelihood for Professional repair	5.97 (1.75)	5.49(1.84)	0.048 [a] *	3.83 (2.02)	3.89 (2.32)	0.479 [a]	4.46 (2.13)	4.40 (2.40)	0.471 [a]
Level of repair knowledge	3.43 (1.29)	3.98 (1.62)	0.124	3.77 (1.53)	3.83 (1.43)	0.872	3.39 (1.51)	4.02 (1.62)	0.087
Level of environmental concern	5.98 (1.00)	5.83 (0.98)	0.541	5.87 (1.21)	5.66 (1.10)	0.462	5.85 (1.10)	6.15 (0.82)	0.193
Level of technological innovativeness	4.66 (1.13)	4.55 (1.47)	0.723	4.91 (1.28)	4.54 (1.10)	0.203	4.74 (1.25)	4.99 (1.18)	0.387

The effect of a fault indication on the willingness to repair

We tested whether a fault indication positively increased consumers' willingness to repair a stick vacuum cleaner (H1a). A nonparametric test (Mann-Whitney) was conducted because the data was not normally distributed. We used the fault indication as independent variable and willingness to repair as the dependent variable in the analyses. The results showed a significant main effect on the 'willingness to repair' a stick vacuum cleaner when a fault indication was present (Mdn_{absent}=4.67 vs. $Mdn_{present}$=5.67; U=798.00, p<0.05), which provides further supporting evidence for H1a.

The mediating effect of self-efficacy on the willingness to repair

The assumptions for parametric tests were met for the level of self-efficacy of the stick vacuum cleaner. The results of the ANOVA showed that the level of self-efficacy was perceived significantly higher when the fault indication was present (M_{absent}=3.36 vs. $M_{present}$=4.67; $F(1,70)=6.68$, $p<0.05$). We performed a mediation analysis using model 4 of the PROCESS macro for SPSS (Hayes, 2013) to check if self-efficacy mediated the relationship between the presence of a fault indication and willingness to repair. Analysing the indirect effects, results revealed that self-efficacy mediated the relationship between the fault indication and the willingness to repair (b=0.55; SE=0.27; 95% CI:[0.11, 1.18]), providing further support for H2. The fault indication positively influenced the level of self-efficacy (b=1.01; SE=0.39; 95% CI:[0.23, 1.78]); $p<0.05$) and self-efficacy, in turn, positively influenced the willingness to repair (b=0.55; SE=0.12; CI:[0.29, 0.80]; $p<0.001$).

4. General Discussion and Implications for Design

The results of study 1 demonstrated that consumers seem to be quite willing to repair their products, see table 1. These are promising results for the circular economy. However, the results also showed that a fault indication significantly increased the willingness to repair a vacuum cleaner, but this is not true for a washing machine. A fault indication will only positively influence consumers' willingness to repair if it is employed on a product that is unlikely to be professionally repaired. Additionally, the mediating effect of self-efficacy showed that fault indications can make consumers feel more competent and knowledgeable to select relevant repair actions. Thereby, self-efficacy is positively influencing the willingness to repair a product. The results of study 2 further demonstrated that for product categories for which consumers are unlikely to go to repair professionals, a failure indication can increase consumers' willingness to repair, also for a variety of failures. Summarizing, we conclude that fault indications are successful in increasing self-efficacy for repair for products that are less likely to be repaired professionally. Therefore, they are useful nudges to encourage consumers to repair these types of products.

Our results showed the importance of design interventions in stimulating more sustainable behaviour. By addressing the consumer perspective, our insights go beyond the engineering perspective adopted in prior research on design for repair. Our results confirm earlier insights that products being physically repairable does not help when consumers are not ready to repair (Makov and Fitzpatrick, 2021). Additionally, we contribute to existing literature by showing that design for repair is also about guiding consumers in their experience towards repair. Support in diagnosing the failure turns an incomprehensible experience of product failure into a more comprehensible one. This gives consumers more control over the situation and therefore a more positive experience. To do so, designers should not only focus on making products more physically repairable, but also on implementing design interventions increasing consumers' repair ability. Our results confirm

this by showing the positive effect of including cues for fault diagnosis on consumer's willingness to repair.

Regarding the expected strength of the effect (Kang, 2021), our research was a successful first attempt to prove this effect. Even though we took diversity of age and gender into account when selecting our sample, we cannot claim that our sample was representative for the vacuum cleaner and washing machine population. Furthermore, we realize that people's responses to hypothetical scenarios may differ from real-life repair intentions. Future research should aim to explore the effects of fault indications in real-life settings using actual product failures and fault indications.

In this paper, we used a fault indication as a design intervention increasing repair ability. However, this does not mean that this is the only design interventions that can trigger this. When designing for repair, it is worthwhile to explore other design interventions that can positively people's self-efficacy. For instance, a step-by step guide for executing repair activities or movies in which repair steps are explained, may have the same positive effect. Future empirical studies could explore what other design interventions could increase self-efficacy and thereby encourage consumers to repair. Furthermore, when aiming to stimulate repair for a wider range of products, it may be interesting to explore if other design interventions can stimulate repair of products. For instance, modular design is an example of a design intervention that makes products easily disassembled for repair activities. As consumers often do not believe products are made to be repaired (Wieser et al., 2015), the perception of a design being modular and may increase consumers' willingness to repair as well. However, the effect of modular design on consumer behaviour is still underexplored (Schischke et al., 2019). Finally, regarding the current lack of available and affordable repair support (Jaeger-Erben et al., 2021) it would be advised to go beyond particular design interventions on a product level. By taking a more system level perspective, research can look beyond the product design and investigate what support on a service, business model or policy level could encourage consumers' repair behaviours. For instance, it may be interesting to explore what specific service design aspects (e.g., pickup service) or business models (e.g., extended warrantees) can increase consumers' willingness to repair, and consequently, encourage repair activities. Also, these outcomes are interesting for policy makers to develop regulations that support consumers in adopting more sustainable behaviour.

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Appendix A – Scales and items

Measure	Items	Scale	Source	Cronbach's α Study 1	Cronbach's α Study 2
Manipulation check fault indication	The fault was clear to me	1= Strongly agree 7= Strongly disagree	N.a.	0.89	0.96
	I would be able to identify the type of failure				
	I have had enough information to know the type of failure				
Willingness to repair	How likely are you to have this product repaired?	1= not at all 7= very much	White et al (2011)	0.95	0.96
	How inclined are you to have this product repaired?				
	How willing are you to have this product repaired?				
Self-Efficacy	I feel competent enough to select the best repair actions needed for this product	1= Strongly agree 7= Strongly disagree	(Fuchs et al 2010)	0.85	0.77
	I feel that I have the relevant knowledge and expertise to make sound evaluations about the repair actions needed for this product				
	I had difficulties evaluating the repair actions needed for this product(r)				
Level of repair knowledge	When it comes to repairing products, you are…	1 = Not at all knowledgeable 7 = Highly knowledgeable	(Lakshmanan and Shanker Krishnan, 2011)	0.85	0.86
	When it comes to repairing products, you are …	1 = A complete beginner 7 = An expert			
	When it comes to repairing products, you …	1 = Know much less than most people 7 = know much more than most people			
Level of environmental concern	I am very concerned about the environment	1= Strongly agree 7= Strongly disagree	(Kilbourne and Pickett, 2008)	0.91	0.91
	Humans are severely abusing the environment				
	I would be willing to reduce my consumption to help protect the environment				
	Major political change is necessary to protect the natural environment				
	Major political change is necessary to protect the natural environment				
	Anti-pollution laws should be enforced more strongly				
Level of technological innovativeness	Other people come to you for advice on new technologies	1= Strongly agree 7= Strongly disagree	(Parasuraman, 2000)	0.90	0.87
	It seems your friends are learning more about the newest technologies than you are. (r)				
	In general, you are among the first in your circle of friends to acquire new technology when it appears.				
	You can usually figure out new high-tech products and services without help from others.				
	You keep up with the latest technological developments in your areas of interest.				
	You enjoy the challenge of figuring out high-tech gadgets.				
	You find you have fewer problems than other people in making technology work for you.				

Appendix E: Product Lifecycle & Product Replacement reasons

PROMPT

(**PR**emature **O**bsolescence **M**ulti-Stakeholder **P**roduct **T**esting Programme)

Product Lifecycle & Product Replacement reasons
Washing machines, Smartphones, TV's and Vacuum cleaners

- Online surveys-

AP-2021-PR19
EC Funded Project

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01 May 2021

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EXECUTIVE SUMMARY

Owners of four categories of products (WASHING MACHINES, SMARTPHONES, TV's and VACUUM CLEANERS) answered questions about **their expectations at the moment of buying/getting these products, their reasons for replacing their previous appliances and the lifecycle of their previous appliances.**

Expected use of an appliance

47% of respondents (BEL 56% FRA 43% ITA 43% POR 54% SPA 45%) expect to use their washing machine for more than 10 years.

45% of respondents (BEL 47% FRA 46% ITA 46% POR 42% SPA 43%) expect to use their smartphone for 4-5 years (from the moment of buying/getting it).

38% of respondents (BEL 41% FRA 44% ITA 35% POR 26% SPA 34%) expect to use their TV for 8-10 years (from the moment of buying/getting it).

40% of respondents (BEL 38% FRA 38% ITA 44% POR 41% SPA 37%) expect to use their vacuum cleaner for more than 10 years (from the moment of buying/getting it).

Expected minimum lifecycle of an appliance

43% of respondents (BEL 57% FRA 34% ITA 35% POR 59% SPA 41%) expect their washing machine to last (functioning) for more than 10 years.

42% of respondents (BEL 43% FRA 41% ITA 43% POR 41% SPA 42%) expect their smartphone to last (functioning) for 4-5 years (from the moment of buying/getting it).

41% of respondents (BEL 41% FRA 36% ITA 36% POR 55% SPA 47%) expect their TV to last (functioning) for more than 10 years (from the moment of buying/getting it).

43% of respondents (BEL 42% FRA 45% ITA 43% POR 47% SPA 37%) expect their vacuum cleaner to last (functioning) for more than 10 years (from the moment of buying/getting it).

Comparison between expected use and minimum lifecycle

Most people don't make a difference between their expected duration length to keep the appliance and their minimum expected lifecycle of the appliance.

20% of respondents (BEL 11% FRA 34% ITA 23% POR 4% SPA 15%) expect to keep using their washing machine longer than its expected minimum lifecycle.

30% of respondents (BEL 31% FRA 32% ITA 26% POR 39% SPA 29%) expect to keep using their smartphone shorter than its expected minimum lifecycle.

20% of respondents (BEL 21% FRA 19% ITA 20% POR 25% SPA 20%) expect to keep using their TV shorter than its expected minimum lifecycle.

8% of respondents (BEL 10% FRA 5% ITA 12% POR 3% SPA 10%) expect to keep using their vacuum cleaner longer than its expected minimum lifecycle.

Brand comparison of expected use and minimum lifecycle

79% of Miele owners (19% of Haier owners) expect to keep using their washing machine for more than 10 years. 75% of Miele owners (19% of Haier owners) expect their washing machine to have a minimum lifecycle of more than 10 years.

39% of Doro owners (14% of Google owners) expect to keep using their smartphone for more than 5 years. 52% of Doro owners (23% of both Honor and Xiaomi owners) expect their smartphone to have a minimum lifecycle of more than 5 years.

47% of Loewe owners (23% of Haier owners) expect to keep using their TV for more than 10 years.

60% of Loewe owners (28% of Haier owners) expect their TV to have a minimum lifecycle of more than 10 years.

76% of Kirby owners (15% of Domo owners) expect to keep using their vacuum cleaner for more than 10 years. 81% of Kirby owners (19% of Ariete owners) expect their vacuum cleaner to have a minimum lifecycle of more than 10 years.

Reasons for replacing an appliance

6 or 7 main reasons for replacing the appliance could be indicated: completely out of use, not working well anymore (and didn't want to repair it), repair costs too high, no spare parts available anymore, out of date (but still functioning well), because of my misuse (just for smartphones and TV's) and another reason (gift, moving, family needs, …).

The first four reasons have been considered as **reliability-related reasons for replacing the previous appliances**.

3 previously owned **Washing machines** out of 4 (BEL 73% FRA 75% ITA 76% POR 73% SPA 75%) were replaced because of reliability-related reasons.

36% of previously owned **Smartphones** (BEL 30% FRA 37% ITA 37% POR 33% SPA 37%) were replaced because of reliability-related reasons.

34% of previously owned **TV's** (BEL 32% FRA 37% ITA 29% POR 41% SPA 27%) were replaced because of reliability-related reasons.

64 % of **Vacuum cleaners** (BEL 66% FRA 65% ITA 57% POR 69% SPA 65%) were replaced because of reliability-related reasons.

Brand comparison of average real lifecycles

In **washing machines**, Miele stands alone with the highest average age.

In **smartphones**, Blackberry, Nokia, Apple and HTC are the brands with the highest average age.

In **tv's**, Thomson, Grundig, Sony and Philips are the brands with the highest average age.

In **vacuum cleaners**, Vorwerk, Panasonic, Nilfisk, Miele and Kirby are the brands with the highest average age.

Difference between expected minimum lifecycle and real lifecycle

Differences between the expected minimum lifecycle duration of the current device and the real lifecycle duration of the previous device (only considering reliability-related reasons for being replaced) are analysed.

In this analysis, only brands having enough cases in both categories (current and previous appliance) are considered. Results of this analysis should however not be understood as an intrinsic quality of the devices. They only indicate the (positive) difference between what people expect to be the minimum lifecycle, and what they experienced to be the real lifecycle.

In **washing machines**, most brands had a higher proportion of 'more than 10 years' real lifecycle than the proportion of people who expected the minimum lifecycle of their washing machine to be 'more than 10 years'.
In **smartphones**, most brands had a higher proportion of 'more than 5 years' real lifecycle than the proportion of people who expected the minimum lifecycle of their smartphone to be 'more than 5 years'.
In **tv's**, only Thomson performed better than the expectations.
In **vacuum cleaners,** only Nilfisk, Tornado, Panasonic and Miele performed better than the expectations.

1. METHODOLOGY

1.1 Washing machines (Large Household appliances survey)

The survey covers five countries: Belgium, France, Italy, Portugal and Spain.
Sampling was done randomly among members of different consumer organizations in the selected countries; data were collected through online questionnaires addressed to product magazine subscribers (Test Achats, UFC-Que Choisir, Altroconsumo, Deco-ProTeste, OCU) during **April 2019**. Respondents assessed their products by answering a unique link sent to their email addresses. The overview below summarizes the number of valid answers collected for this survey.

Belgium	7687
France	9932
Italy	11584
Portugal	5661
Spain	6868

The survey focused on following dimensions**:**

FORESEEN DURATION OF USE & EXPECTED MINIMUM LIFECYCLE OF CURRENT APPLIANCES
In this section, people reported how long they expected to keep using their current appliance at the moment of buying, and how long they expected to be its minimum lifecycle.

REAL LIFECYCLE OF PREVIOUS APPLIANCES
In this section, people reported for how long they kept their previous appliance, and what was the reason for replacing it. Average lifecycle durations by brand have been compared through One Way ANOVA.

By analyzing the differences between the expected minimum lifecycle and the real lifecycle (reliability-related reasons for being replaced), the report summarizes whether consumer expectations are met by the manufacturers.

1.2 Smartphones and TV's (Hi-Tech devices survey)

The survey covers five countries: Belgium, France, Italy, Portugal and Spain.
Sampling was done randomly among members of different consumer organizations in the selected countries; data were collected through online questionnaires addressed to product magazine subscribers (Test Achats, UFC-Que Choisir, Altroconsumo, Deco-ProTeste, OCU) during **November 2019**. Respondents assessed their products by answering a unique link sent to their email addresses. The overview below summarizes the number of valid answers collected for this survey.

Belgium	6204
France	10595
Italy	10395
Portugal	3612
Spain	6344

The survey focused on the following dimensions**:**

FORESEEN DURATION OF USE & EXPECTED MINIMUM LIFECYCLE OF CURRENT DEVICES
In this section, people reported how long they expected to keep using their current device at the moment of buying, and how long they expected to be its minimum lifecycle.

REAL LIFECYCLE OF PREVIOUS DEVICES
In this section, people reported for how long they kept their previous device, and what was the reason for replacing it. Average lifecycle durations by brand have been compared through One Way ANOVA.

By analyzing the differences between the expected minimum lifecycle and the real lifecycle (reliability-related reasons for being replaced), the report summarizes whether consumer expectations are met by the manufacturers.

1.3 Vacuum cleaners (Small Household appliances survey)

The survey covers five countries: Belgium, France, Italy, Portugal and Spain.
Sampling was done randomly among members of different consumer organizations in the selected countries; data were collected through online questionnaires addressed to product magazine subscribers (Test Achats, UFC-Que Choisir, Altroconsumo, Deco-ProTeste, OCU) during **June 2019 and June 2020**. Respondents assessed their products by answering a unique link sent to their email addresses. The overview below summarizes the number of valid answers collected for this survey.

			country					Total
			Belgium	Italy	Portugal	Spain	France	
YEAR	2019	Count	5163	8851	4410	4141	10392	32957
		% within country	41,5%	45,0%	42,7%	40,9%	43,9%	43,2%
	2020	Count	7283	10813	5924	5988	13301	43309
		% within country	58,5%	55,0%	57,3%	59,1%	56,1%	56,8%
Total		Count	12446	19664	10334	10129	23693	76266

The survey focused on the following dimensions**:**

FORESEEN DURATION OF USE & EXPECTED MINIMUM LIFECYCLE OF CURRENT DEVICES
In this section, people reported how long they expected to keep using their current device at the moment of buying, and how long they expected to be its minimum lifecycle.

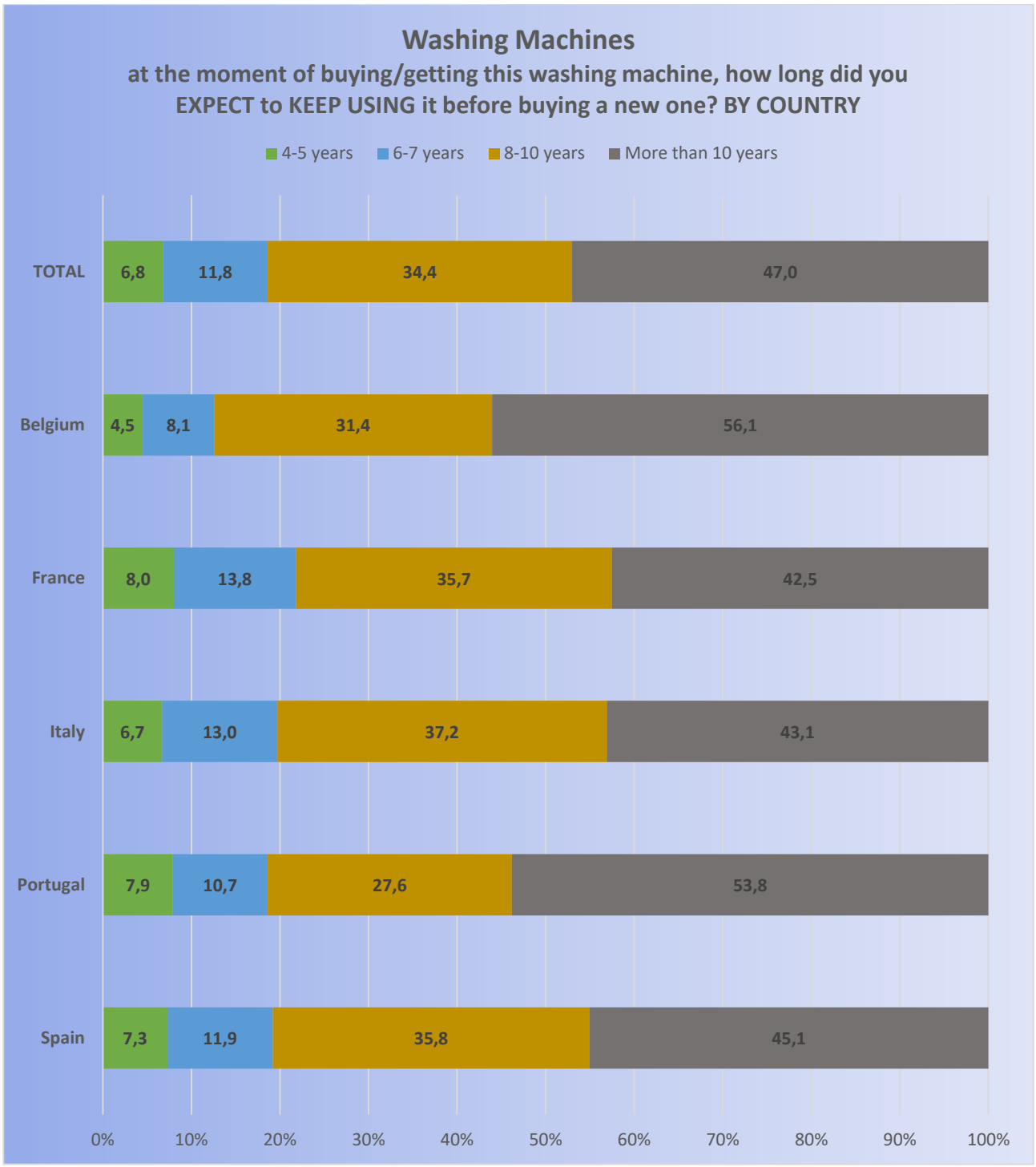
REAL LIFECYCLE OF PREVIOUS DEVICES
In this section, people reported for how long they kept their previous device, and what was the reason for replacing it. Average lifecycle durations by brand have been compared through One Way ANOVA.

By analysing the differences between the expected minimum lifecycle and the real lifecycle (reliability-related reasons for being replaced), the report summarizes whether consumer expectations are met by the manufacturers.

2. FORESEEN DURATION OF USE & EXPECTED MINIMUM LIFECYCLE OF CURRENT APPLIANCES

2.1 WASHING MACHINES

Chart 1.1



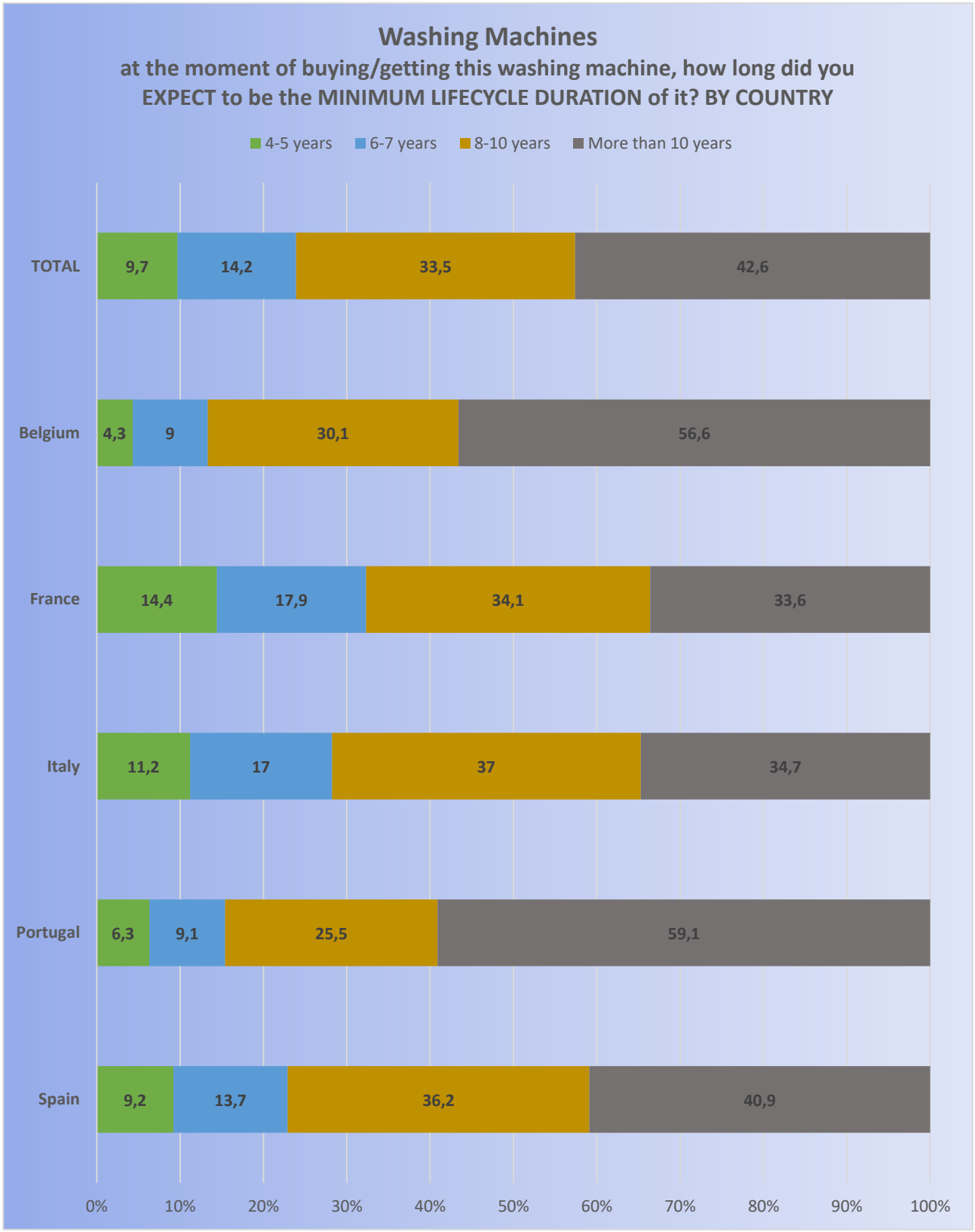
LHHA Appliances 2019

47% of respondents (BEL 56% FRA 43% ITA 43% POR 54% SPA 45%) expect to use their washing machine for more than 10 years (from the moment of buying/getting it).

Table 1.1 WASHING MACHINES –at the moment of buying/getting this washing machine, how long did you EXPECT to KEEP USING it before buying a new one? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	4-5y	Count	317	734	693	333	462	2539
		%	4,5%	8,0%	6,7%	7,9%	7,3%	6,8%
	6-7y	Count	576	1270	1337	453	755	4391
		%	8,1%	13,8%	13,0%	10,7%	11,9%	11,8%
	8-10y	Count	2230	3292	3822	1164	2281	12789
		%	31,4%	35,7%	37,2%	27,6%	35,8%	34,4%
	More than 10y	Count	3987	3918	4432	2270	2871	17478
		%	56,1%	42,5%	43,1%	53,8%	45,1%	47,0%
Total		*Count*	7110	9214	10284	4220	6369	37197

Chart 1.2



LHHA Appliances 2019

43% of respondents (BEL 57% FRA 34% ITA 35% POR 59% SPA 41%) expect their washing machine to last (functioning) for more than 10 years (from the moment of buying/getting it).

Table 1.2 WASHING MACHINES –at the moment of buying/getting this washing machine, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	4-5y	Count	302	1271	1147	285	565	3570
		%	4,3%	14,4%	11,2%	6,3%	9,2%	9,7%
	6-7y	Count	625	1576	1739	410	845	5195
		%	9,0%	17,9%	17,0%	9,1%	13,7%	14,2%
	8-10y	Count	2097	3003	3780	1154	2232	12266
		%	30,1%	34,1%	37,0%	25,5%	36,2%	33,5%
	More than 10y	Count	3942	2955	3540	2668	2516	15621
		%	56,6%	33,6%	34,7%	59,1%	40,9%	42,6%
Total		*Count*	6966	8805	10206	4517	6158	36652

Chart 1.3.1

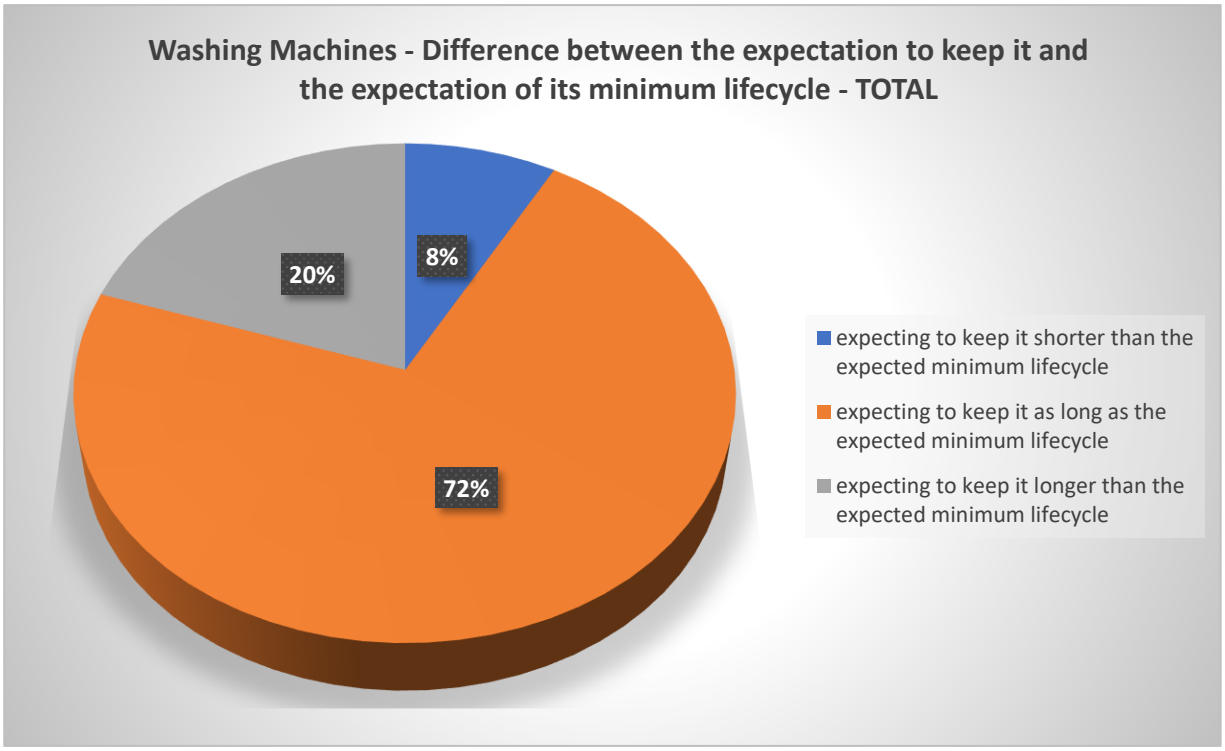


Chart 1.3.2

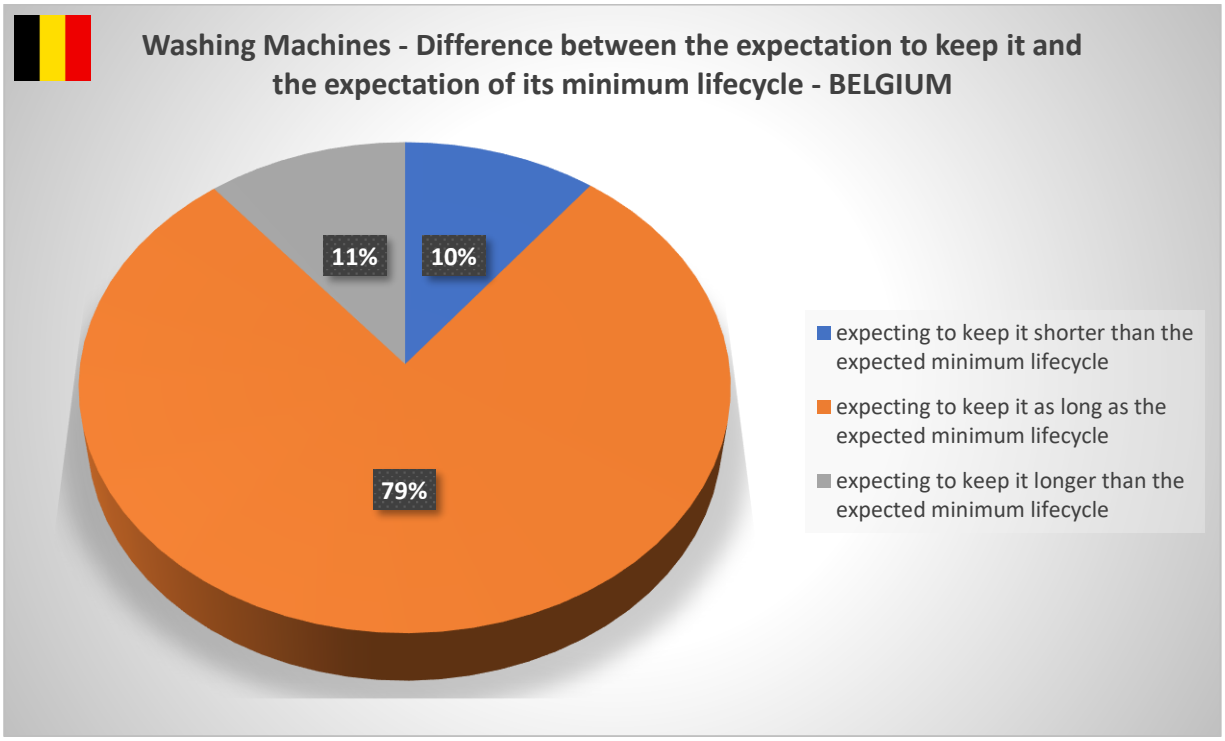


Chart 1.3.3

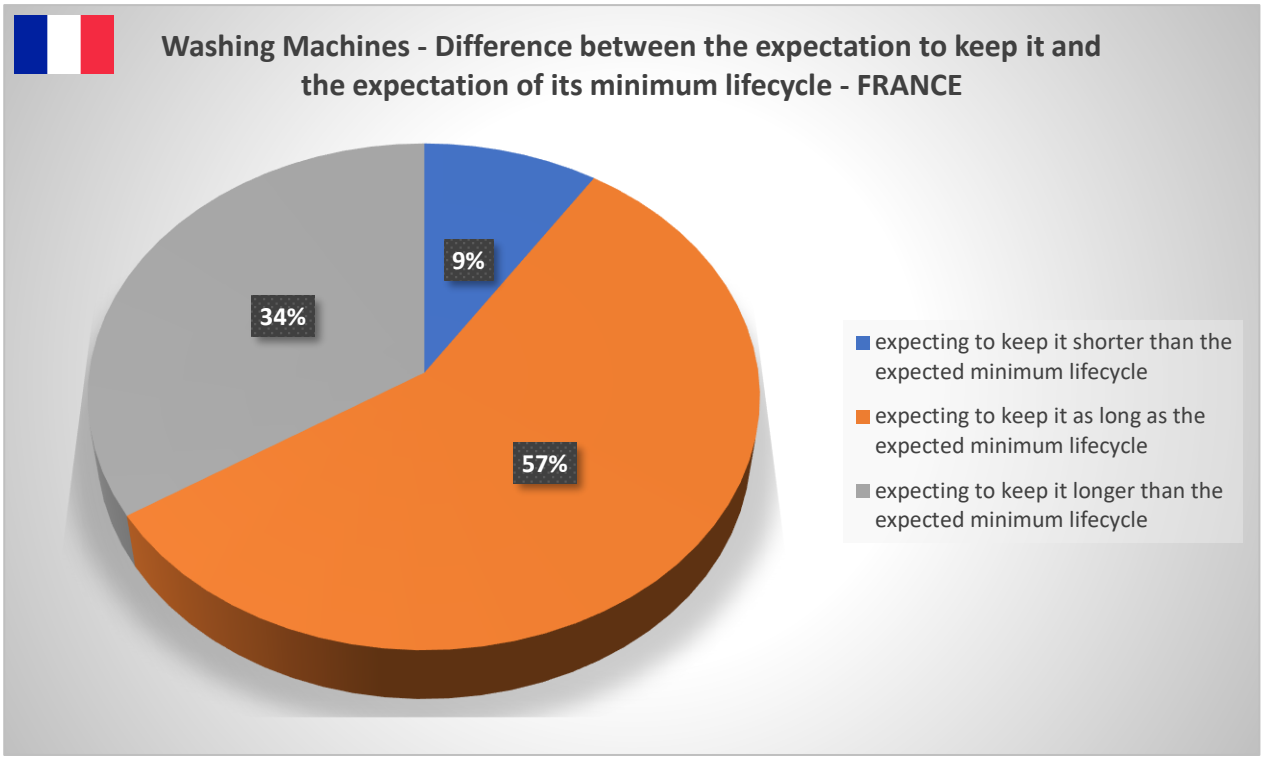


Chart 1.3.4

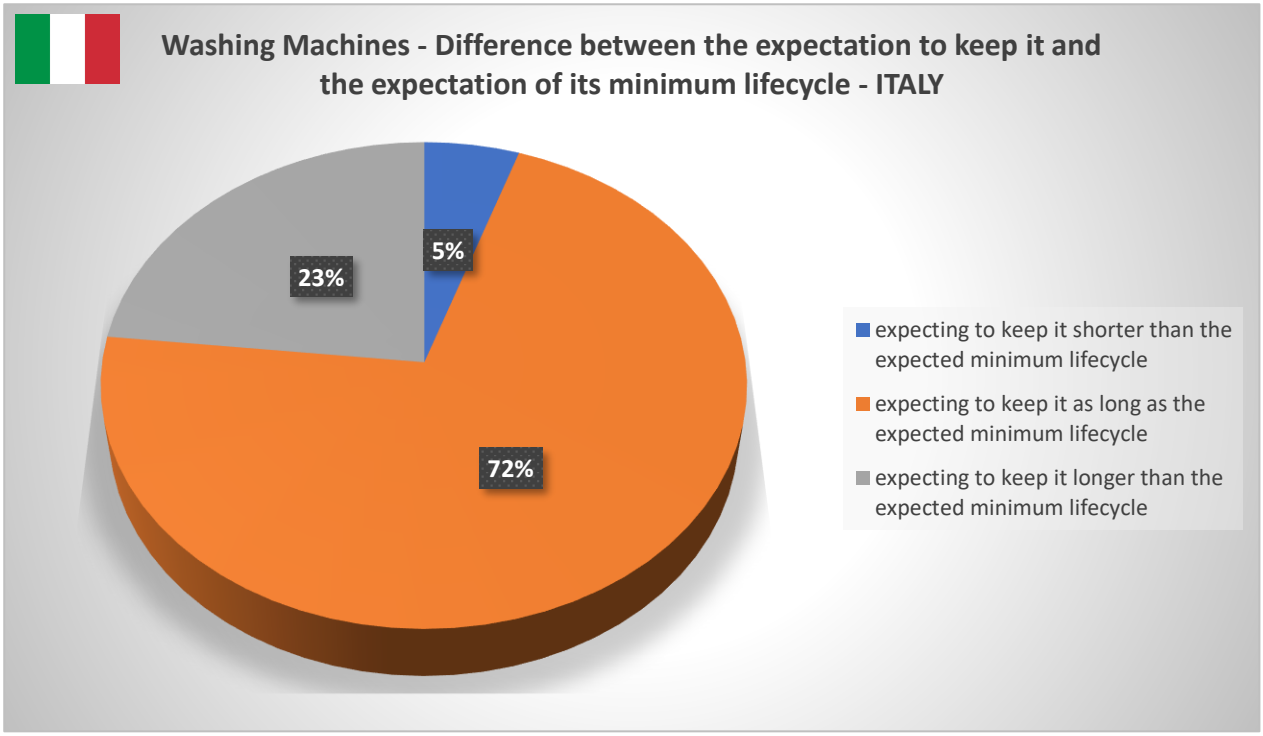


Chart 1.3.5

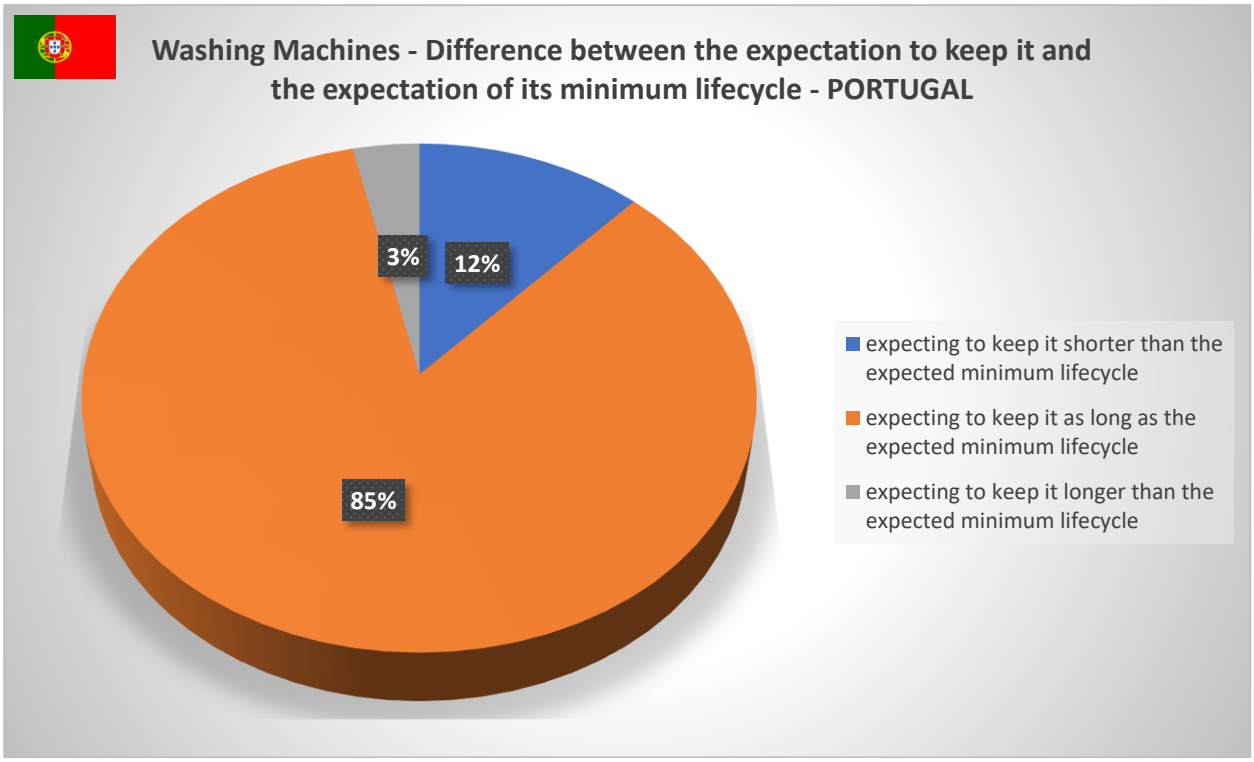
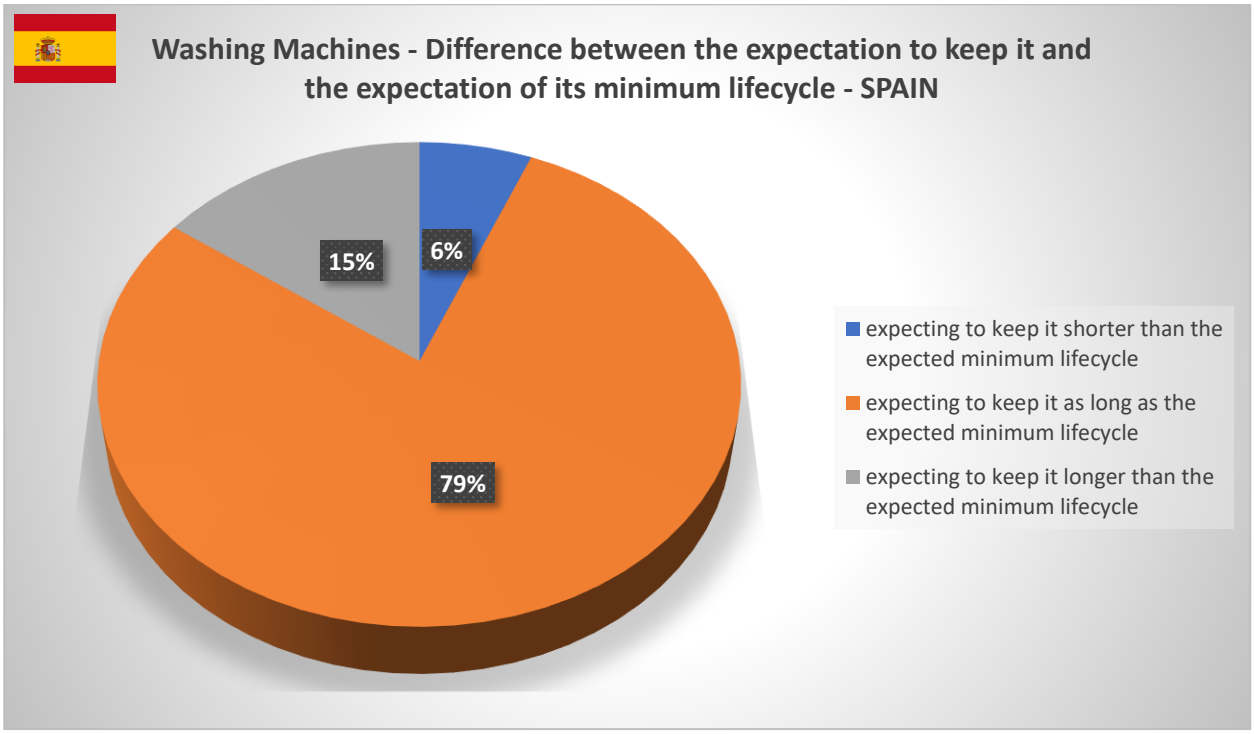


Chart 1.3.6

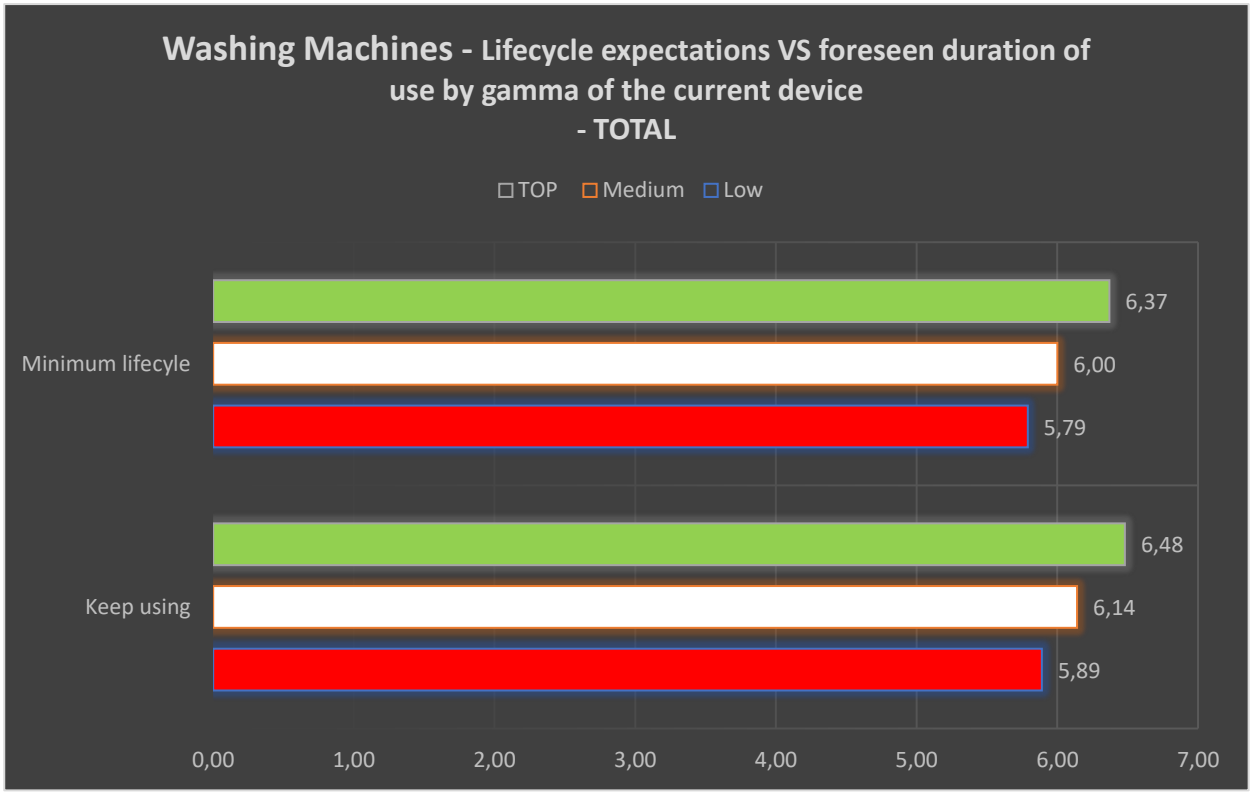


20% of respondents (BEL 11% FRA 34% ITA 23% POR 4% SPA 15%) expect to keep using their washing machine longer than its expected minimum lifecycle.

Table 1.3 WASHING MACHINES – Difference between the expectation to keep it and the expectation of its minimum lifecycle BY COUNTRY

		country					
		Belgium	France	Italy	Portugal	Spain	Total
expecting to keep it shorter than the expected minimum lifecycle	Count	714	786	508	458	370	2836
	% within country	10,5%	9,2%	5,2%	12,0%	6,2%	8,1%
expecting to keep it as long as the expected minimum lifecycle	Count	5341	4837	6984	3238	4707	25107
	% within country	78,6%	56,7%	71,5%	84,5%	78,8%	72,0%
expecting to keep it longer than the expected minimum lifecycle	Count	740	2907	2275	134	895	6951
	% within country	10,9%	34,1%	23,3%	3,5%	15,0%	19,9%
Total	Count	6795	8530	9767	3830	5972	34894
	% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 1.4



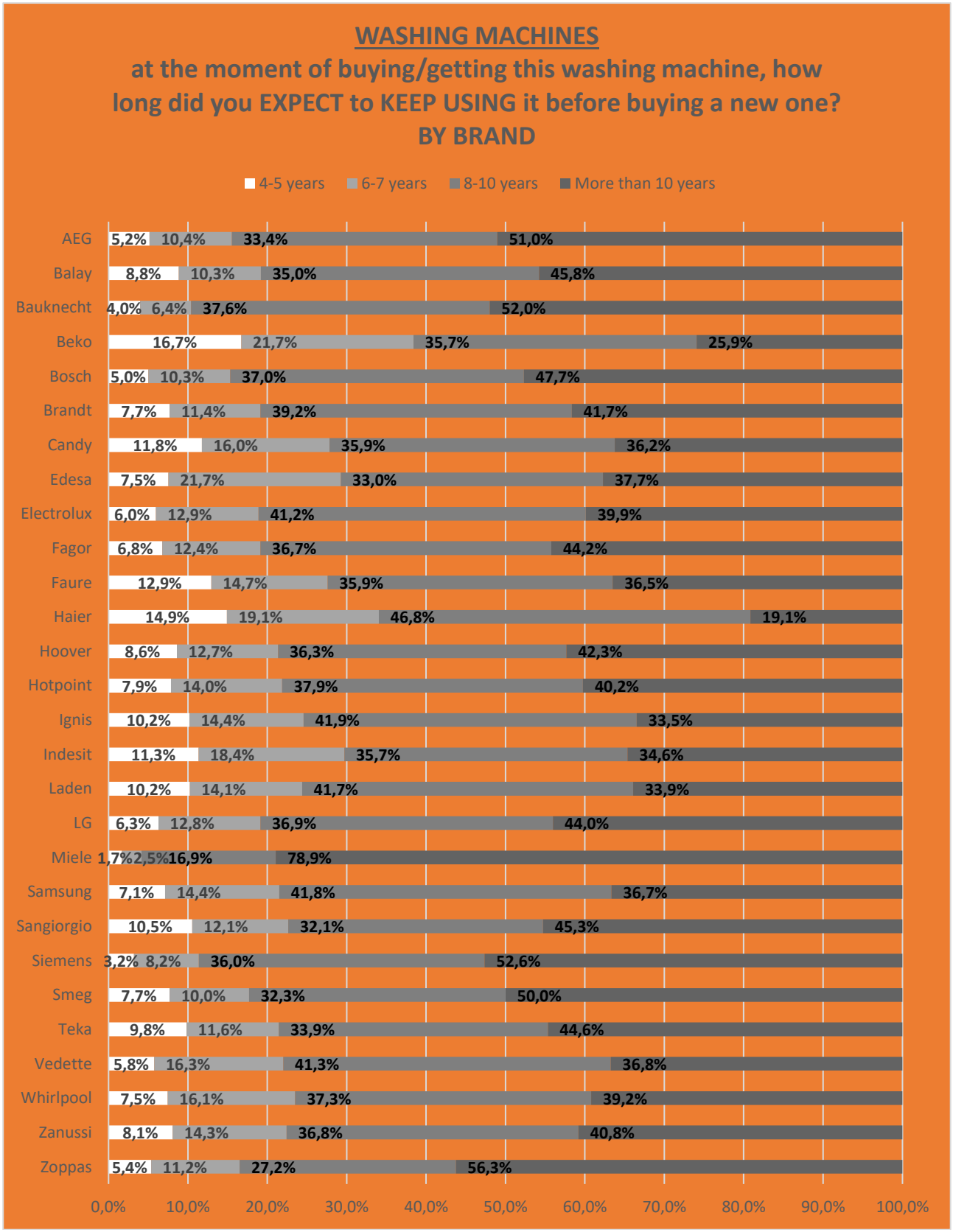
Top, medium and low levels of gamma are defined by respondents themselves when answering the questionnaire.

Table 1.4 WASHING MACHINES - Foreseen duration of use VS Lifecycle expectations by gamma

		Keep using (average)	Minimum lifecycle (average)
Total	Low	5,89	5,79
	Medium	6,14	6,00
	Top gamma	6,48	6,37

Tested through OneWay ANOVA; green significantly better, red significantly worse

Chart 1.5



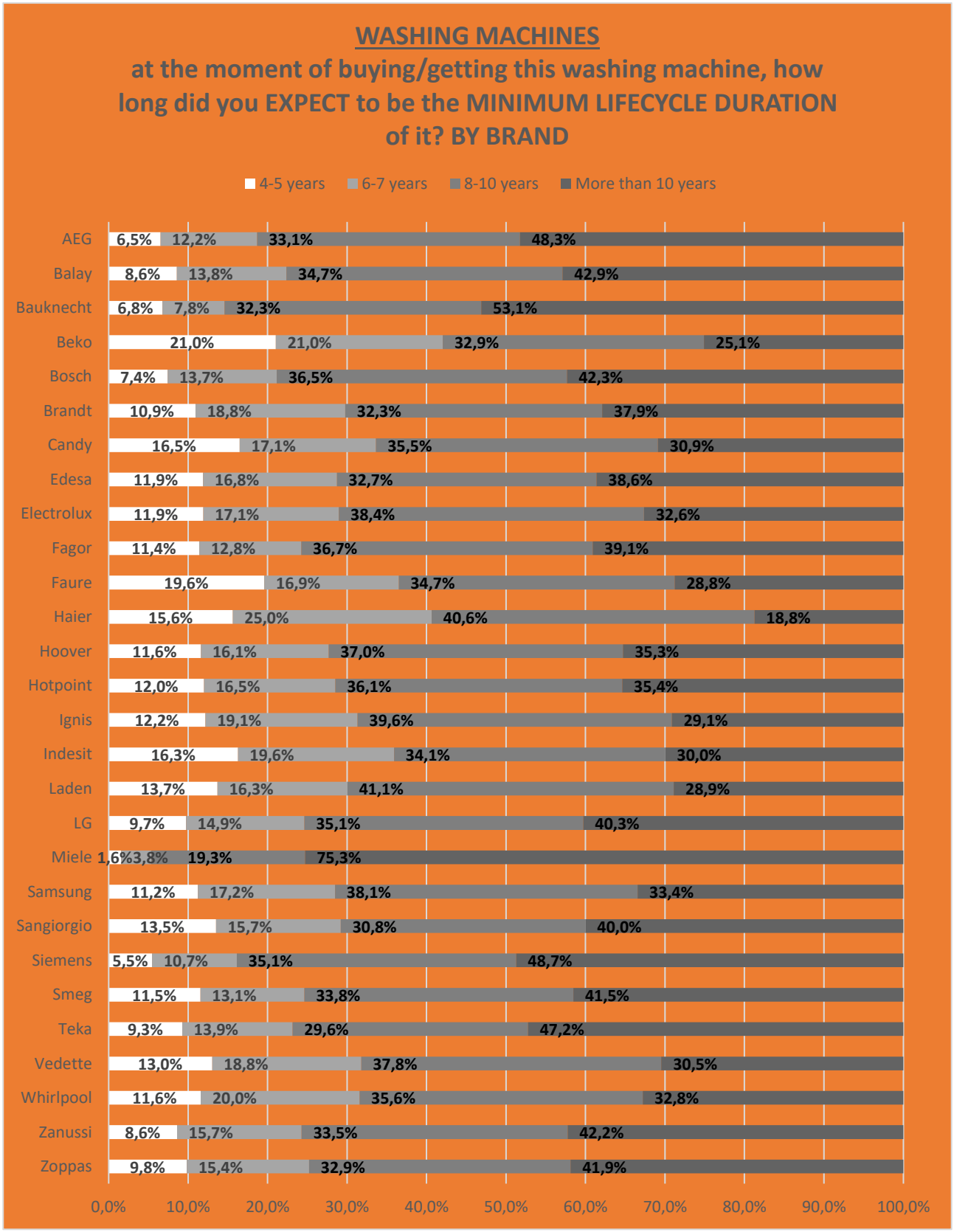
LHHA Appliances 2019

79% of Miele owners (19% of Haier owners) expect to keep using their washing machine for more than 10 years.

Table 1.5 WASHING MACHINES –at the moment of buying/getting this washing machine, how long did you EXPECT to KEEP USING it before buying a new one? BY BRAND

	N	4-5y	6-7y	8-10y	more than 10y
AEG	2596	5,2%	10,4%	33,4%	51,0%
Balay	939	8,8%	10,3%	35,0%	45,8%
Bauknecht	202	4,0%	6,4%	37,6%	52,0%
Beko	802	16,7%	21,7%	35,7%	25,9%
Bosch	5820	5,0%	10,3%	37,0%	47,7%
Brandt	533	7,7%	11,4%	39,2%	41,7%
Candy	1402	11,8%	16,0%	35,9%	36,2%
Edesa	106	7,5%	21,7%	33,0%	37,7%
Electrolux	2028	6,0%	12,9%	41,2%	39,9%
Fagor	502	6,8%	12,4%	36,7%	44,2%
Faure	348	12,9%	14,7%	35,9%	36,5%
Haier	141	14,9%	19,1%	46,8%	19,1%
Hoover	581	8,6%	12,7%	36,3%	42,3%
Hotpoint	979	7,9%	14,0%	37,9%	40,2%
Ignis	236	10,2%	14,4%	41,9%	33,5%
Indesit	1421	11,3%	18,4%	35,7%	34,6%
Laden	283	10,2%	14,1%	41,7%	33,9%
LG	2260	6,3%	12,8%	36,9%	44,0%
Miele	4231	1,7%	2,5%	16,9%	78,9%
Samsung	2575	7,1%	14,4%	41,8%	36,7%
Sangiorgio	190	10,5%	12,1%	32,1%	45,3%
Siemens	2434	3,2%	8,2%	36,0%	52,6%
Smeg	130	7,7%	10,0%	32,3%	50,0%
Teka	112	9,8%	11,6%	33,9%	44,6%
Vedette	400	5,8%	16,3%	41,3%	36,8%
Whirlpool	2629	7,5%	16,1%	37,3%	39,2%
Zanussi	669	8,1%	14,3%	36,8%	40,8%
Zoppas	224	5,4%	11,2%	27,2%	56,3%

Chart 1.6



LHHA Appliances 2019

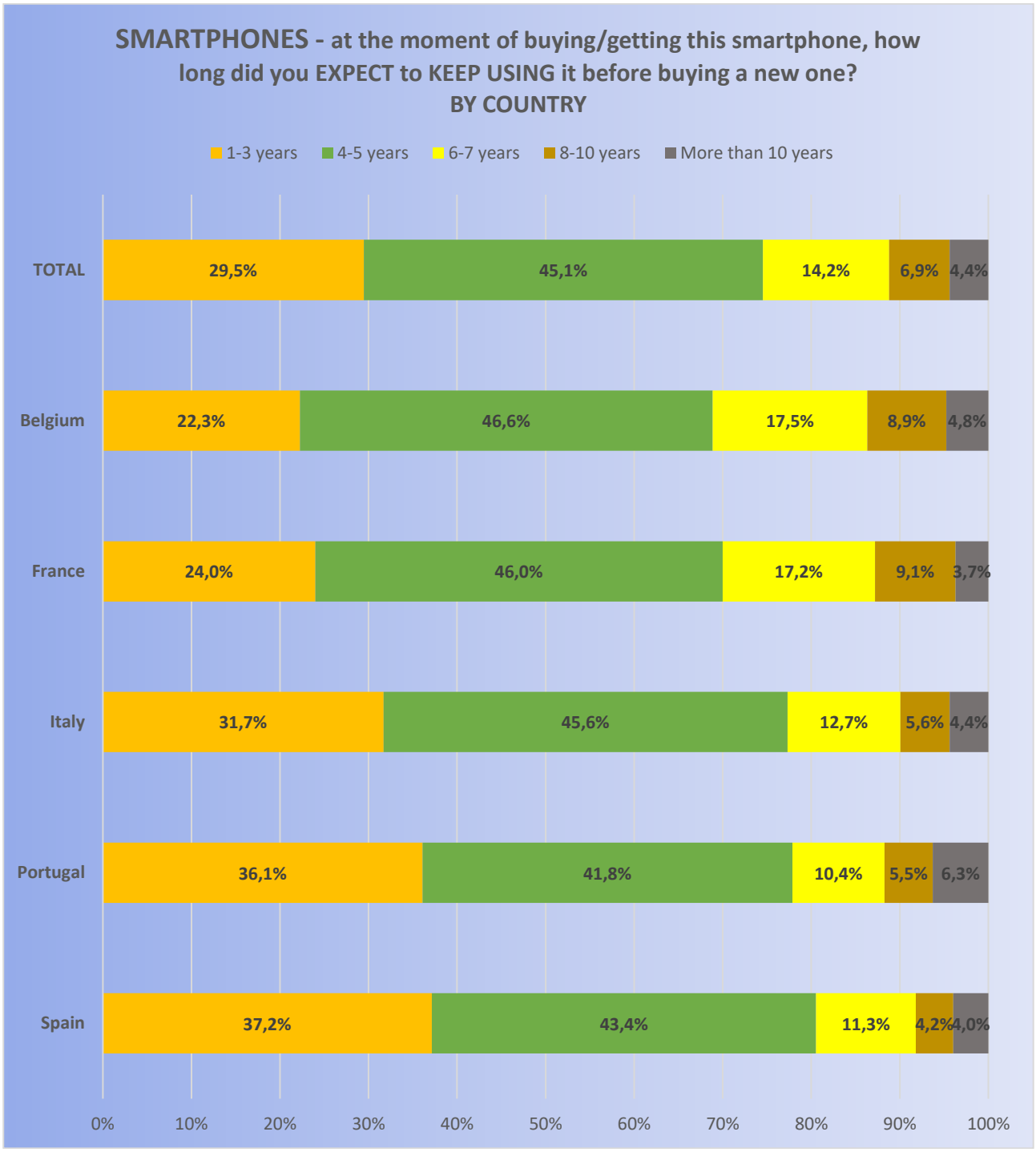
75% of Miele owners (19% of Haier owners) expect their washing machine to have a minimum lifecycle of more than 10 years.

Table 1.6 WASHING MACHINES –at the moment of buying/getting this washing machine, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY BRAND

	N	4-5y	6-7y	8-10y	more than 10y
AEG	2549	6,5%	12,2%	33,1%	48,3%
Balay	921	8,6%	13,8%	34,7%	42,9%
Bauknecht	192	6,8%	7,8%	32,3%	53,1%
Beko	785	21,0%	21,0%	32,9%	25,1%
Bosch	5753	7,4%	13,7%	36,5%	42,3%
Brandt	504	10,9%	18,8%	32,3%	37,9%
Candy	1389	16,5%	17,1%	35,5%	30,9%
Edesa	101	11,9%	16,8%	32,7%	38,6%
Electrolux	1992	11,9%	17,1%	38,4%	32,6%
Fagor	491	11,4%	12,8%	36,7%	39,1%
Faure	337	19,6%	16,9%	34,7%	28,8%
Haier	128	15,6%	25,0%	40,6%	18,8%
Hoover	578	11,6%	16,1%	37,0%	35,3%
Hotpoint	975	12,0%	16,5%	36,1%	35,4%
Ignis	230	12,2%	19,1%	39,6%	29,1%
Indesit	1401	16,3%	19,6%	34,1%	30,0%
Laden	263	13,7%	16,3%	41,1%	28,9%
LG	2242	9,7%	14,9%	35,1%	40,3%
Miele	4192	1,6%	3,8%	19,3%	75,3%
Samsung	2592	11,2%	17,2%	38,1%	33,4%
Sangiorgio	185	13,5%	15,7%	30,8%	40,0%
Siemens	2399	5,5%	10,7%	35,1%	48,7%
Smeg	130	11,5%	13,1%	33,8%	41,5%
Teka	108	9,3%	13,9%	29,6%	47,2%
Vedette	384	13,0%	18,8%	37,8%	30,5%
Whirlpool	2598	11,6%	20,0%	35,6%	32,8%
Zanussi	651	8,6%	15,7%	33,5%	42,2%
Zoppas	234	9,8%	15,4%	32,9%	41,9%

2.2 SMARTPHONES

Chart 2.1



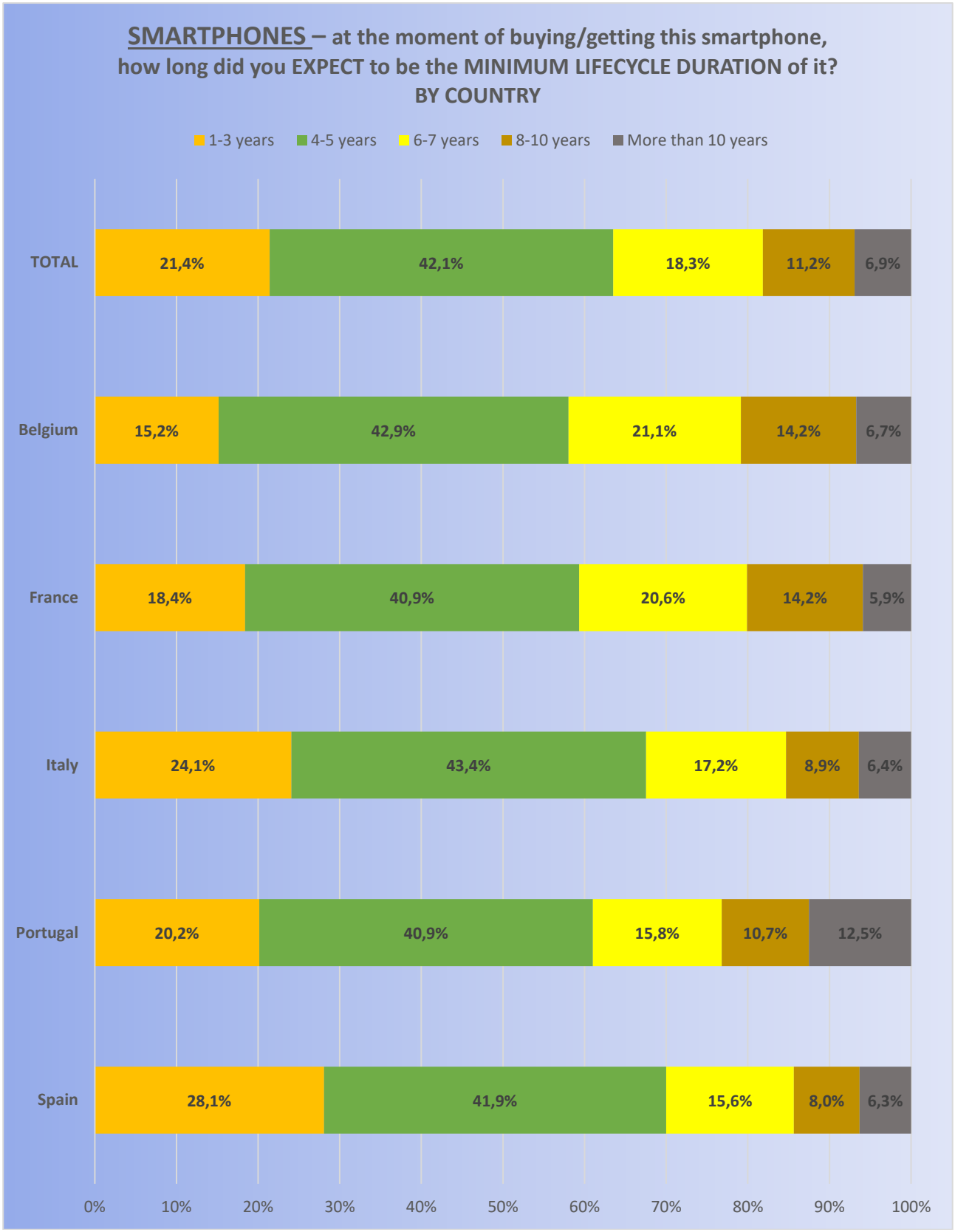
Hi-Tech Devices 2019

45% of respondents (BEL 47% FRA 46% ITA 46% POR 42% SPA 43%) expect to use their smartphone for 4-5 years (from the moment of buying/getting it).

Table 2.1 SMARTPHONES–at the moment of buying/getting this smartphone, how long did you EXPECT to KEEP USING it before buying a new one? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	1-3y	Count	1947	3939	5141	2154	3719	16900
		%	22,3%	24,0%	31,7%	36,1%	37,2%	29,5%
	4-5y	Count	4075	7554	7402	2492	4342	25865
		%	46,6%	46,0%	45,6%	41,8%	43,4%	45,1%
	6-7y	Count	1527	2825	2066	620	1126	8164
		%	17,5%	17,2%	12,7%	10,4%	11,3%	14,2%
	8-10y	Count	779	1495	906	326	424	3930
		%	8,9%	9,1%	5,6%	5,5%	4,2%	6,9%
	More than 10y	Count	416	608	707	374	396	2501
		%	4,8%	3,7%	4,4%	6,3%	4,0%	4,4%
Total		*Count*	8744	16421	16222	5966	10007	57360

Chart 2.2



Hi-Tech Devices 2019

42% of respondents (BEL 43% FRA 41% ITA 43% POR 41% SPA 42%) expect their smartphone to last (functioning) for 4-5 years (from the moment of buying/getting it).

Table 2.2 SMARTPHONES–at the moment of buying/getting this smartphone, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	1-3y	Count	1294	2934	3849	1180	2764	12021
		%	15,2%	18,4%	24,1%	20,2%	28,1%	21,4%
	4-5y	Count	3655	6520	6945	2392	4126	23638
		%	42,9%	40,9%	43,4%	40,9%	41,9%	42,1%
	6-7y	Count	1799	3278	2743	923	1539	10282
		%	21,1%	20,6%	17,2%	15,8%	15,6%	18,3%
	8-10y	Count	1207	2260	1427	626	792	6312
		%	14,2%	14,2%	8,9%	10,7%	8,0%	11,2%
	More than 10y	Count	572	940	1022	732	621	3887
		%	6,7%	5,9%	6,4%	12,5%	6,3%	6,9%
Total		*Count*	8527	15932	15986	5853	9842	56140

Chart 2.3.1

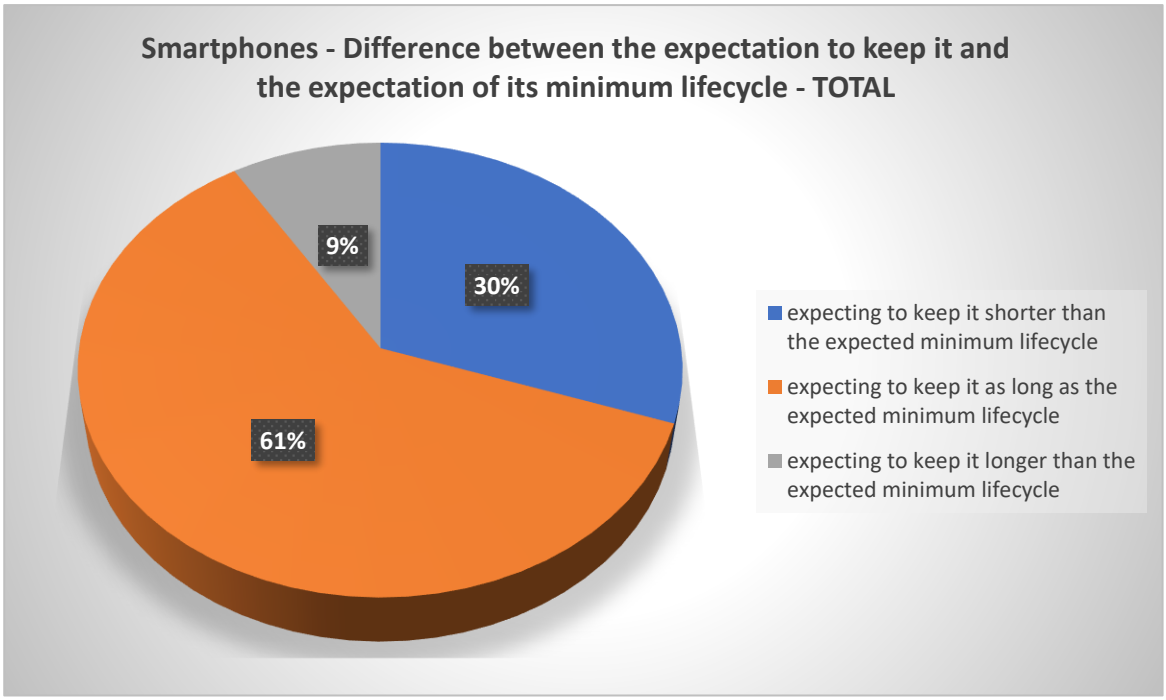


Chart 2.3.2

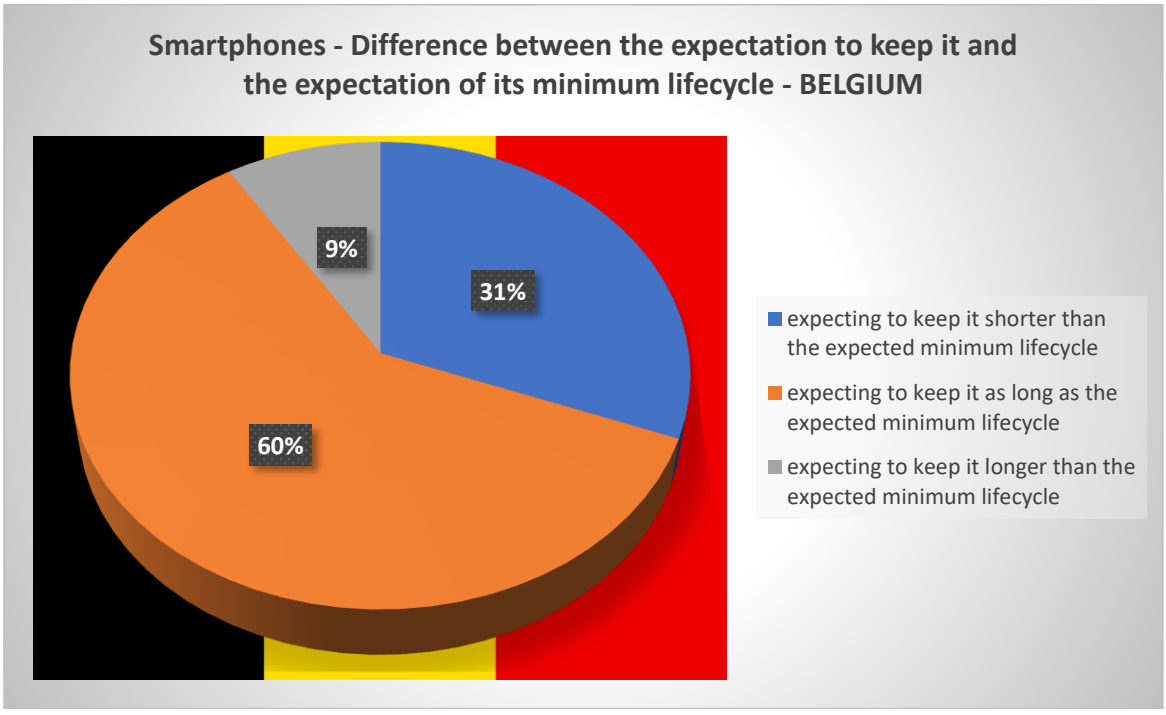


Chart 2.3.3

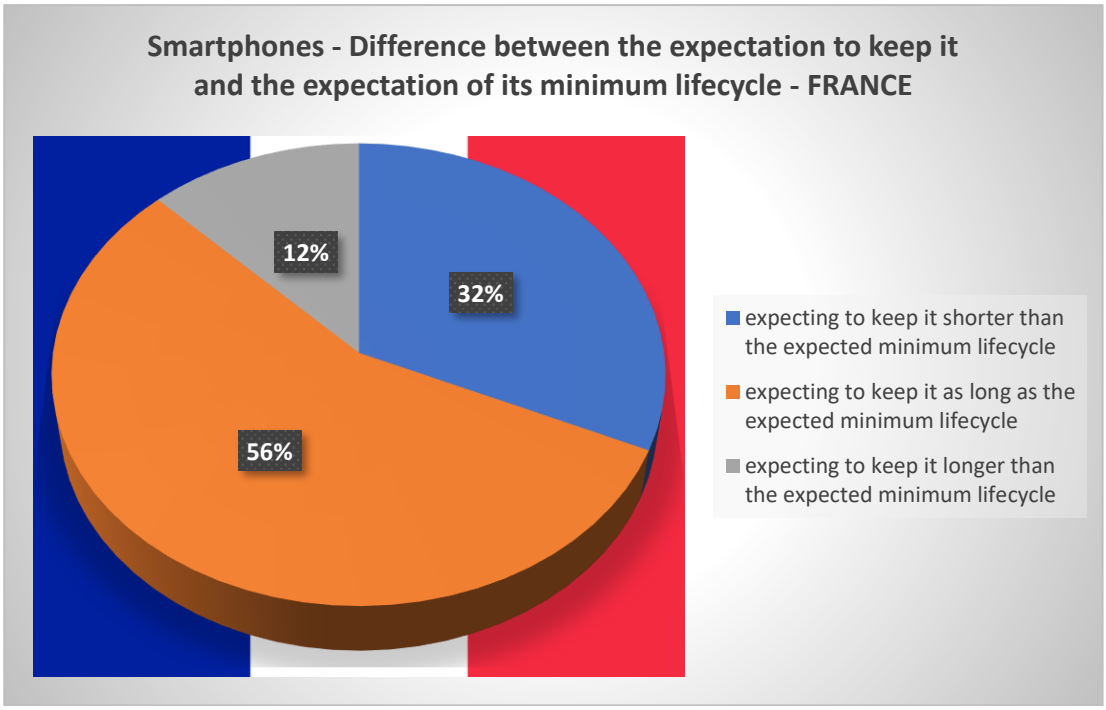


Chart 2.3.4

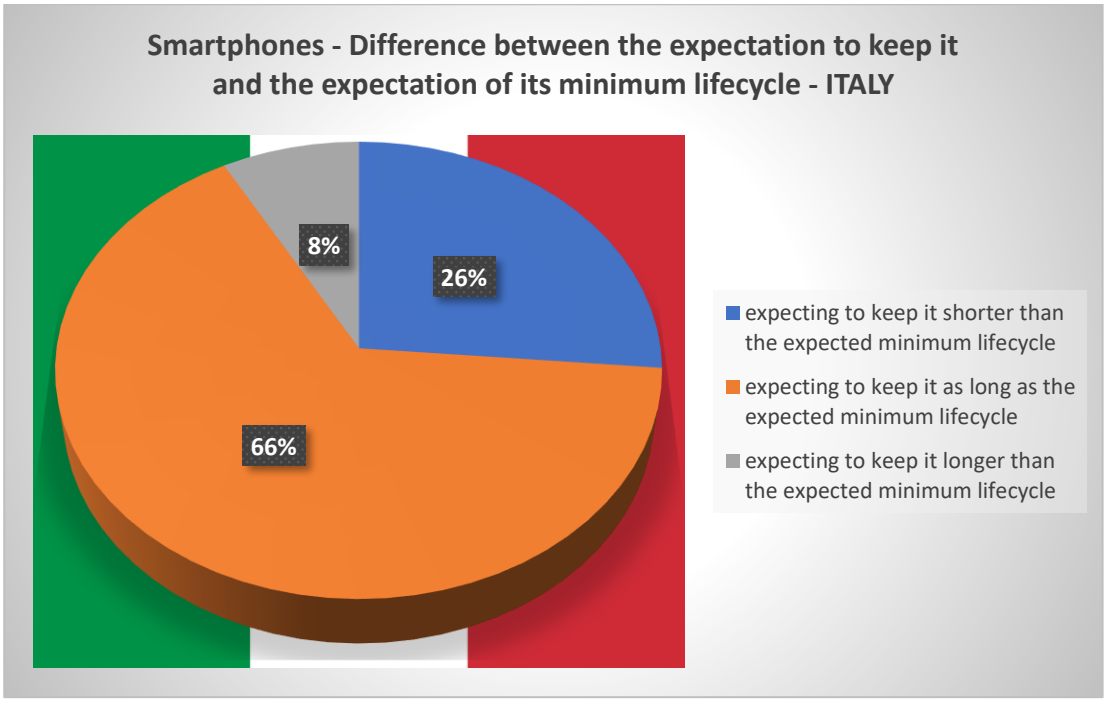


Chart 2.3.5

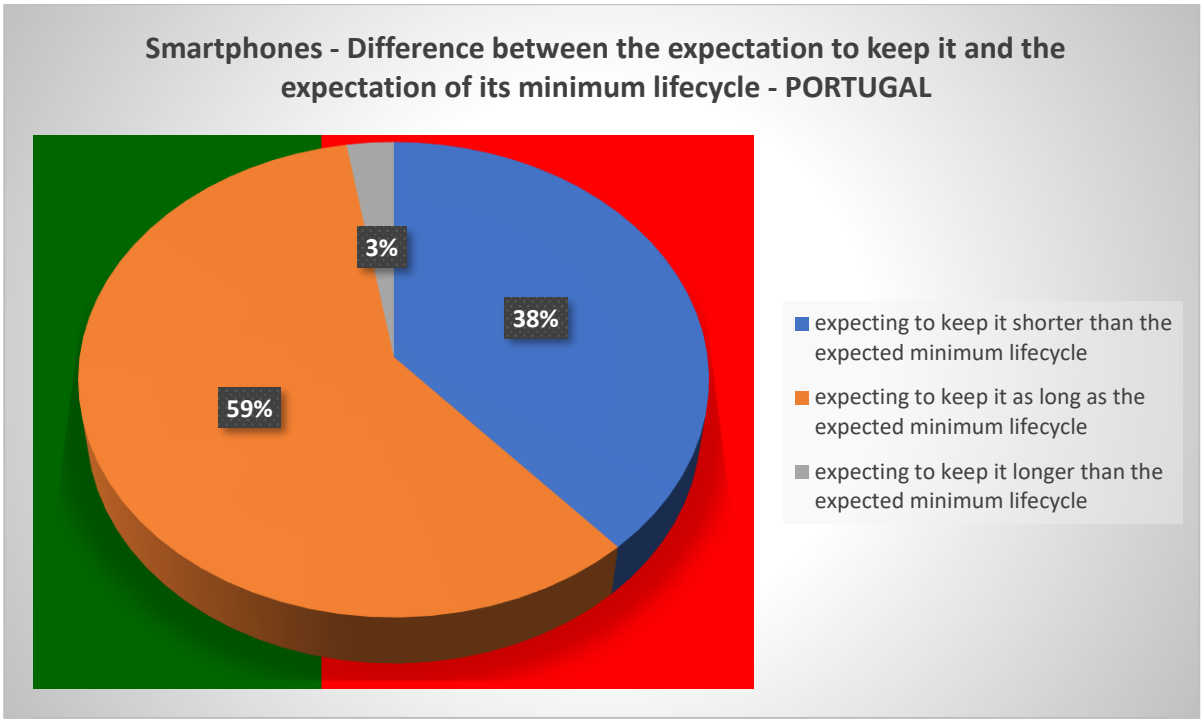
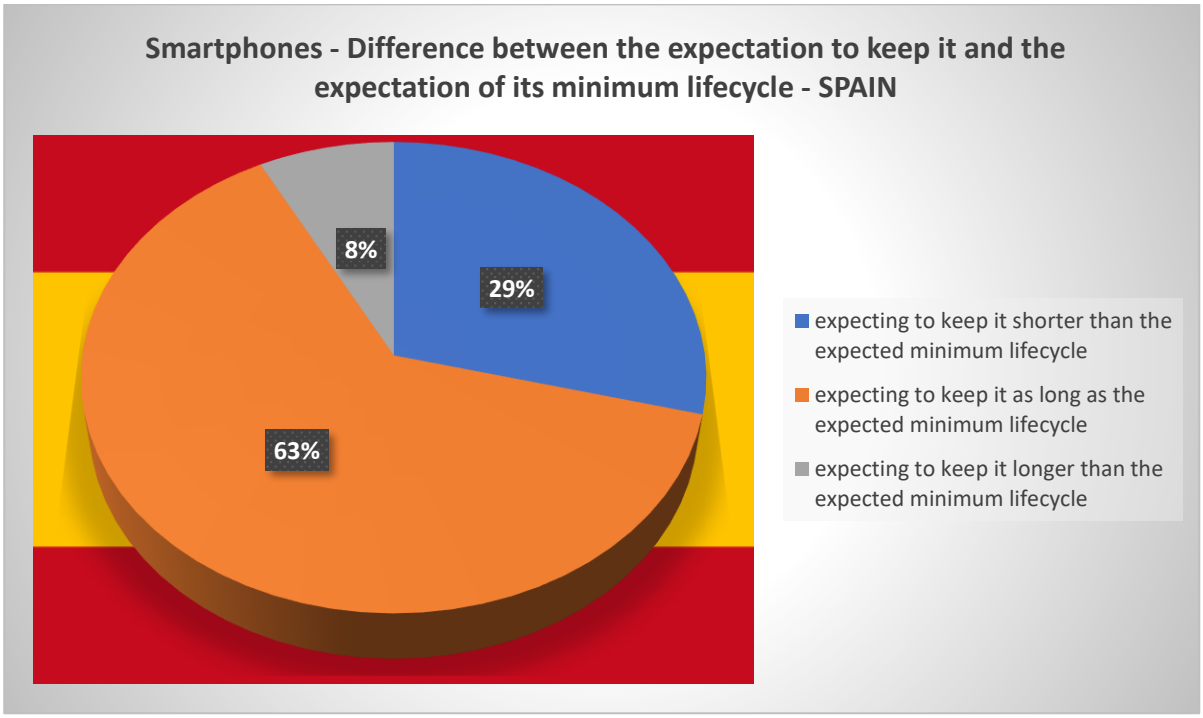


Chart 2.3.6

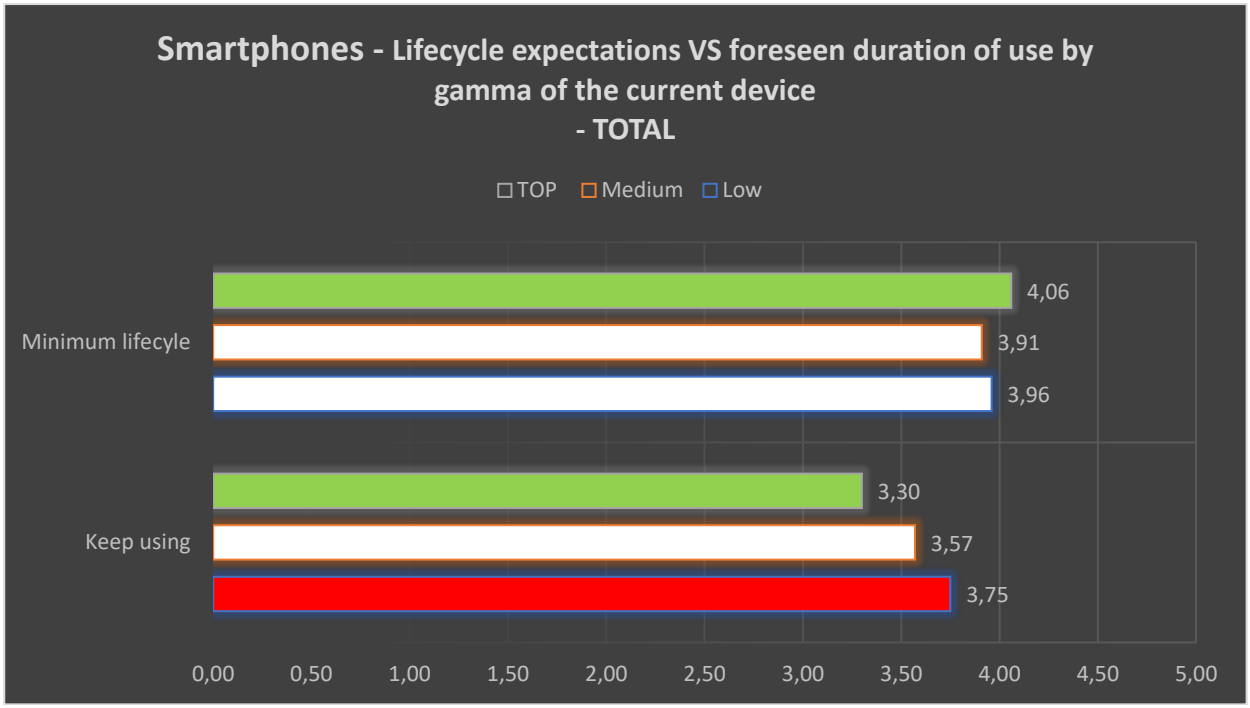


30% of respondents (BEL 31% FRA 32% ITA 26% POR 39% SPA 29%) expect to keep using their smartphone shorter than its expected minimum lifecycle.

Table 2.3 SMARTPHONES– Difference between the expectation to keep it and the expectation of its minimum lifecycle BY COUNTRY

		country					
		Belgium	France	Italy	Portugal	Spain	Total
expecting to keep it shorter than the expected minimum lifecycle	Count	2620	5037	4192	2184	2822	16855
	% within country	30,8%	31,7%	26,4%	38,5%	29,0%	30,3%
expecting to keep it as long as the expected minimum lifecycle	Count	5125	8886	10429	3342	6170	33952
	% within country	60,3%	55,9%	65,6%	58,9%	63,3%	60,9%
expecting to keep it longer than the expected minimum lifecycle	Count	755	1967	1277	150	749	4898
	% within country	8,9%	12,4%	8,0%	2,6%	7,7%	8,8%
Total	Count	8500	15890	15898	5676	9741	55705
	% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 2.4



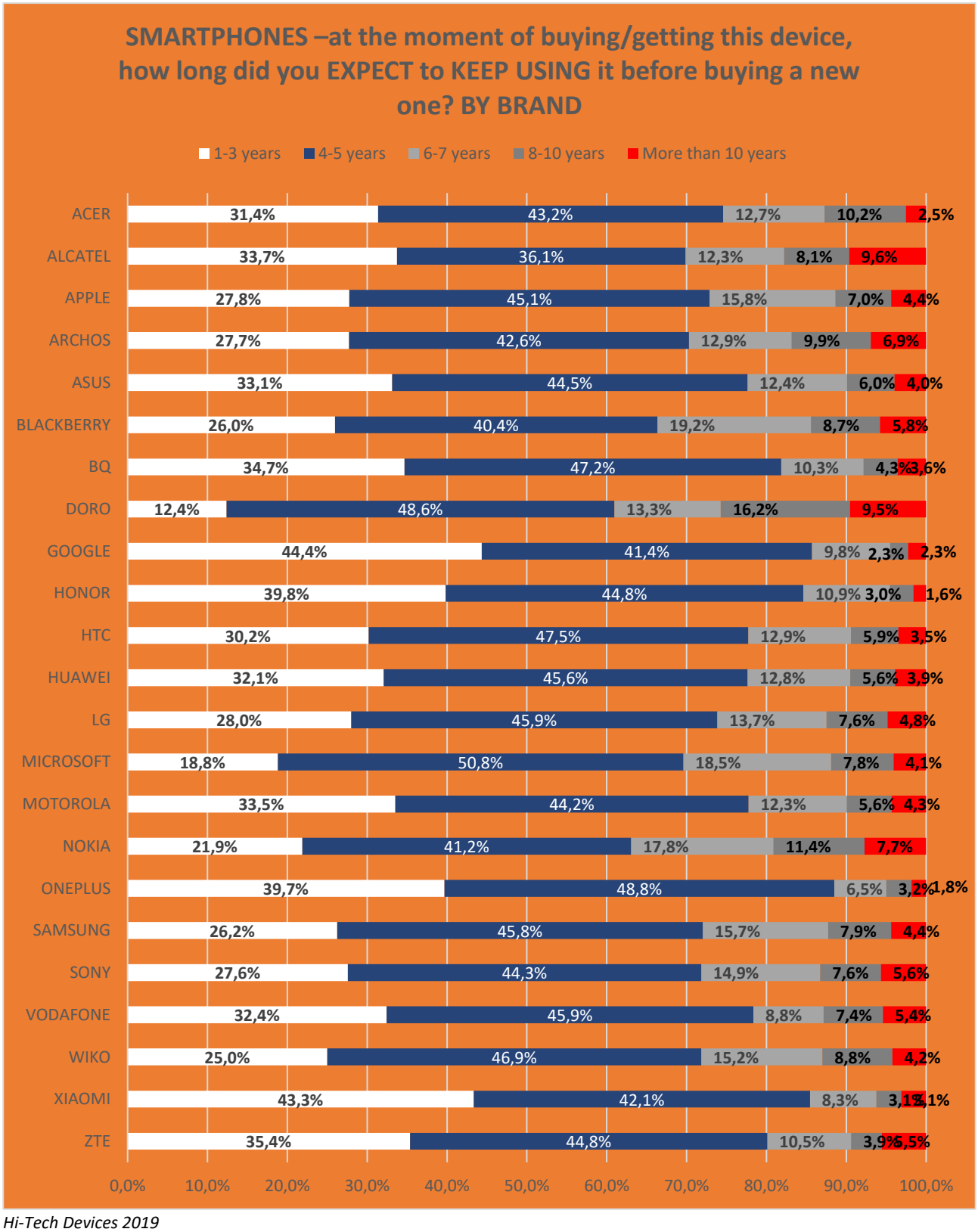
Top, medium and low levels of gamma are defined by respondents themselves when answering the questionnaire.

Table 2.4 SMARTPHONES - Foreseen duration of use VS Lifecycle expectations by gamma

		Keep using (average)	Minimum lifecycle (average)
Total	Low	3,75	3,96
	Medium	3,57	3,91
	Top gamma	3,30	4,06

Tested through OneWay ANOVA; green significantly better, red significantly worse

Chart 2.5



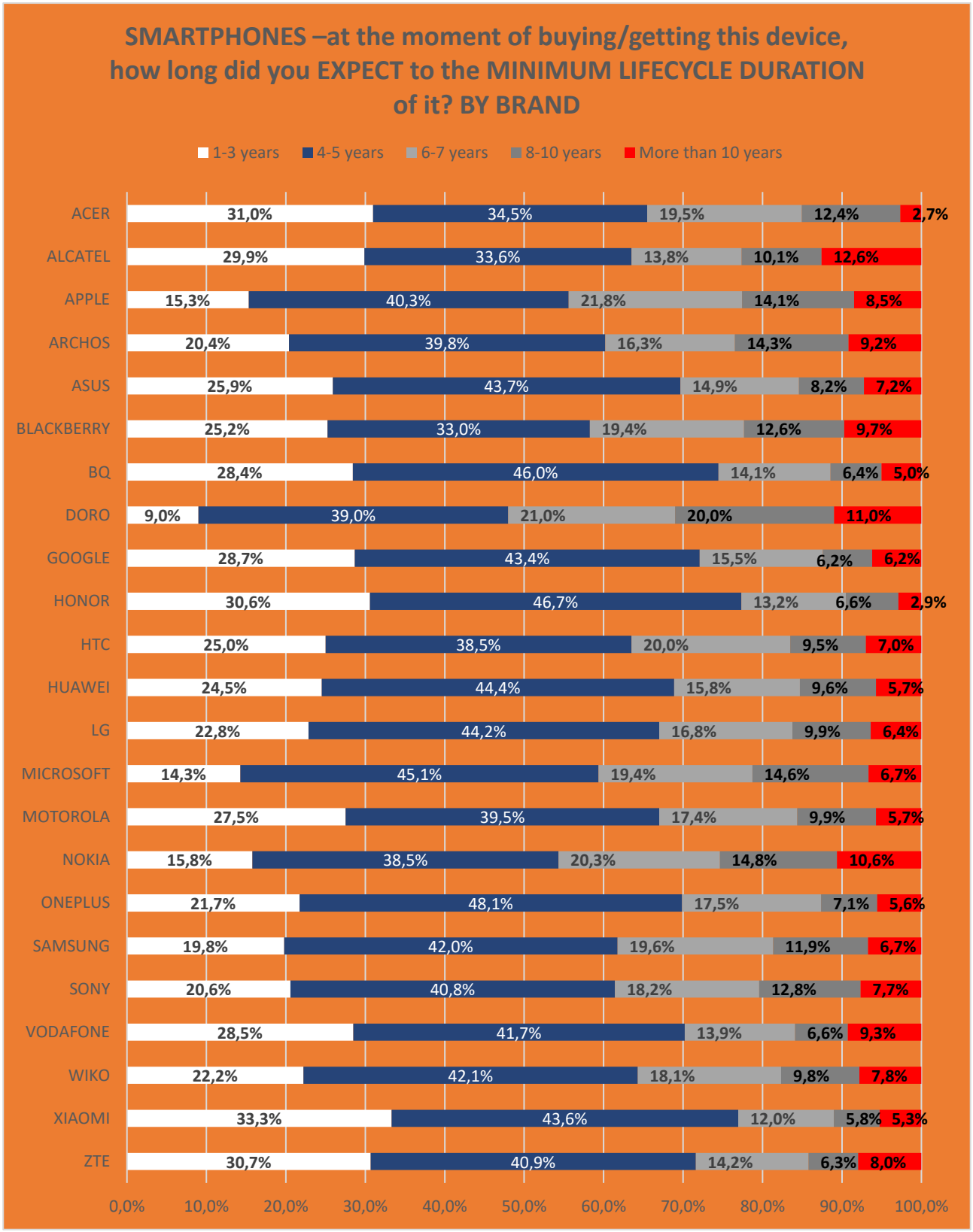
Hi-Tech Devices 2019

39% of Doro owners (14% of Google owners) expect to keep using their smartphone for more than 5 years.

Table 2.5 SMARTPHONES–at the moment of buying/getting this smartphone, how long did you EXPECT to KEEP USING it before buying a new one? BY BRAND

	N	1-3 y	4-5y	6-7y	8-10y	more than 10y
ACER	118	31,4%	43,2%	12,7%	10,2%	2,5%
ALCATEL	332	33,7%	36,1%	12,3%	8,1%	9,6%
APPLE	11601	27,8%	45,1%	15,8%	7,0%	4,4%
ARCHOS	101	27,7%	42,6%	12,9%	9,9%	6,9%
ASUS	1189	33,1%	44,5%	12,4%	6,0%	4,0%
BLACKBERRY	104	26,0%	40,4%	19,2%	8,7%	5,8%
BQ	816	34,7%	47,2%	10,3%	4,3%	3,6%
DORO	105	12,4%	48,6%	13,3%	16,2%	9,5%
GOOGLE	133	44,4%	41,4%	9,8%	2,3%	2,3%
HTC	202	30,2%	47,5%	12,9%	5,9%	3,5%
HUAWEI	9269	32,1%	45,6%	12,8%	5,6%	3,9%
LG	1404	29,0%	46,8%	12,3%	5,9%	5,9%
MICROSOFT	319	28,0%	45,9%	13,7%	7,6%	4,8%
MOTOROLA	904	18,8%	50,8%	18,5%	7,8%	4,1%
NOKIA	1088	33,5%	44,2%	12,3%	5,6%	4,3%
ONEPLUS	600	21,9%	41,2%	17,8%	11,4%	7,7%
SAMSUNG	20605	39,7%	48,8%	6,5%	3,2%	1,8%
SONY	1222	26,2%	45,8%	15,7%	7,9%	4,4%
VODAFONE	148	27,6%	44,3%	14,9%	7,6%	5,6%
WIKO	1061	25,0%	46,9%	15,2%	8,8%	4,2%
XIAOMI	2969	43,3%	42,1%	8,3%	3,1%	3,1%
ZTE	181	35,4%	44,8%	10,5%	3,9%	5,5%

Chart 2.6



Hi-Tech Devices 2019

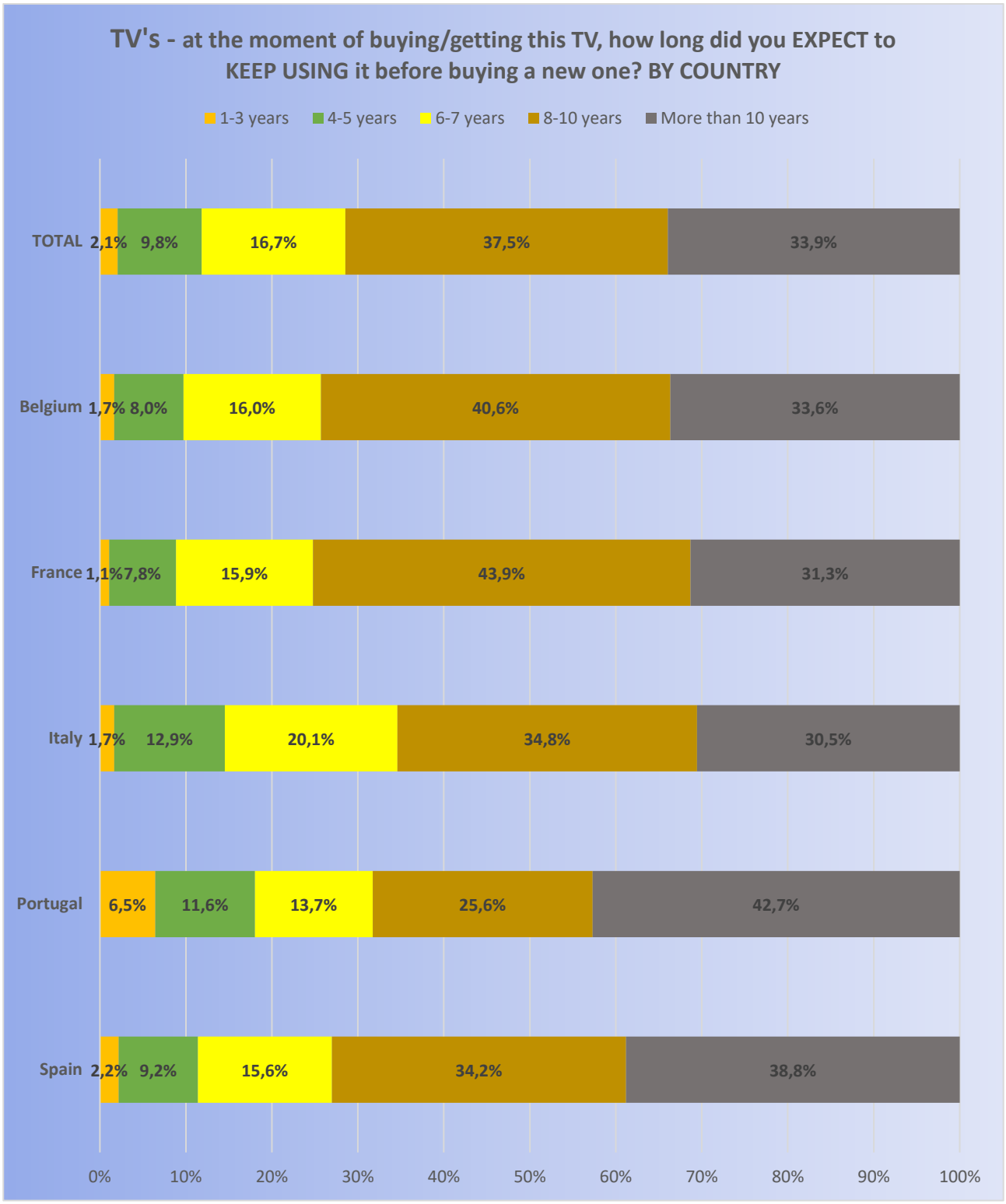
52% of Doro owners (23% of both Honor and Xiaomi owners) expect their smartphone to have a minimum lifecycle of more than 5 years.

Table 2.6 SMARTPHONES–at the moment of buying/getting this smartphone, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY BRAND

	N	1-3 y	4-5y	6-7y	8-10y	more than 10y
ACER	113	31,0%	34,5%	19,5%	12,4%	2,7%
ALCATEL	318	29,9%	33,6%	13,8%	10,1%	12,6%
APPLE	11375	15,3%	40,3%	21,8%	14,1%	8,5%
ARCHOS	101	20,4%	39,8%	16,3%	14,3%	9,2%
ASUS	1173	25,9%	43,7%	14,9%	8,2%	7,2%
BLACKBERRY	103	25,2%	33,0%	19,4%	12,6%	9,7%
BQ	795	28,4%	46,0%	14,1%	6,4%	5,0%
DORO	100	9,0%	39,0%	21,0%	20,0%	11,0%
GOOGLE	129	28,7%	43,4%	15,5%	6,2%	6,2%
HONOR	935	30,6%	46,7%	13,2%	6,6%	2,9%
HTC	200	25,0%	38,5%	20,0%	9,5%	7,0%
HUAWEI	9112	24,5%	44,4%	15,8%	9,6%	5,7%
LG	1379	22,8%	44,2%	16,8%	9,9%	6,4%
MICROSOFT	315	14,3%	45,1%	19,4%	14,6%	6,7%
MOTOROLA	876	27,5%	39,5%	17,4%	9,9%	5,7%
NOKIA	1064	15,8%	38,5%	20,3%	14,8%	10,6%
ONEPLUS	594	21,7%	48,1%	17,5%	7,1%	5,6%
SAMSUNG	20098	19,8%	42,0%	19,6%	11,9%	6,7%
SONY	1200	20,6%	40,8%	18,2%	12,8%	7,7%
VODAFONE	151	28,5%	41,7%	13,9%	6,6%	9,3%
WIKO	986	22,2%	42,1%	18,1%	9,8%	7,8%
XIAOMI	2914	33,3%	43,6%	12,0%	5,8%	5,3%
ZTE	176	30,7%	40,9%	14,2%	6,3%	8,0%

2.3 TVs

Chart 3.1



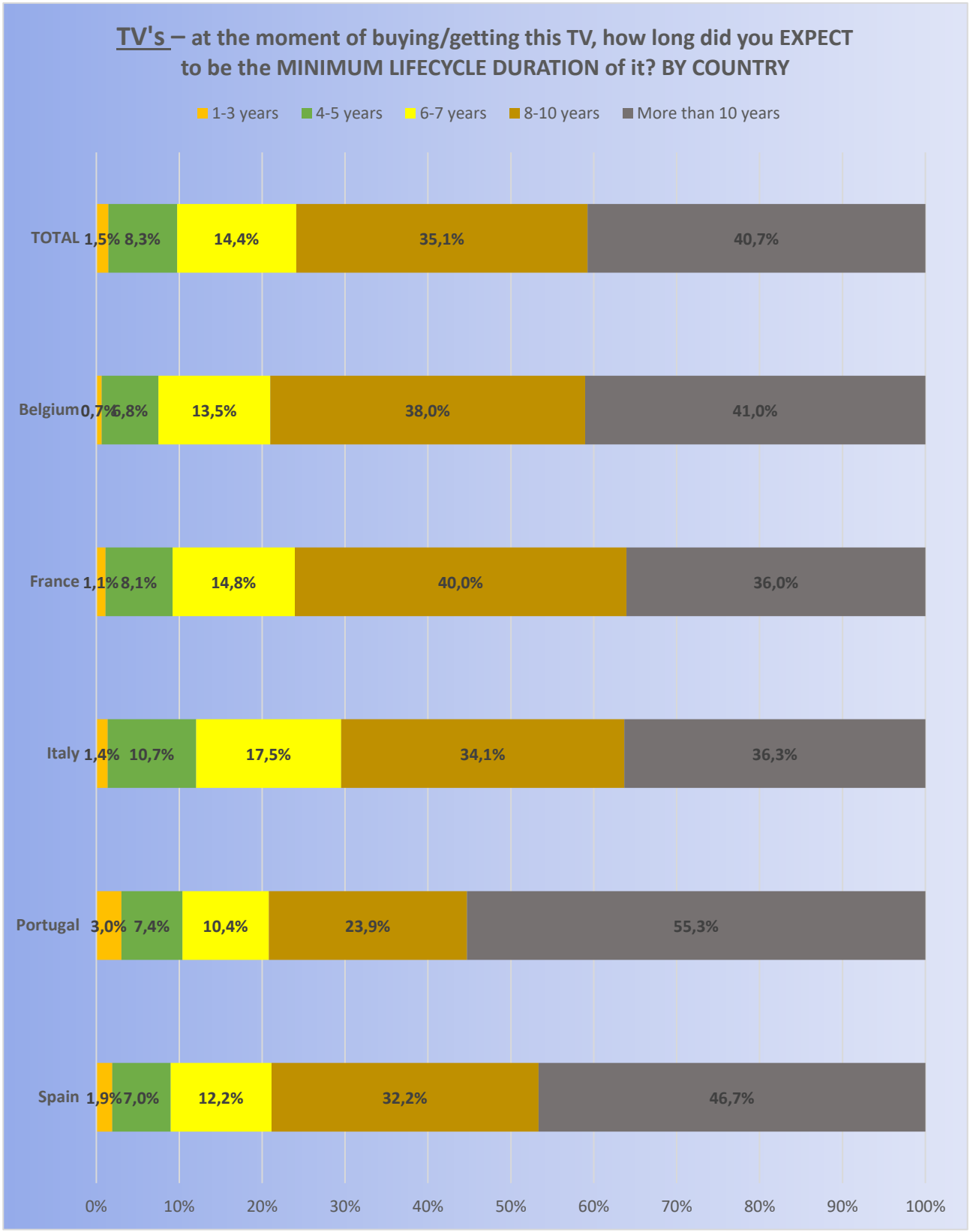
Hi-Tech Devices 2019

38% of respondents (BEL 41% FRA 44% ITA 35% POR 26% SPA 34%) expect to use their TV for 8-10 years (from the moment of buying/getting it).

Table 3.1 TV'S–at the moment of buying/getting this TV, how long did you EXPECT to KEEP USING it before buying a new one? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	1-3y	Count	157	201	257	400	224	1239
		%	1,7%	1,1%	1,7%	6,5%	2,2%	2,1%
	4-5y	Count	755	1442	1974	717	942	5830
		%	8,0%	7,8%	12,9%	11,6%	9,2%	9,8%
	6-7y	Count	1501	2960	3082	850	1589	9982
		%	16,0%	15,9%	20,1%	13,7%	15,6%	16,7%
	8-10y	Count	3813	8152	5348	1586	3497	22396
		%	40,6%	43,9%	34,8%	25,6%	34,2%	37,5%
	More than 10y	Count	3157	5812	4688	2646	3963	20266
		%	33,6%	31,3%	30,5%	42,7%	38,8%	33,9%
Total		*Count*	9383	18567	15349	6199	10215	59713

Chart 3.2



Hi-Tech Devices 2019

41% of respondents (BEL 41% FRA 36% ITA 36% POR 55% SPA 47%) expect their TV to last (functioning) for more than 10 years (from the moment of buying/getting it).

Table 3.2 TV'S–at the moment of buying/getting this TV, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	1-3y	Count	60	202	208	185	195	850
		%	0,7%	1,1%	1,4%	3,0%	1,9%	1,5%
	4-5y	Count	627	1453	1609	452	708	4849
		%	6,8%	8,1%	10,7%	7,4%	7,0%	8,3%
	6-7y	Count	1236	2661	2646	640	1226	8409
		%	13,5%	14,8%	17,5%	10,4%	12,2%	14,4%
	8-10y	Count	3477	7207	5158	1466	3247	20555
		%	38,0%	40,0%	34,1%	23,9%	32,2%	35,1%
	More than 10y	Count	3759	6494	5484	3393	4703	23833
		%	41,0%	36,0%	36,3%	55,3%	46,7%	40,7%
Total		*Count*	9159	18017	15105	6136	10079	58496

Chart 3.3.1

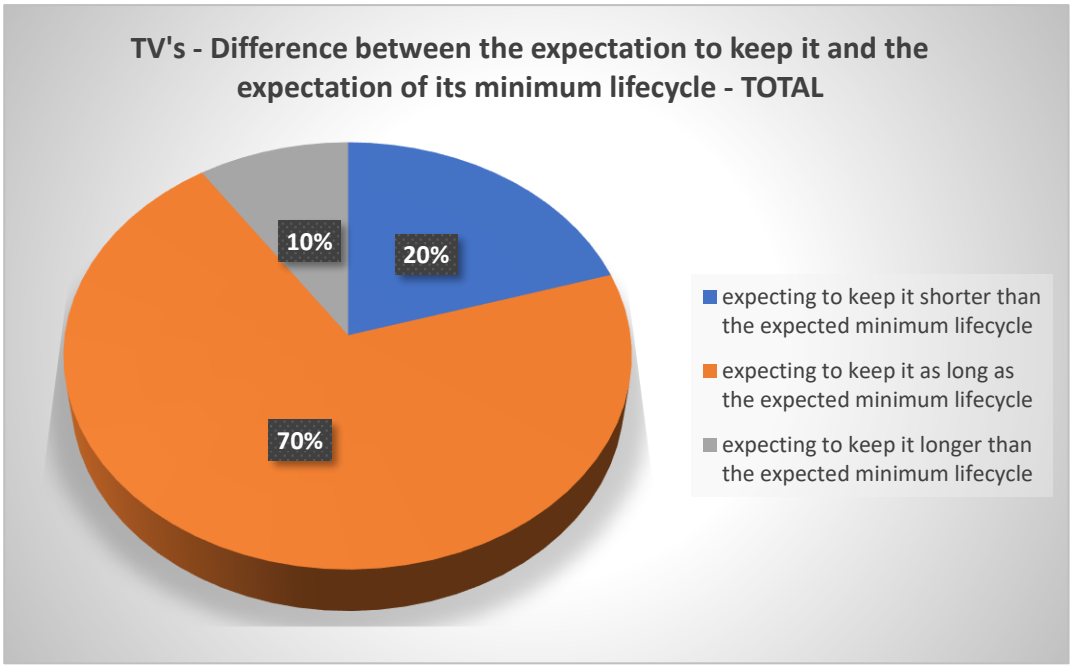


Chart 3.3.2

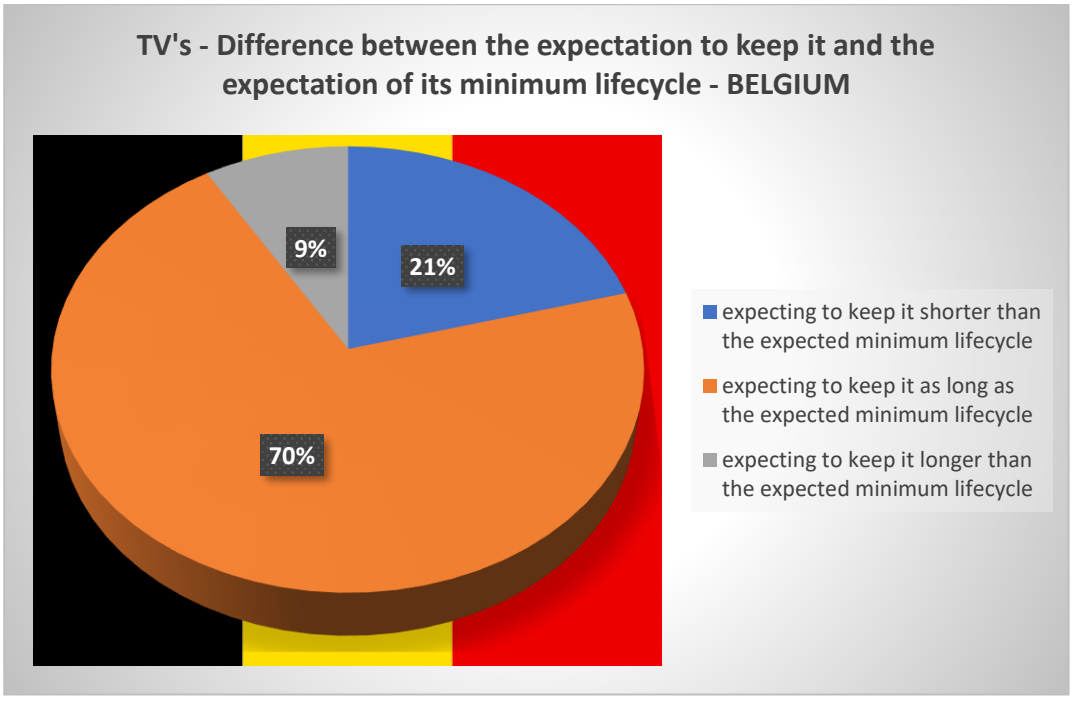


Chart 3.3.3

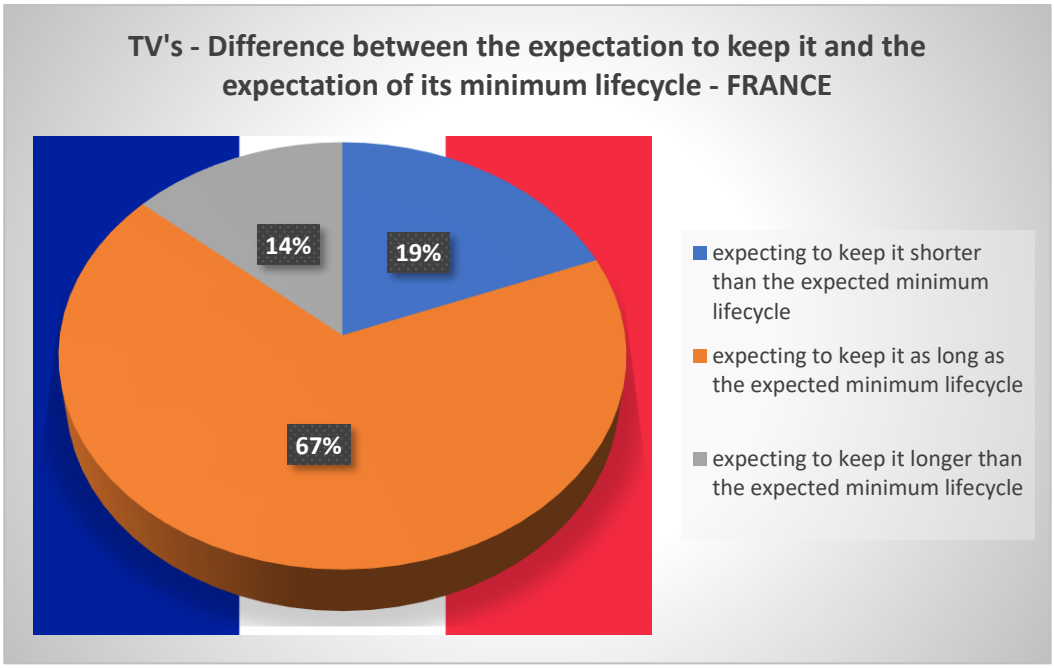


Chart 3.3.4

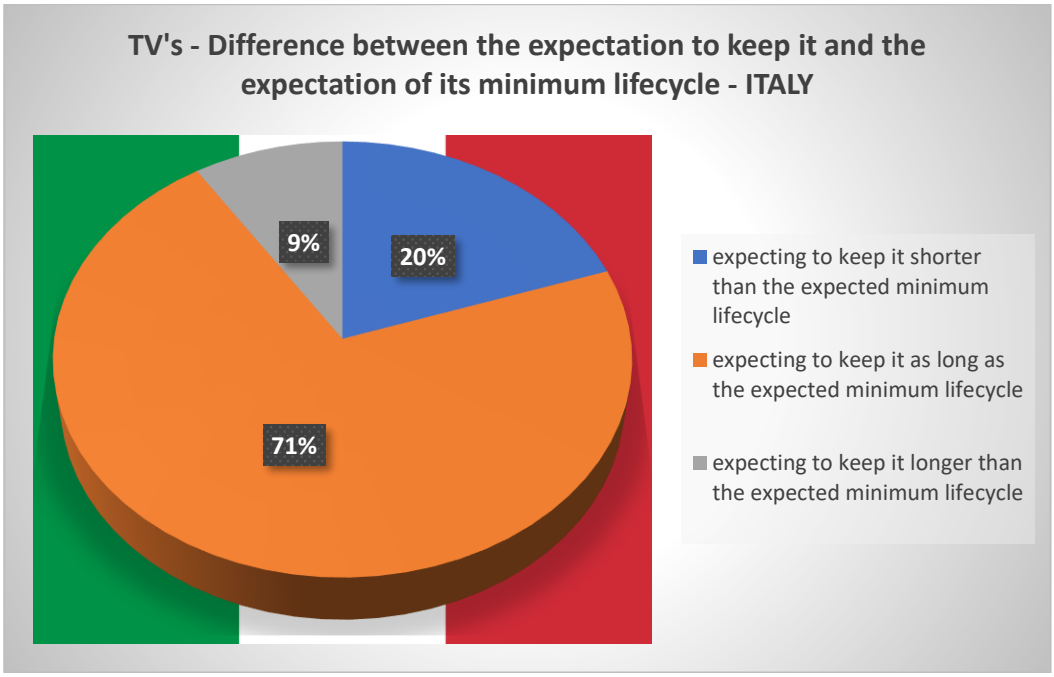


Chart 3.3.5

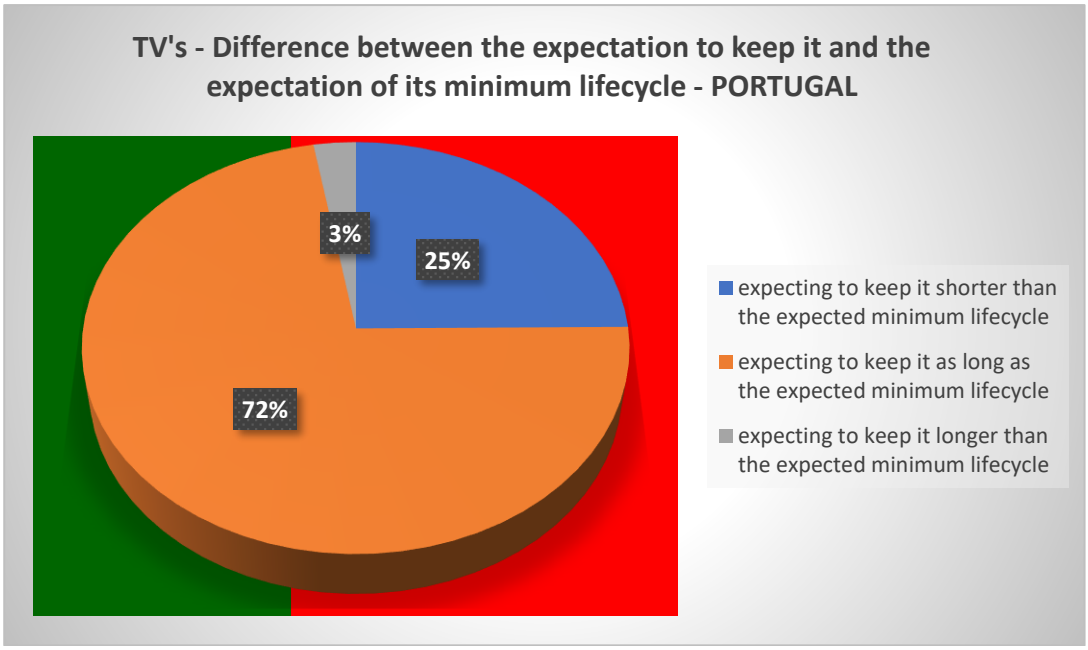
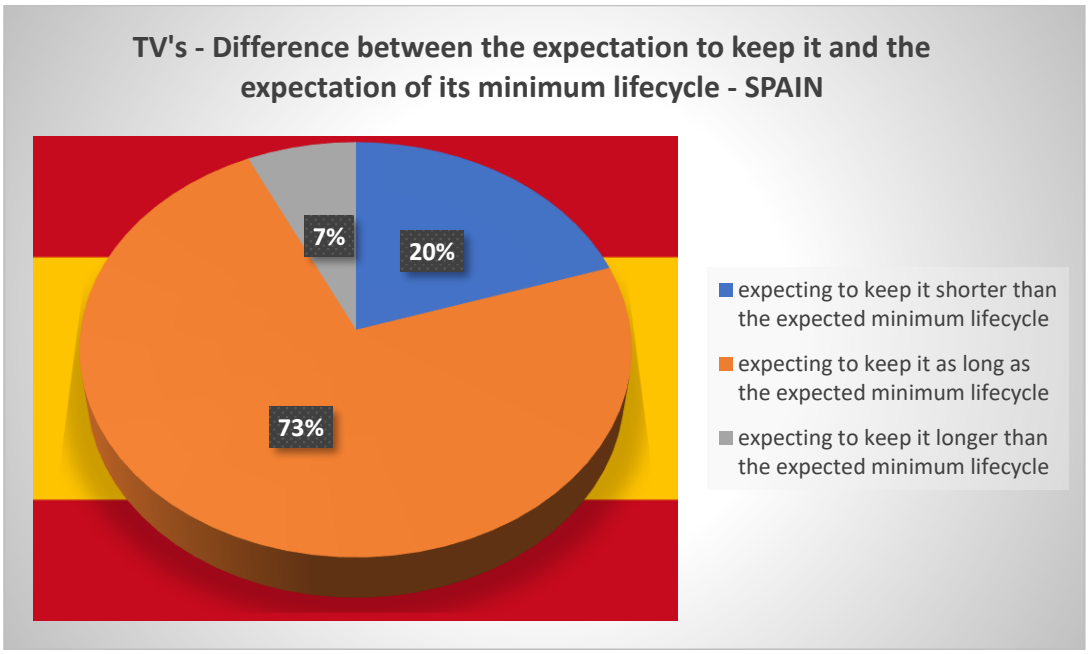


Chart 3.3.6

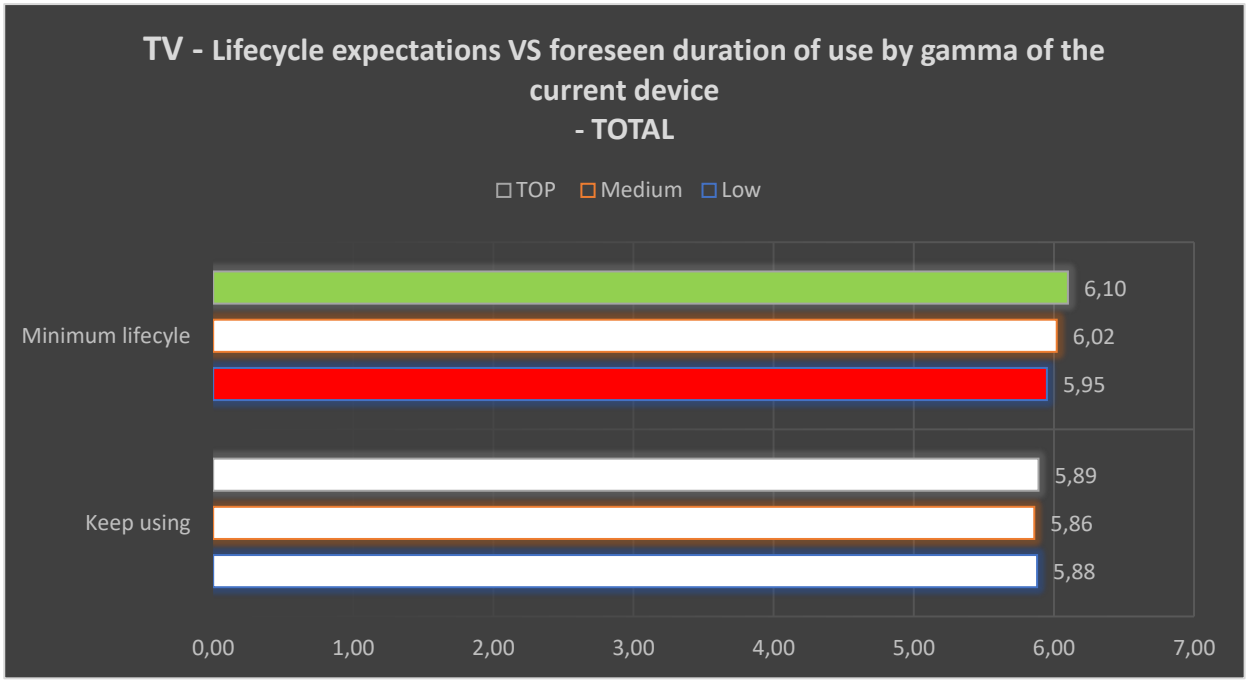


20% of respondents (BEL 21% FRA 19% ITA 20% POR 25% SPA 20%) expect to keep using their TV shorter than its expected minimum lifecycle.

Table 3.3 TV'S– Difference between the expectation to keep it and the expectation of its minimum lifecycle BY COUNTRY

		country					
		Belgium	France	Italy	Portugal	Spain	Total
expecting to keep it shorter than the expected minimum lifecycle	Count	1902	3411	2968	1464	1993	11738
	% within country	20,8%	19,0%	19,8%	24,9%	20,0%	20,3%
expecting to keep it as long as the expected minimum lifecycle	Count	6435	12105	10658	4260	7284	40742
	% within country	70,5%	67,5%	71,0%	72,4%	73,0%	70,3%
expecting to keep it longer than the expected minimum lifecycle	Count	788	2430	1377	161	698	5454
	% within country	8,6%	13,5%	9,2%	2,7%	7,0%	9,4%
Total	Count	9125	17946	15003	5885	9975	57934
	% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 3.4



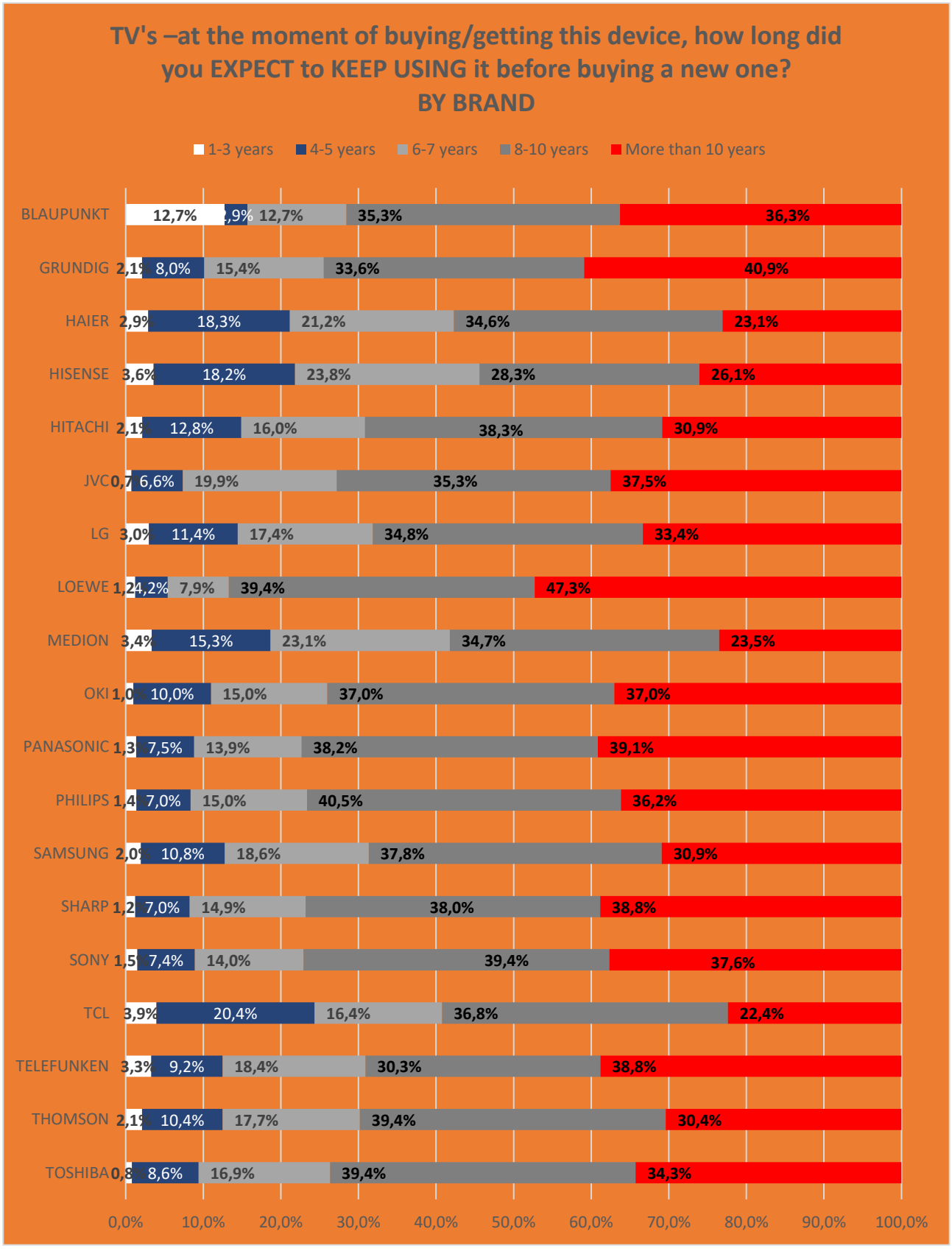
Top, medium and low levels of gamma are defined by respondents themselves when answering the questionnaire.

Table 3.4 TV'S - Foreseen duration of use VS Lifecycle expectations by gamma

Country		Keep using (average)	Minimum lifecycle (average)
Total	Low	5,88	5,95
	Medium	5,86	6,02
	Top gamma	5,89	6,10

Tested through OneWay ANOVA; green significantly better, red significantly worse

Chart 3.5



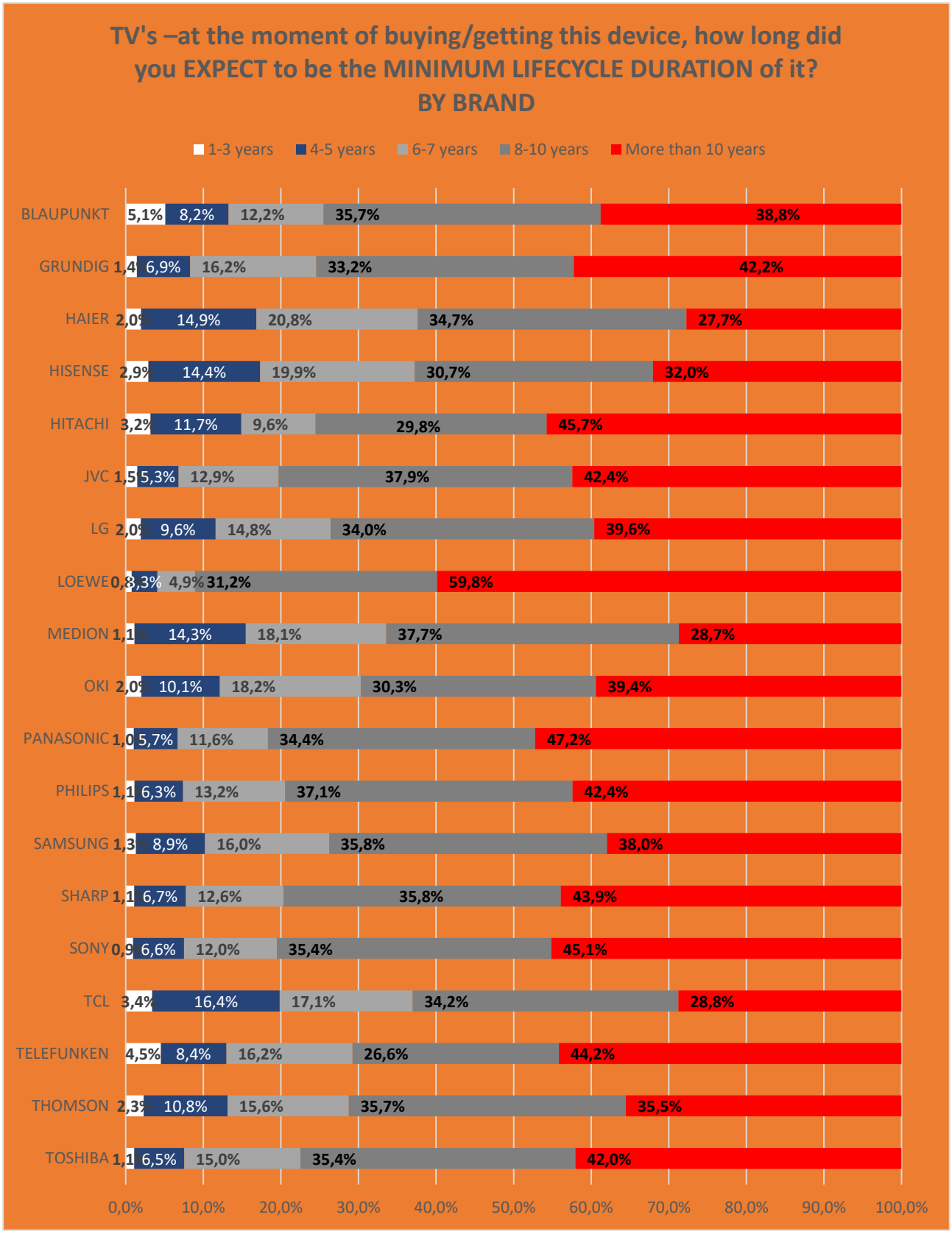
Hi-Tech Devices 2019

47% of Loewe owners (23% of Haier owners) expect to keep using their TV for more than 10 years.

Table 3.5 TV'S–at the moment of buying/getting this TV, how long did you EXPECT to KEEP USING it before buying a new one? BY BRAND

	N	1-3 y	4-5y	6-7y	8-10y	more than 10y
BLAUPUNKT	102	12,7%	2,9%	12,7%	35,3%	36,3%
GRUNDIG	286	2,1%	8,0%	15,4%	33,6%	40,9%
HAIER	104	2,9%	18,3%	21,2%	34,6%	23,1%
HISENSE	307	3,6%	18,2%	23,8%	28,3%	26,1%
HITACHI	101	2,1%	12,8%	16,0%	38,3%	30,9%
JVC	136	0,7%	6,6%	19,9%	35,3%	37,5%
LG	10965	3,0%	11,4%	17,4%	34,8%	33,4%
LOEWE	406	1,2%	4,2%	7,9%	39,4%	47,3%
MEDION	268	3,4%	15,3%	23,1%	34,7%	23,5%
OKI	100	1,0%	10,0%	15,0%	37,0%	37,0%
PANASONIC	4105	1,3%	7,5%	13,9%	38,2%	39,1%
PHILIPS	6389	1,4%	7,0%	15,0%	40,5%	36,2%
SAMSUNG	23038	2,0%	10,8%	18,6%	37,8%	30,9%
SHARP	824	1,2%	7,0%	14,9%	38,0%	38,8%
SONY	9315	1,5%	7,4%	14,0%	39,4%	37,6%
TCL	152	3,9%	20,4%	16,4%	36,8%	22,4%
TELEFUNKEN	152	3,3%	9,2%	18,4%	30,3%	38,8%
THOMSON	520	2,1%	10,4%	17,7%	39,4%	30,4%
TOSHIBA	744	0,8%	8,6%	16,9%	39,4%	34,3%

Chart 3.6



Hi-Tech Devices 2019

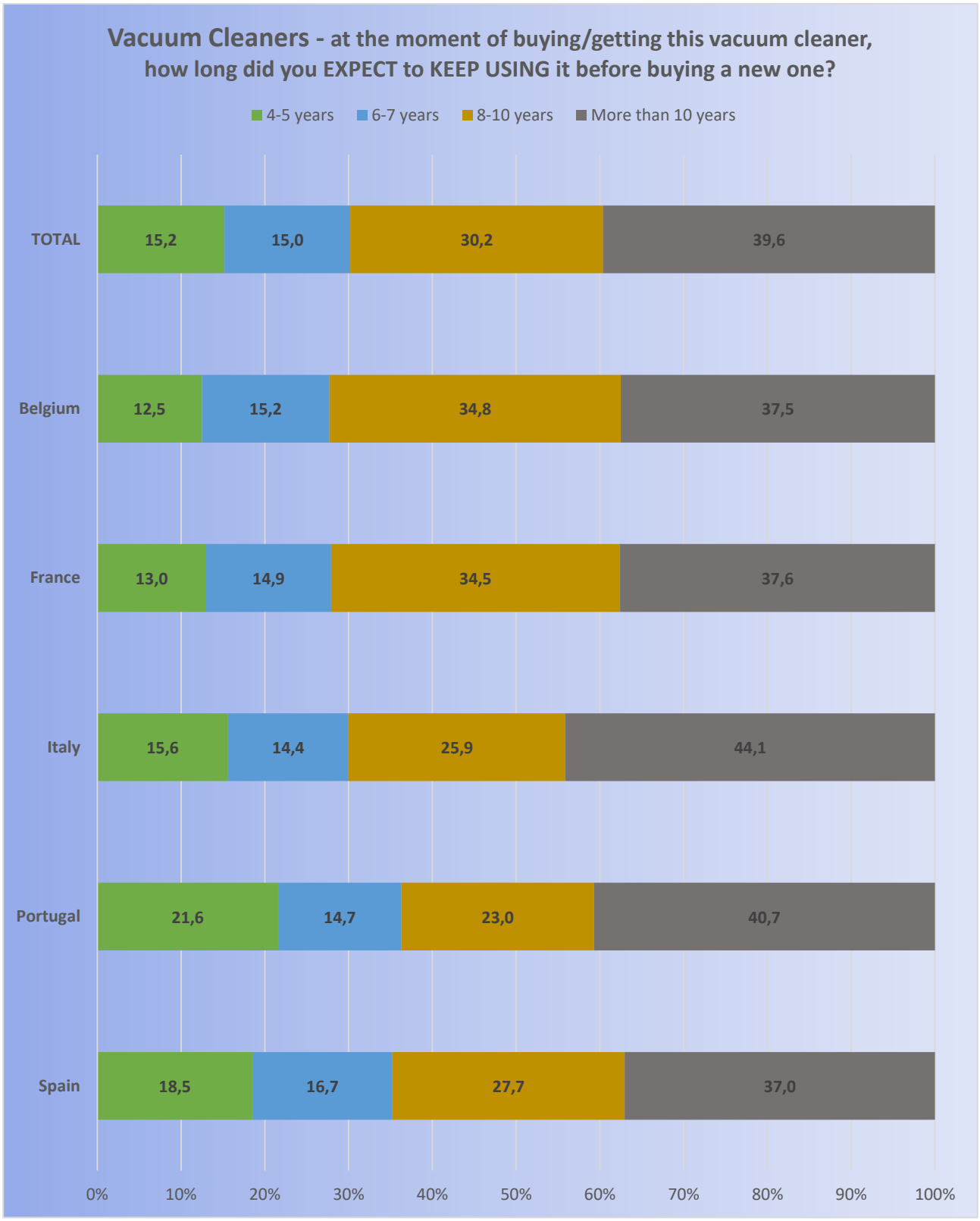
60% of Loewe owners (28% of Haier owners) expect their TV to have a minimum lifecycle of more than 10 years.

Table 3.6 TV'S–at the moment of buying/getting this TV, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY BRAND

	N	1-3 y	4-5y	6-7y	8-10y	more than 10y
BLAUPUNKT	98	5,1%	8,2%	12,2%	35,7%	38,8%
GRUNDIG	277	1,4%	6,9%	16,2%	33,2%	42,2%
HAIER	101	2,0%	14,9%	20,8%	34,7%	27,7%
HISENSE	306	2,9%	14,4%	19,9%	30,7%	32,0%
HITACHI	97	3,2%	11,7%	9,6%	29,8%	45,7%
JVC	132	1,5%	5,3%	12,9%	37,9%	42,4%
LG	10778	2,0%	9,6%	14,8%	34,0%	39,6%
LOEWE	391	0,8%	3,3%	4,9%	31,2%	59,8%
MEDION	265	1,1%	14,3%	18,1%	37,7%	28,7%
OKI	99	2,0%	10,1%	18,2%	30,3%	39,4%
PANASONIC	4012	1,0%	5,7%	11,6%	34,4%	47,2%
PHILIPS	6233	1,1%	6,3%	13,2%	37,1%	42,4%
SAMSUNG	22594	1,3%	8,9%	16,0%	35,8%	38,0%
SHARP	811	1,1%	6,7%	12,6%	35,8%	43,9%
SONY	9099	0,9%	6,6%	12,0%	35,4%	45,1%
TCL	146	3,4%	16,4%	17,1%	34,2%	28,8%
TELEFUNKEN	154	4,5%	8,4%	16,2%	26,6%	44,2%
THOMSON	518	2,3%	10,8%	15,6%	35,7%	35,5%
TOSHIBA	728	1,1%	6,5%	15,0%	35,4%	42,0%

2.4 VACUUM CLEANERS

Chart 4.1



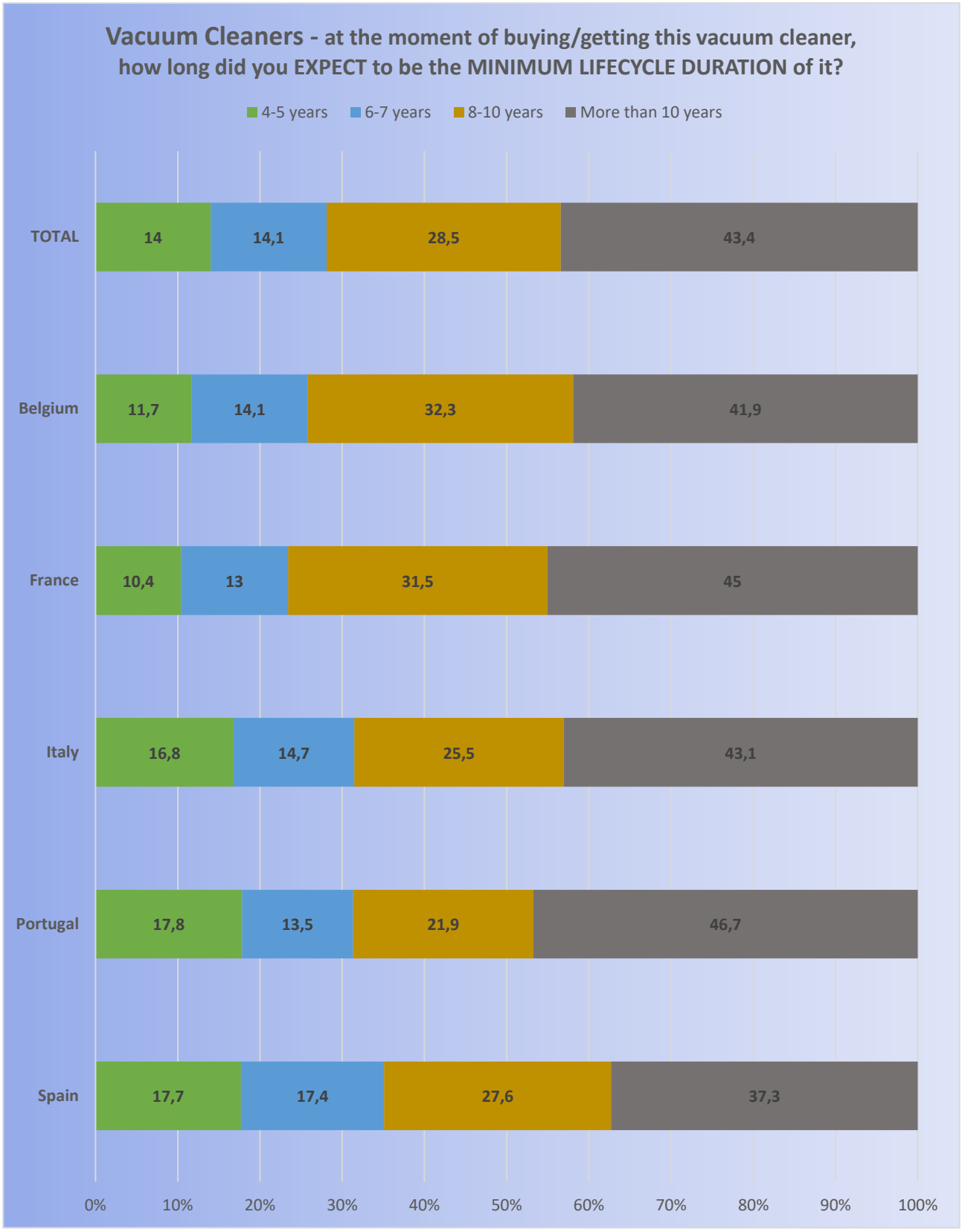
SHHA Appliances 2019-2020

40% of respondents (BEL 38% FRA 38% ITA 44% POR 41% SPA 37%) expect to use their vacuum cleaner for more than 10 years (from the moment of buying/getting it).

Table 4.1 VACUUM CLEANERS –at the moment of buying/getting this vacuum cleaner, how long did you EXPECT to KEEP USING it before buying a new one? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	4-5y	Count	1113	2180	1957	1338	932	7520
		%	12,5%	13,0%	15,6%	21,6%	18,5%	15,2%
	6-7y	Count	1353	2487	1813	914	842	7409
		%	15,2%	14,9%	14,4%	14,7%	16,7%	15,0%
	8-10y	Count	3104	5781	3248	1430	1394	14957
		%	34,8%	34,5%	25,9%	23,0%	27,7%	30,2%
	More than 10y	Count	3341	6295	5546	2524	1862	19568
		%	37,5%	37,6%	44,1%	40,7%	37,0%	39,6%
Total		*Count*	8911	16743	12564	6206	5030	49454

Chart 4.2



SHHA Appliances 2019-2020

43% of respondents (BEL 42% FRA 45% ITA 43% POR 47% SPA 37%) expect their vacuum cleaner to last (functioning) for more than 10 years (from the moment of buying/getting it).

Table 4.2 VACUUM CLEANERS –at the moment of buying/getting this vacuum cleaner, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY COUNTRY

			country					Total
			Belgium	France	Italy	Portugal	Spain	
	4-5y	Count	1031	1717	2091	1154	873	6866
		%	11,7%	10,4%	16,8%	17,8%	17,7%	14,0%
	6-7y	Count	1235	2145	1831	874	862	6947
		%	14,1%	13,0%	14,7%	13,5%	17,4%	14,1%
	8-10y	Count	2839	5186	3182	1419	1363	13989
		%	32,3%	31,5%	25,5%	21,9%	27,6%	28,5%
	More than 10y	Count	3683	7398	5376	3022	1844	21323
		%	41,9%	45,0%	43,1%	46,7%	37,3%	43,4%
Total		*Count*	8788	16446	12480	6469	4942	49125

Chart 4.3.1

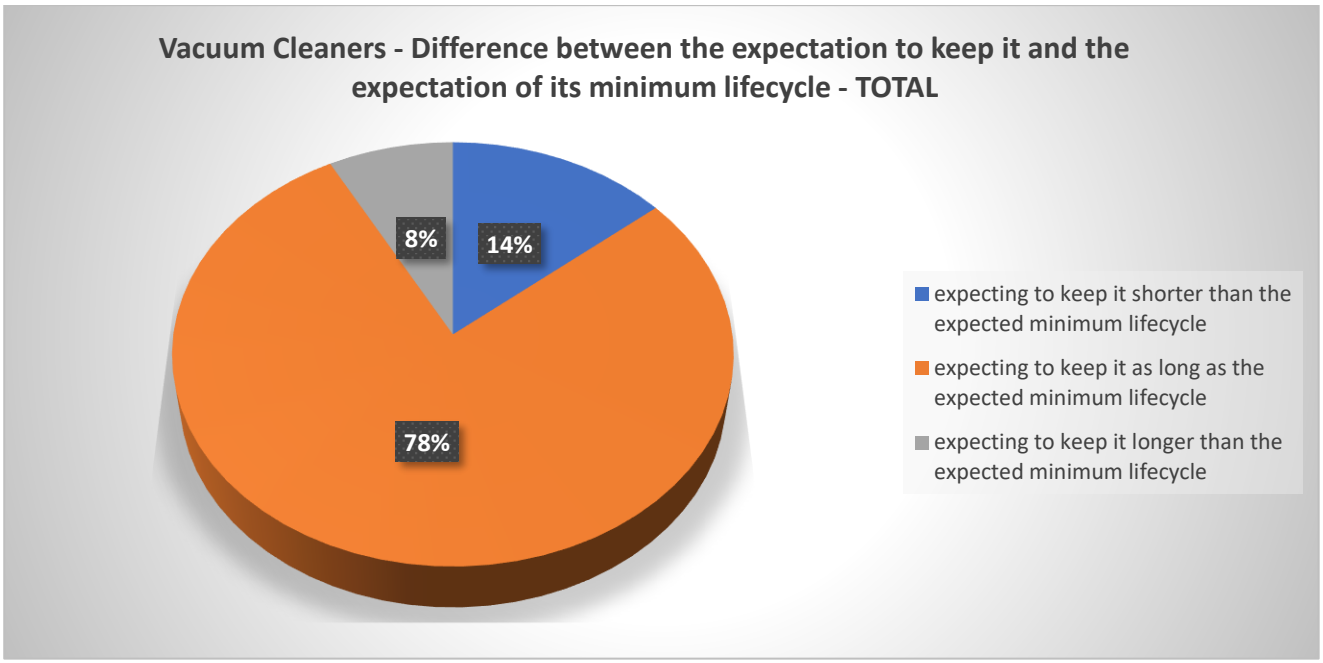


Chart 4.3.2

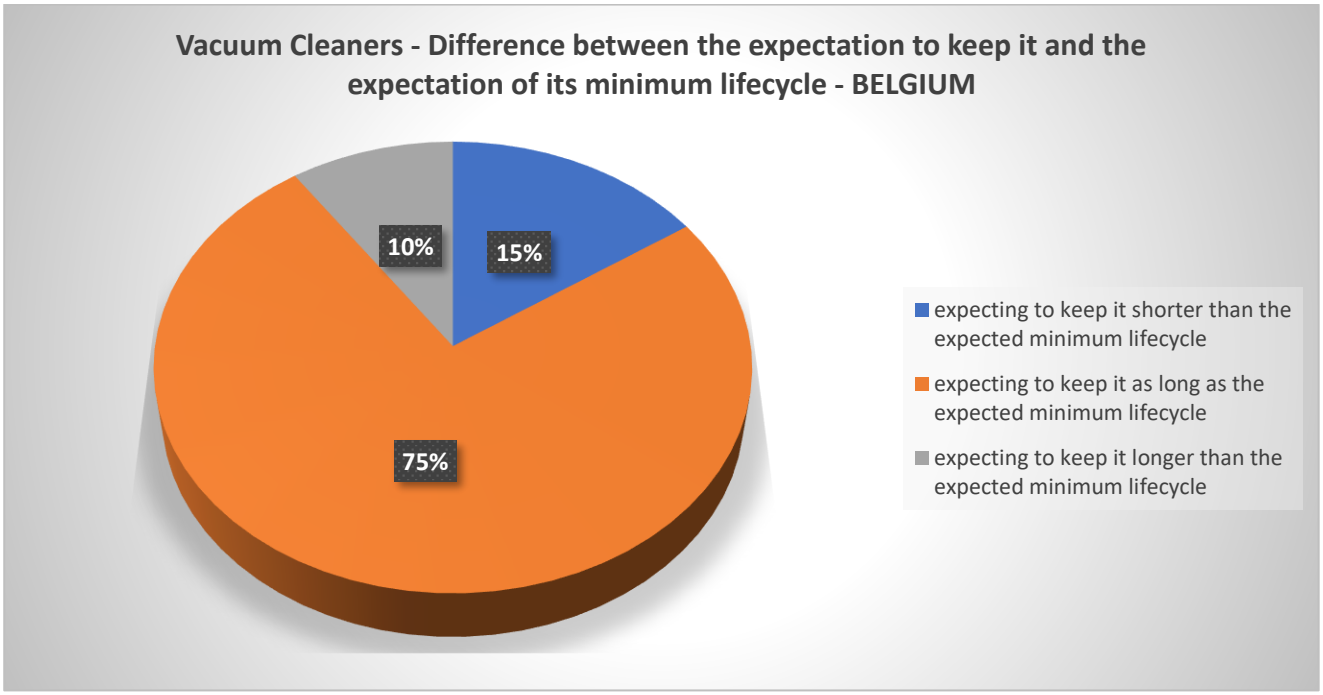


Chart 4.3.3

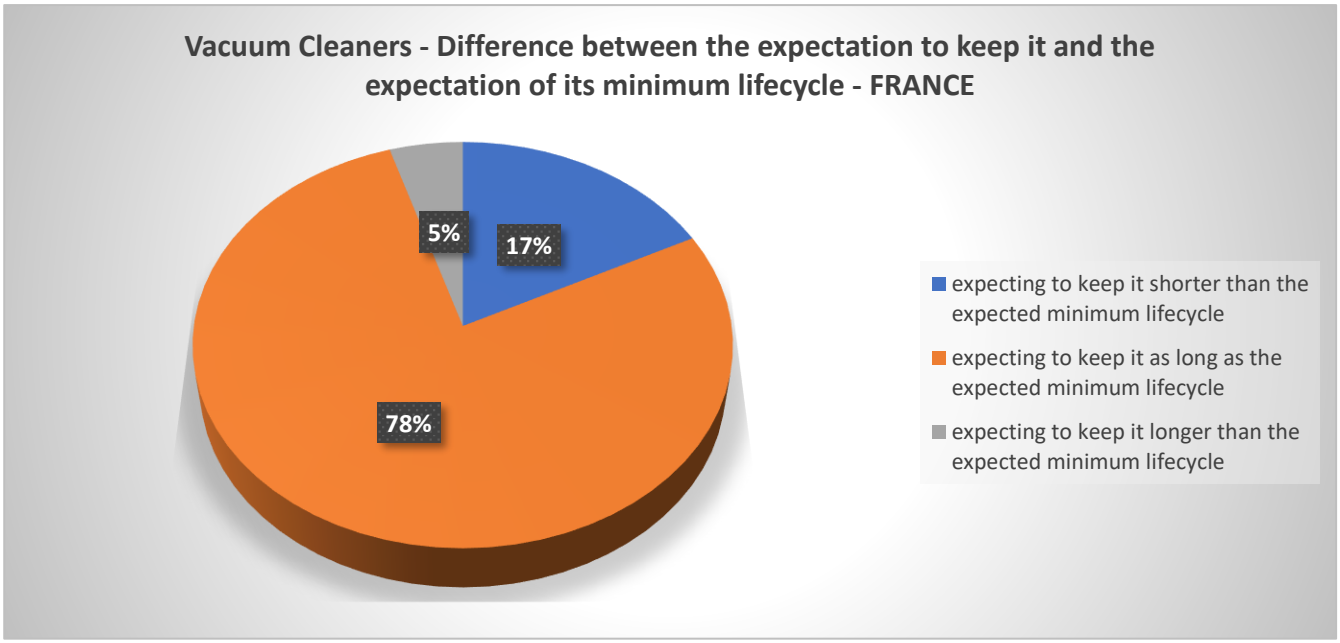


Chart 4.3.4

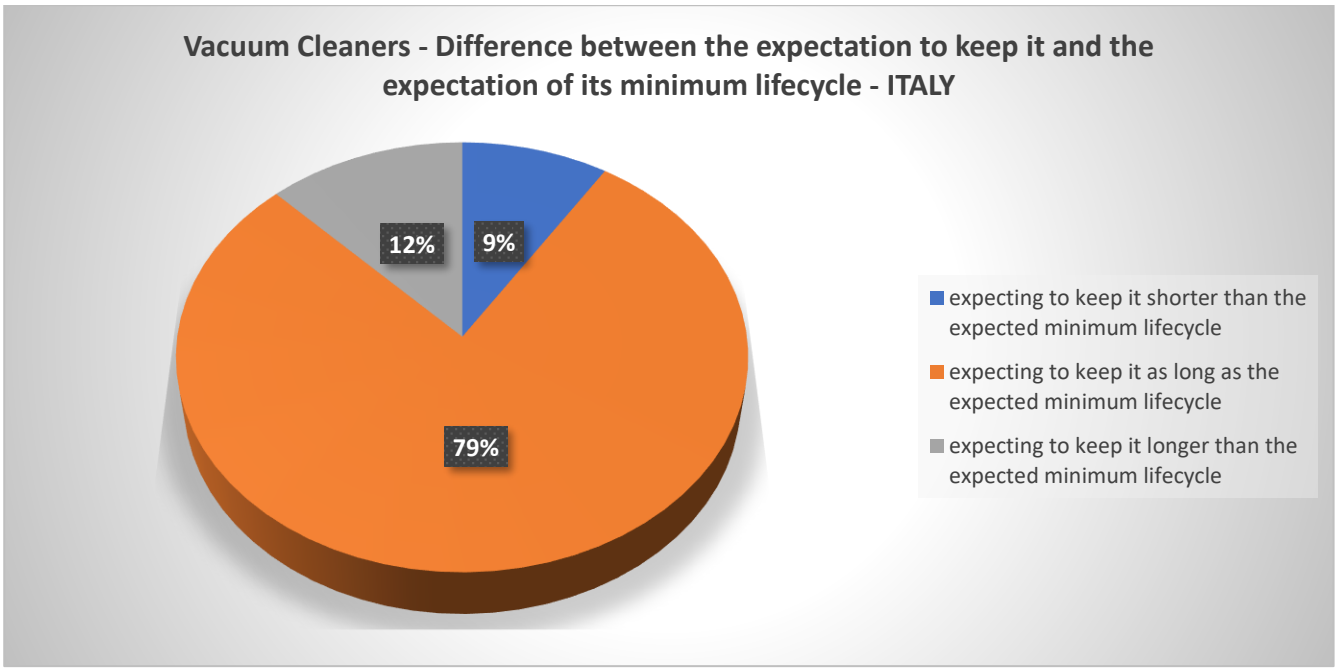


Chart 4.3.5

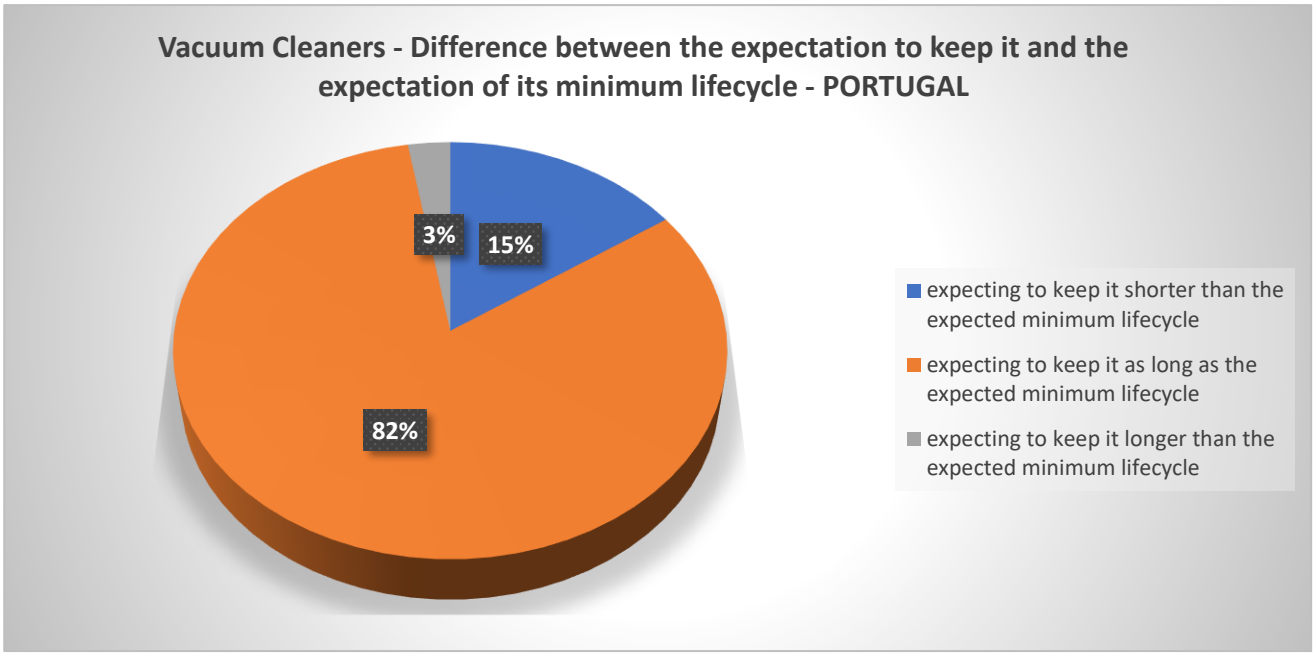
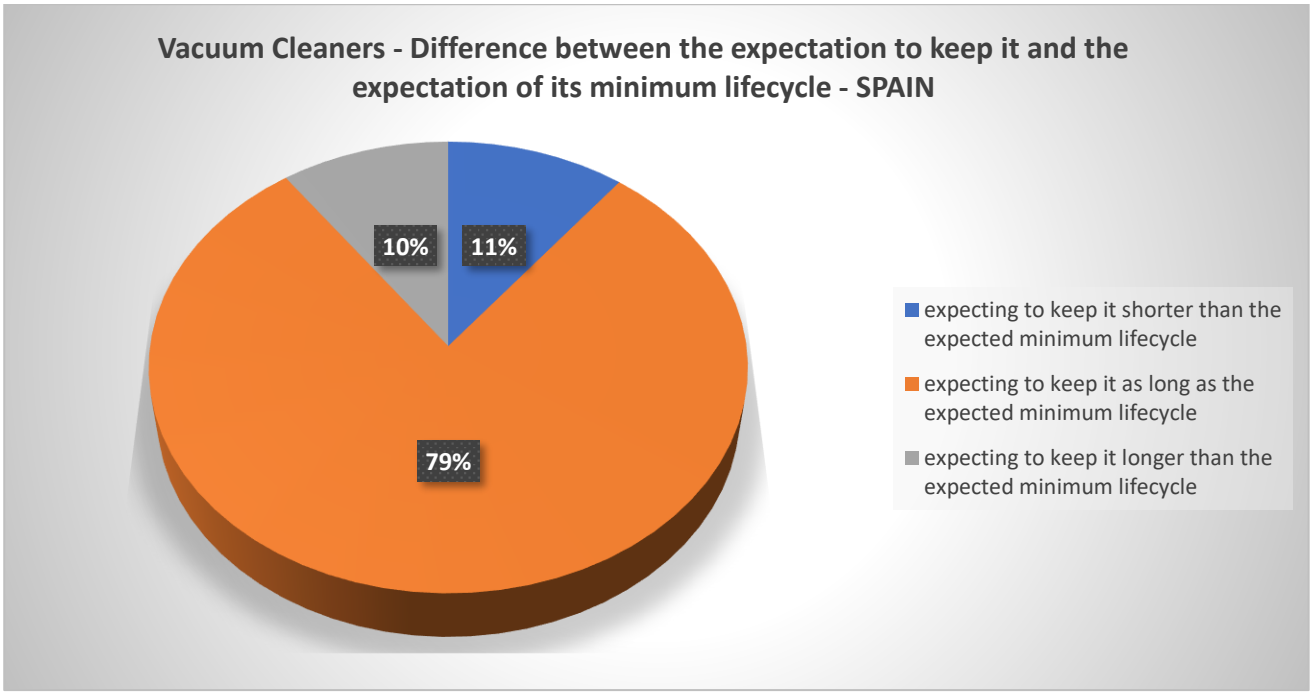


Chart 4.3.6

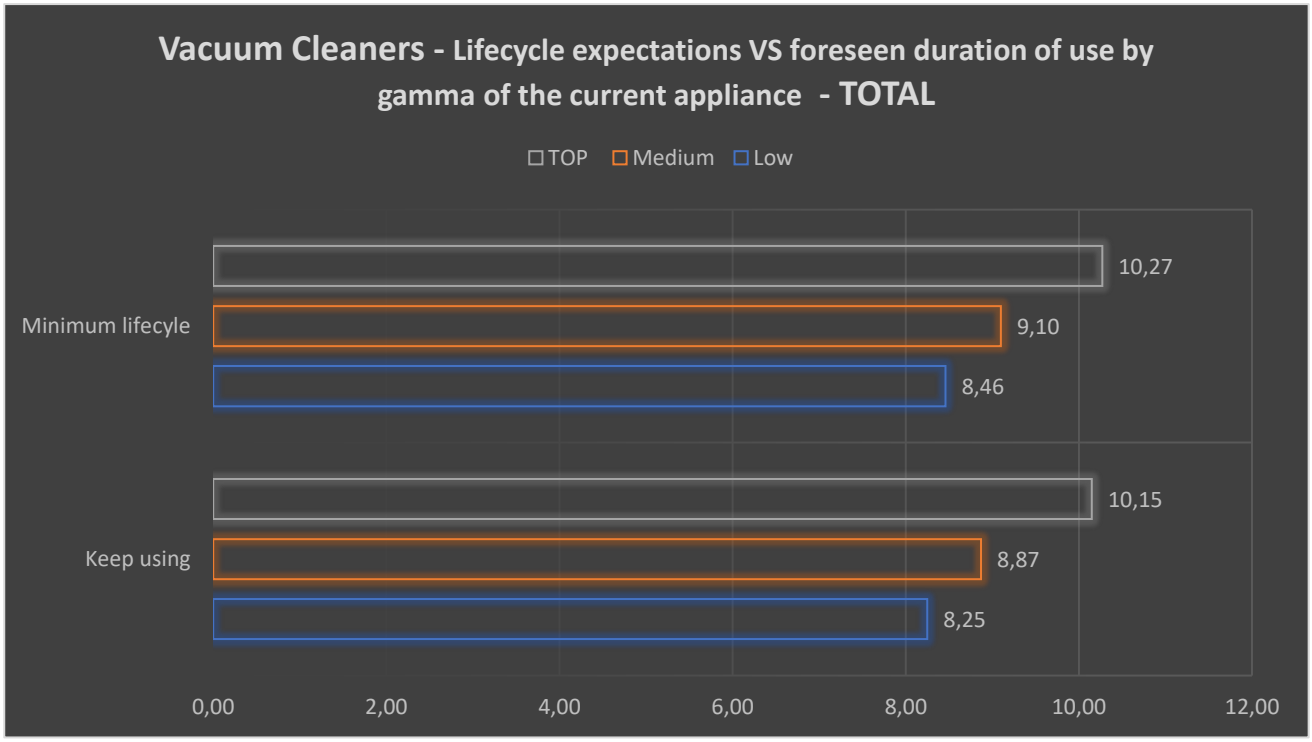


8% of respondents (BEL 10% FRA 5% ITA 12% POR 3% SPA 10%) expect to keep using their vacuum cleaner longer than its expected minimum lifecycle.

Table 4.3 VACUUM CLEANERS – Difference between the expectation to keep it and the expectation of its minimum lifecycle BY COUNTRY

		country					
		Belgium	France	Italy	Portugal	Spain	Total
expecting to keep it shorter than the expected minimum lifecycle	Count	1330	2815	1102	889	504	6640
	% within country	15,5%	17,5%	9,1%	15,4%	10,6%	14,0%
expecting to keep it as long as the expected minimum lifecycle	Count	6434	12513	9507	4736	3782	36972
	% within country	74,8%	77,7%	78,6%	81,9%	79,5%	78,1%
expecting to keep it longer than the expected minimum lifecycle	Count	837	778	1486	156	474	3731
	% within country	9,7%	4,8%	12,3%	2,7%	10,0%	7,9%
Total	Count	8601	16106	12095	5781	4760	47343
	% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 4.4



SHHA Appliances 2019-2020

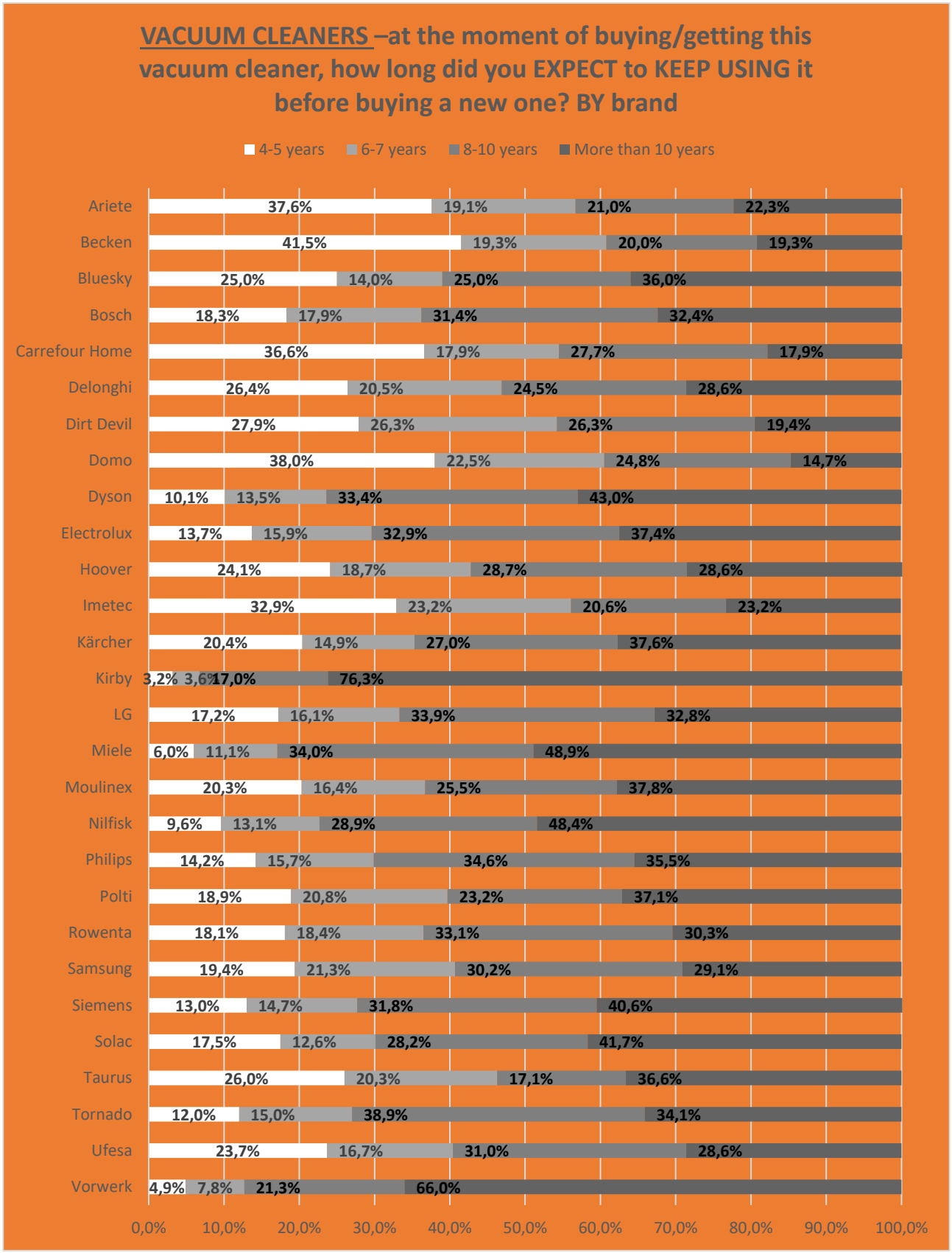
Top, medium and low levels of gamma are defined by respondents themselves when answering the questionnaire.

Table 4.4 VACUUM CLEANERS - Foreseen duration of use VS Lifecycle expectations by gamma

		Keep using (average)	Minimum lifecycle (average)
Total	Low	8,25	8,46
	Medium	8,87	9,10
	Top gamma	10,15	10,27

Tested through OneWay ANOVA; green significantly better, red significantly worse

Chart 4.5



SHHA Appliances 2019-2020

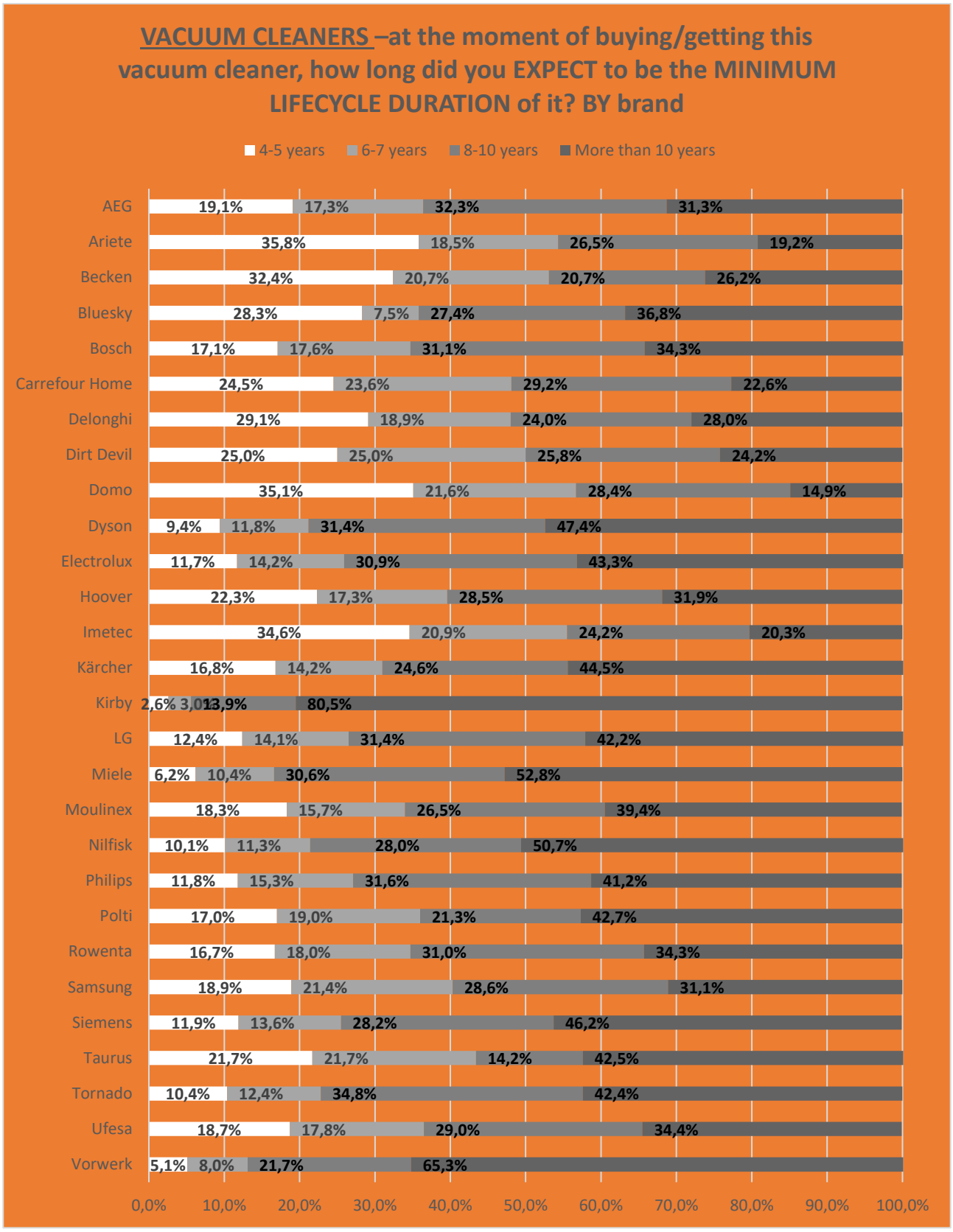
76% of Kirby owners (15% of Domo owners) expect to keep using their vacuum cleaner for more than 10 years.

Table 4.5 VACUUM CLEANERS –at the moment of buying/getting this vacuum cleaner, how long did you EXPECT to KEEP USING it before buying a new one? BY BRAND

	N	4-5y	6-7y	8-10y	more than 10y
AEG	1647	20,5%	18,2%	32,6%	28,7%
Ariete	157	37,6%	19,1%	21,0%	22,3%
Becken	135	41,5%	19,3%	20,0%	19,3%
Bluesky	100	25,0%	14,0%	25,0%	36,0%
Bosch	2306	18,3%	17,9%	31,4%	32,4%
Carrefour Home	112	36,6%	17,9%	27,7%	17,9%
Delonghi	273	26,4%	20,5%	24,5%	28,6%
Dirt Devil	247	27,9%	26,3%	26,3%	19,4%
Domo	129	38,0%	22,5%	24,8%	14,7%
Dyson	3150	10,1%	13,5%	33,4%	43,0%
Electrolux	2201	13,7%	15,9%	32,9%	37,4%
Hoover	2300	24,1%	18,7%	28,7%	28,6%
Imetec	155	32,9%	23,2%	20,6%	23,2%
Kärcher	348	20,4%	14,9%	27,0%	37,6%
Kirby	253	3,2%	3,6%	17,0%	76,3%
LG	186	17,2%	16,1%	33,9%	32,8%
Miele	5455	6,0%	11,1%	34,0%	48,9%
Moulinex	384	20,3%	16,4%	25,5%	37,8%
Nilfisk	1157	9,6%	13,1%	28,9%	48,4%
Philips	1882	14,2%	15,7%	34,6%	35,5%
Polti	259	18,9%	20,8%	23,2%	37,1%
Rowenta	4785	18,1%	18,4%	33,1%	30,3%
Samsung	470	19,4%	21,3%	30,2%	29,1%
Siemens	409	13,0%	14,7%	31,8%	40,6%
Solac	103	17,5%	12,6%	28,2%	41,7%
Taurus	123	26,0%	20,3%	17,1%	36,6%
Tornado	440	12,0%	15,0%	38,9%	34,1%
Ufesa	245	23,7%	16,7%	31,0%	28,6%
Vorwerk	3602	4,9%	7,8%	21,3%	66,0%

Base: SHHA Appliances 2019-2020 – brands with at least 100 answers

Chart 4.6



SHHA Appliances 2019-2020

81% of Kirby owners (19% of Ariete owners) expect their vacuum cleaner to have a minimum lifecycle of more than 10 years.

Table 4.6 VACUUM CLEANERS –at the moment of buying/getting this vacuum cleaner, how long did you EXPECT to be the MINIMUM LIFECYCLE DURATION of it? BY BRAND

	N	4-5y	6-7y	8-10y	more than 10y
AEG	1673	19,1%	17,3%	32,3%	31,3%
Ariete	151	35,8%	18,5%	26,5%	19,2%
Becken	145	32,4%	20,7%	20,7%	26,2%
Bluesky	106	28,3%	7,5%	27,4%	36,8%
Bosch	2285	17,1%	17,6%	31,1%	34,3%
Carrefour Home	106	24,5%	23,6%	29,2%	22,6%
Delonghi	275	29,1%	18,9%	24,0%	28,0%
Dirt Devil	248	25,0%	25,0%	25,8%	24,2%
Domo	134	35,1%	21,6%	28,4%	14,9%
Dyson	3123	9,4%	11,8%	31,4%	47,4%
Electrolux	2178	11,7%	14,2%	30,9%	43,3%
Hoover	2307	22,3%	17,3%	28,5%	31,9%
Imetec	153	34,6%	20,9%	24,2%	20,3%
Kärcher	346	16,8%	14,2%	24,6%	44,5%
Kirby	266	2,6%	3,0%	13,9%	80,5%
LG	185	12,4%	14,1%	31,4%	42,2%
Miele	5401	6,2%	10,4%	30,6%	52,8%
Moulinex	388	18,3%	15,7%	26,5%	39,4%
Nilfisk	1143	10,1%	11,3%	28,0%	50,7%
Philips	1877	11,8%	15,3%	31,6%	41,2%
Polti	253	17,0%	19,0%	21,3%	42,7%
Rowenta	4743	16,7%	18,0%	31,0%	34,3%
Samsung	476	18,9%	21,4%	28,6%	31,1%
Siemens	411	11,9%	13,6%	28,2%	46,2%
Taurus	120	21,7%	21,7%	14,2%	42,5%
Tornado	443	10,4%	12,4%	34,8%	42,4%
Ufesa	241	18,7%	17,8%	29,0%	34,4%
Vorwerk	3628	5,1%	8,0%	21,7%	65,3%

Base: SHHA Appliances 2019-2020 – brands with at least 100 answers

3. REAL LIFECYCLE OF PREVIOUS APPLIANCES

3.1 WASHING MACHINES

Chart 6.

LHHA Appliances 2019

3 previously owned washing machines out of 4 (BEL 73% FRA 75% ITA 76% POR 73% SPA 75%) were replaced because of reliability-related reasons.

Table 6. Main reason for replacing the previous washing machines – BY COUNTRY

			Belgium	France	Italy	Portugal	Spain	TOTAL
	completely out of use	Count	805	1337	1286	772	301	4501
		% within country	14,0%	16,7%	14,6%	19,8%	5,5%	14,1%
	not working well anymore (and didn't want to repair it)	Count	1430	2223	2263	898	1496	8310
		% within country	25,0%	27,7%	25,7%	23,0%	27,5%	26,0%
	repair costs too high	Count	1778	2215	2813	1010	2075	9891
		% within country	31,0%	27,6%	31,9%	25,9%	38,1%	31,0%
	no spare parts available anymore	Count	172	251	331	177	225	1156
		% within country	3,0%	3,1%	3,8%	4,5%	4,1%	3,6%
	RELIABILITY-RELATED REASONS	***% within country***	***73,0%***	***75,1%***	***76,0%***	***73,2%***	***75,2%***	***74,7%***
	out of date (but still working well)	Count	931	634	966	422	389	3342
		% within country	16,2%	7,9%	11,0%	10,8%	7,1%	10,5%
	another reason (gift, moving, family needs, …)	Count	615	1358	1161	617	963	4714
		% within country	10,7%	16,9%	13,2%	15,8%	17,7%	14,8%
Total		Count	5731	8018	8820	3896	5449	31914
		% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 6.1

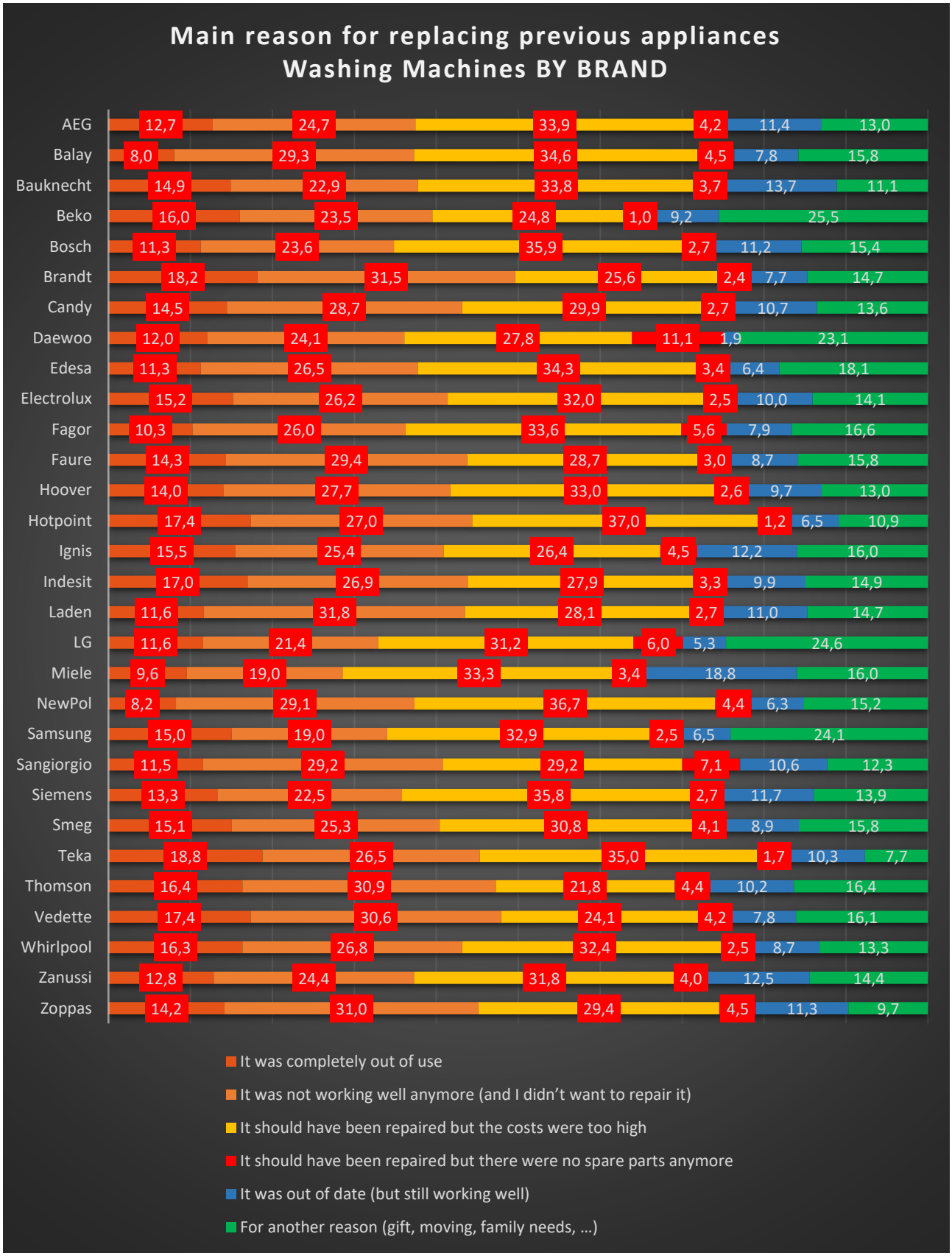
LHHA Appliances 2019

Washing machines have been divided into early, intermediate and late replacement through a Two-steps cluster analysis (poor/early = 1, 2, 3 or 4 years (11%), intermediate/fair = 5, 6, 7 or 8 years (49%), late/good = 9, 10 or more than 10 years (40%)). 79% of intermediately replaced washing machines were replaced because of reliability-related reasons; this is significantly higher than in the other groups (*Pearson chi square = 28,3*).

Table 6.1 Main reason for replacing the previous WASHING MACHINES – BY REPLACEMENT

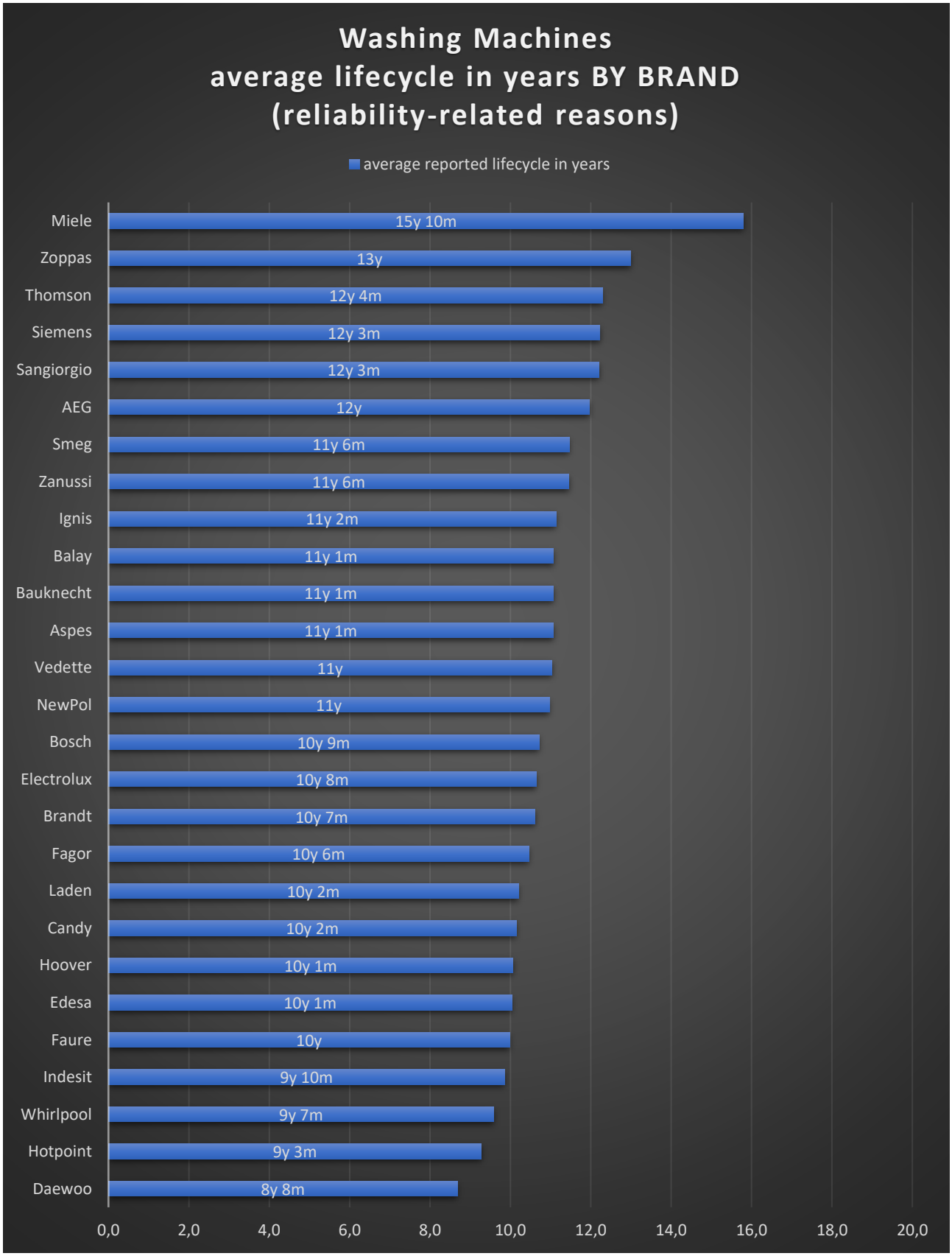
			Early	Intermediate	Late	TOTAL
	completely out of use	Count	287	927	685	1899
		% within country	18,4%	13,8%	12,5%	13,8%
	not working well anymore (and didn't want to repair it)	Count	297	1778	1487	3562
		% within country	19,0%	26,4%	27,2%	25,9%
	repair costs too high	Count	570	2477	1796	4843
		% within country	36,5%	36,8%	32,9%	35,2%
	no spare parts available anymore	Count	26	130	128	284
		% within country	1,7%	1,9%	2,3%	2,1%
	RELIABILITY-RELATED REASONS	***% within country***	**75,5%**	**78,9%**	**75,0%**	**77,0%**
	out of date (but still working well)	Count	41	362	514	917
		% within country	2,6%	5,4%	9,4%	6,7%
	another reason (gift, moving, family needs, …)	Count	341	1059	854	2254
		% within country	21,8%	15,7%	15,6%	16,4%
Total		Count	1562	6733	5464	13759
		% within country	100,0%	100,0%	100,0%	100,0%

Chart 6.2



LHHA Appliances 2019 - these results should be read within the context of a varying lifecycle duration of the respective brands

Chart 7.



LHHA Appliances 2019

Considering only reliability-related reasons for replacing, the **average lifecycle of previous washing machines** has been analysed, by including all brands with at least 30 valid cases. Further statistical analysis was done with One-Way ANOVA in order to detect homogenous subsets of brands.

Table 7. Average lifecycle of washing machines in years (reliability-related reasons) – BY BRAND

brand	N	Mean
Miele	1125	15y 10m
Zoppas	203	13y
Thomson	142	12y 4m
Siemens	664	12y 3m
Sangiorgio	297	12y 3m
AEG	1400	12y
Smeg	73	11y 6m
Zanussi	635	11y 6m
Ignis	191	11y 2m
Balay	703	11y 1m
Bauknecht	362	11y 1m
Aspes	61	11y 1m
Vedette	271	11y
NewPol	111	11y
Bosch	1564	10y 9m
Electrolux	615	10y 8m
Brandt	622	10y 7m
Fagor	492	10y 6m
Laden	146	10y 2m
Candy	1135	10y 2m
Hoover	345	10y 1m
Edesa	130	10y 1m
Faure	138	10y
Indesit	836	9y 10m
Whirlpool	1704	9y 7m
Hotpoint	350	9y 3m
Daewoo	66	8y 8m

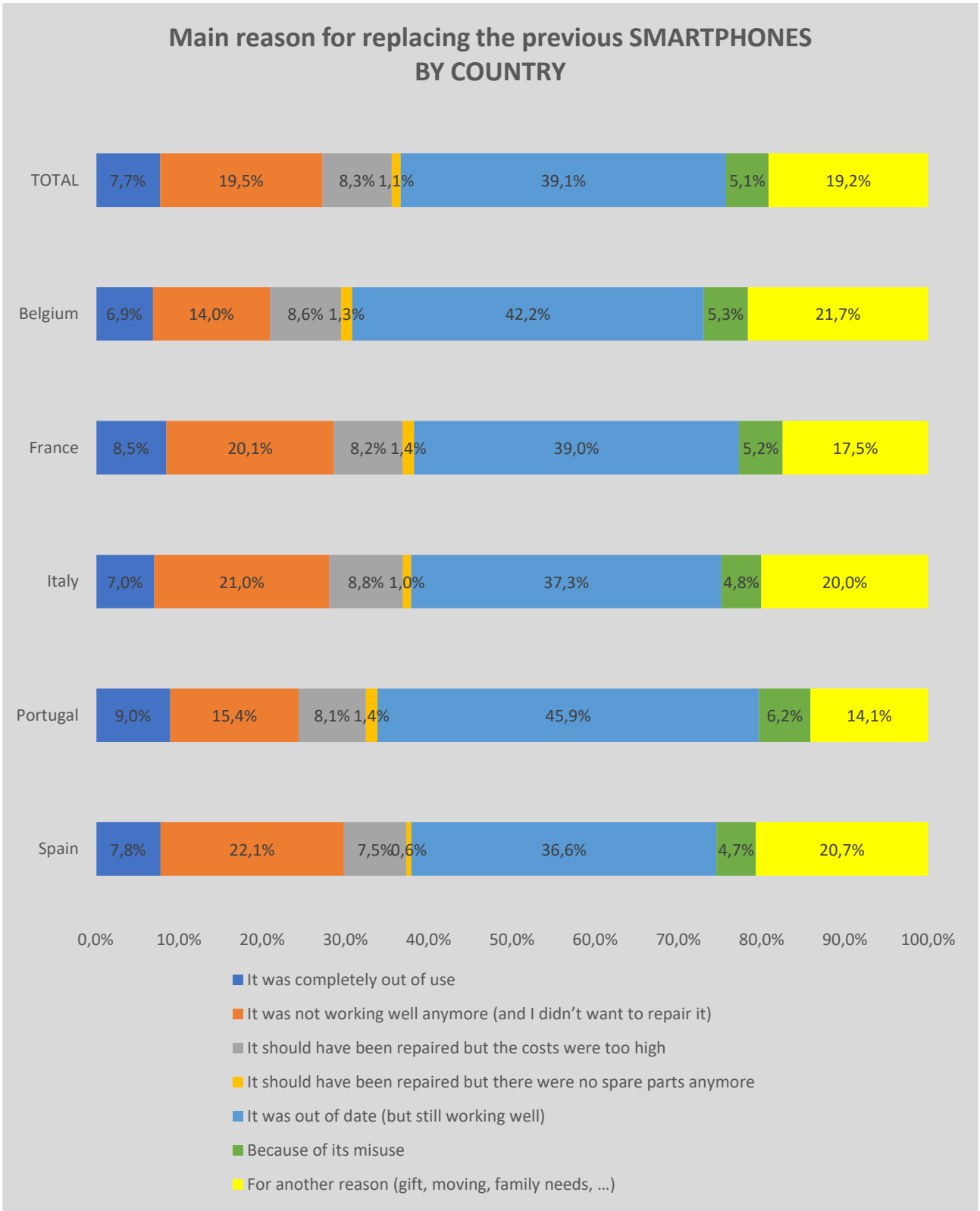
Only devices that have been replaced because of lack of (good) functioning reasons were considered for this analysis.

For lifecycle duration, brands more recently on the market cannot be fairly compared with brands being on the market for a longer period already. Therefore, the 95th percentile of each brand current appliance age (assumed to be a realistic indicator of the presence on the market) has been compared with the highest average age (within all previous appliances brands) plus half of the specific brand standard deviation of the previous appliance. Brands having their 95th percentile below this value have been excluded from the analysis: Becken (Worten), Beko, Carrefour Home, Far, Friac (Eldi), LG, Samsung and Teka**.** For these specific brands, the overview below gives a (less accurate) indication of their lifecycle.

brand	N	Mean
Carrefour Home	40	9y
Teka	67	8y 10m
Friac (Eldi)	36	8y 8m
LG	212	8y 8m
Far	37	8y 6m
Becken (Worten)	30	7y 10m
Samsung	179	7y 2m
Beko	150	6y 10m

3.2 SMARTPHONES

Chart 8.



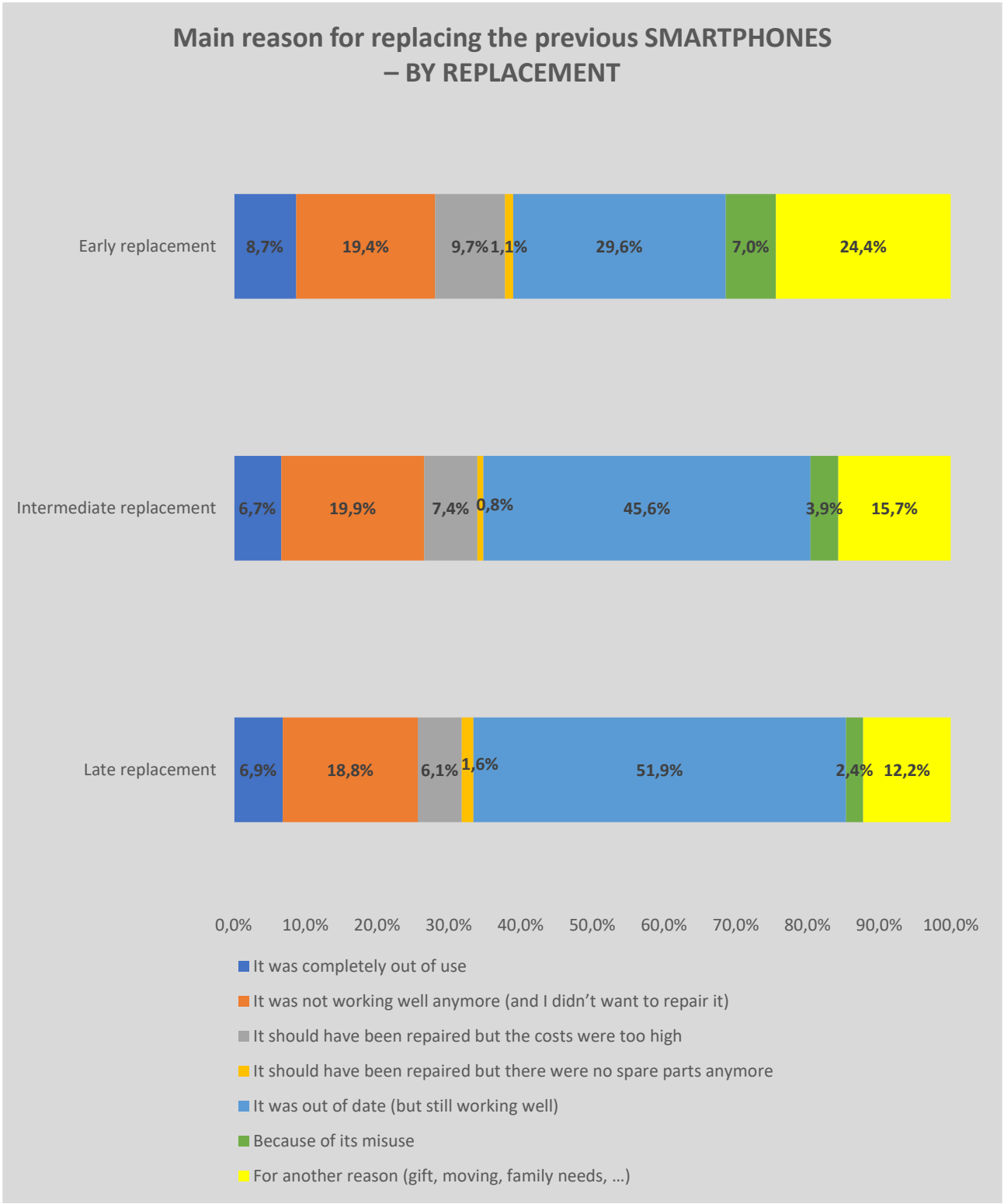
Hi-Tech Devices 2019

36% of previously owned smartphones (BEL 30% FRA 37% ITA 37% POR 33% SPA 37%) were replaced because of reliability-related reasons.

Table 8. Main reason for replacing the previous SMARTPHONES – BY COUNTRY

			Belgium	France	Italy	Portugal	Spain	TOTAL
	completely out of use	Count	236	558	551	206	382	1933
		% within country	6,6%	8,2%	6,9%	8,8%	7,7%	7,5%
	not working well anymore (and didn't want to repair it)	Count	482	1321	1646	354	1083	4886
		% within country	13,6%	19,5%	20,6%	15,0%	21,7%	19,0%
	repair costs too high	Count	294	541	691	185	368	2079
		% within country	8,3%	8,0%	8,6%	7,9%	7,4%	8,1%
	no spare parts available anymore	Count	45	89	78	32	30	274
		% within country	1,3%	1,3%	1,0%	1,4%	0,6%	1,1%
	RELIABILITY-RELATED REASONS	***% within country***	**29,8%**	**37,1%**	**37,1%**	**33,0%**	**37,4%**	**35,7%**
	out of date (but still working well)	Count	1449	2561	2918	1053	1799	9780
		% within country	40,8%	37,9%	36,5%	44,7%	36,1%	38,1%
	because of its misuse (e.g. fall)	Count	182	344	373	142	233	1274
		% within country	5,1%	5,1%	4,7%	6,0%	4,7%	5,0%
	another reason (gift, moving, family needs, …)	Count	743	1146	1568	324	1015	4796
		% within country	20,9%	16,9%	19,6%	13,8%	20,4%	18,7%
Total		Count	3431	6560	7825	2296	4910	25022
		% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 8.1



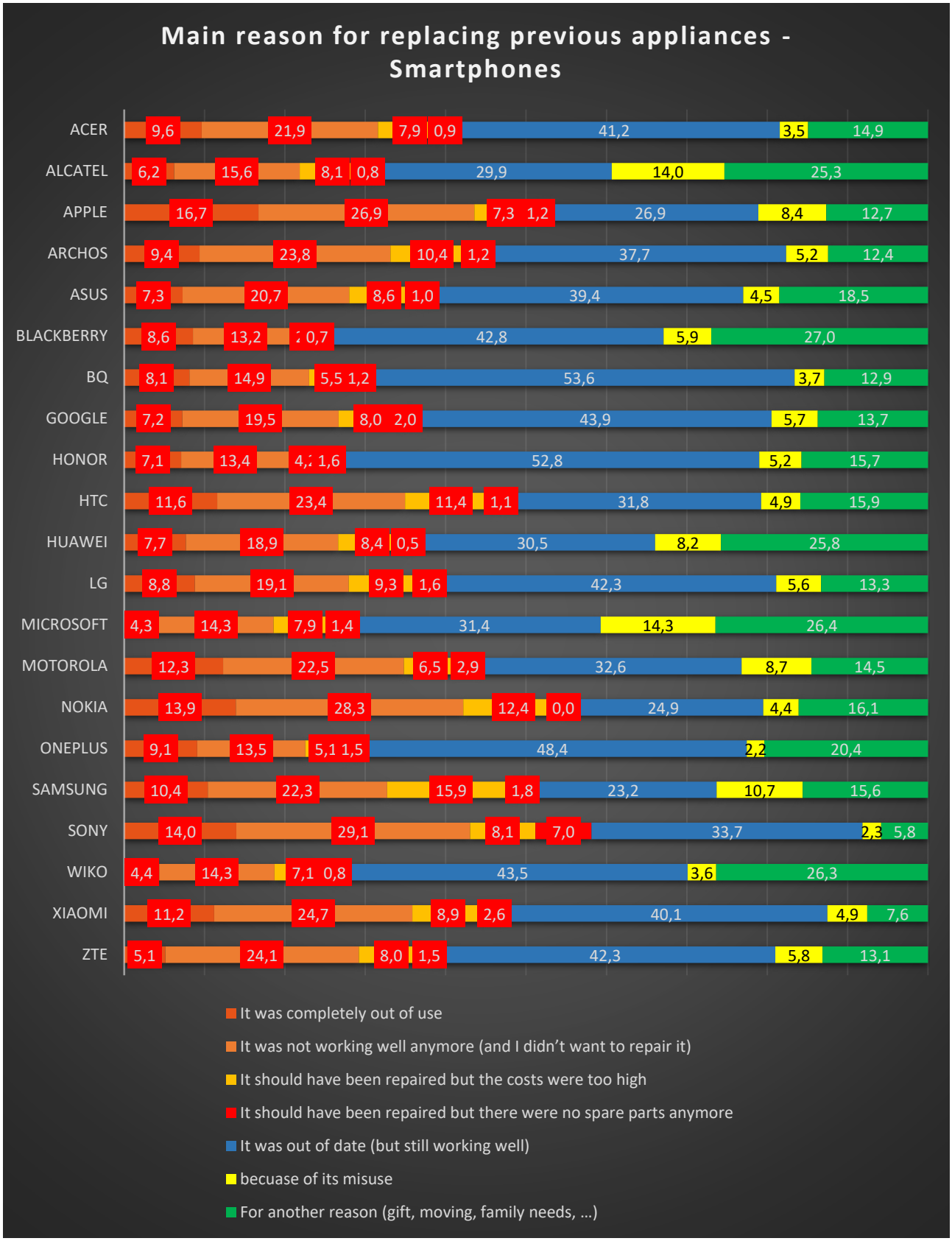
Hi-Tech Devices 2019

Smartphones have been divided into early, intermediate and late replacement through a Two-steps cluster analysis (poor/early = 1, 2 or 3 years (52%), intermediate/fair =4 or 5 years (39%), late/good = 6, 7, 8, 9, 10 or more than 10 years (9%)). 39% of early replaced smartphones were replaced because of reliability-related reasons; this is significantly higher than in the other groups (*Pearson chi square = 55,8*).

Table 8.1 Main reason for replacing the previous SMARTPHONES – BY REPLACEMENT

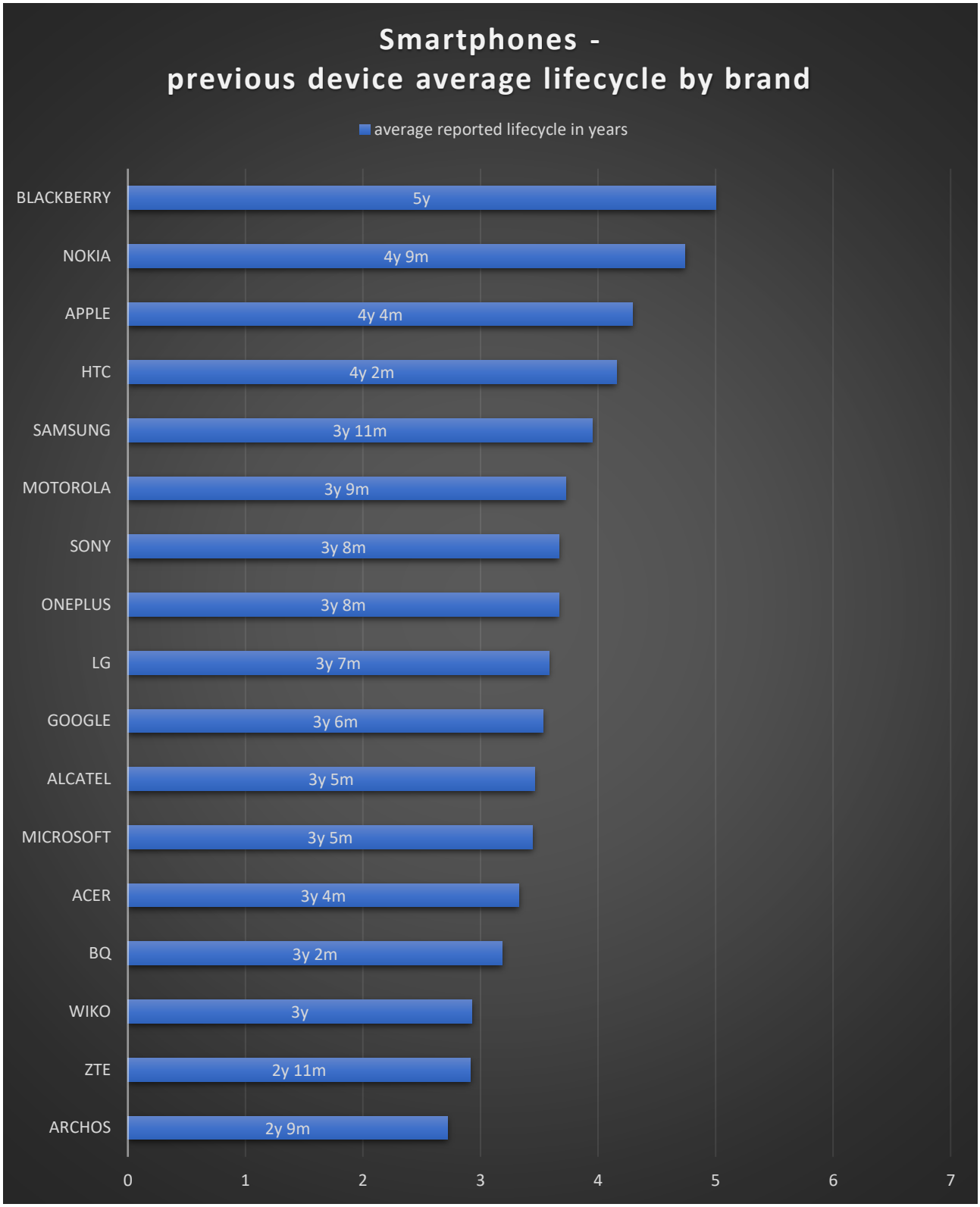
			Early	Intermediate	Late	TOTAL
	completely out of use	Count	999	636	242	1877
		% within country	8,7%	6,7%	6,9%	7,6%
	not working well anymore (and didn't want to repair it)	Count	2219	1903	664	4786
		% within country	19,4%	19,9%	18,8%	19,5%
	repair costs too high	Count	1114	712	216	2042
		% within country	9,7%	7,4%	6,1%	8,3%
	no spare parts available anymore	Count	131	79	58	268
		% within country	1,1%	0,8%	1,6%	1,1%
	RELIABILITY-RELATED REASONS	***% within country***	**39,0%**	**34,8%**	**33,4%**	**36,6%**
	out of date (but still working well)	Count	3393	4359	1832	9584
		% within country	29,6%	45,6%	51,9%	39,1%
	because of its misuse (e.g. fall)	Count	801	372	85	1258
		% within country	7,0%	3,9%	2,4%	5,1%
	another reason (gift, moving, family needs, …)	Count	2794	1499	431	4724
		% within country	24,4%	15,7%	12,2%	19,3%
Total		Count	11451	9560	3528	24539
		% within country	100,0%	100,0%	100,0%	100,0%

Chart 8.2



Hi-Tech Devices 2019 - these results should be read within the context of a varying lifecycle duration of the respective brands

Chart 9.



Hi-Tech Devices 2019

Considering only reliability-related reasons for replacing, the **average lifecycle of previous smartphones** has been analysed, by including all brands with at least 30 valid cases. Further statistical analysis was done with One-Way ANOVA in order to detect homogenous subsets of brands.

Table 9. Average lifecycle of smartphones in years (reliability-related reasons) – BY BRAND

brand	N	Mean
BLACKBERRY	79	5 years
NOKIA	448	4 years and 9 months
APPLE	1246	4 years and 4 months
HTC	142	4 years and 2 months
SAMSUNG	3294	3 years and 11 months
MOTOROLA	142	3 years and 9 months
ONEPLUS	33	3 years and 8 months
SONY	446	3 years and 8 months
LG	473	3 years and 7 months
GOOGLE	60	3 years and 6 months
ALCATEL	141	3 years and 6 months
MICROSOFT	99	3 years and 5 months
ACER	52	3 years and 4 months
BQ	221	3 years and 2 months
WIKO	266	2 years and 11 months
ZTE	46	2 years and 11 months
ARCHOS	50	2 years and 9 months

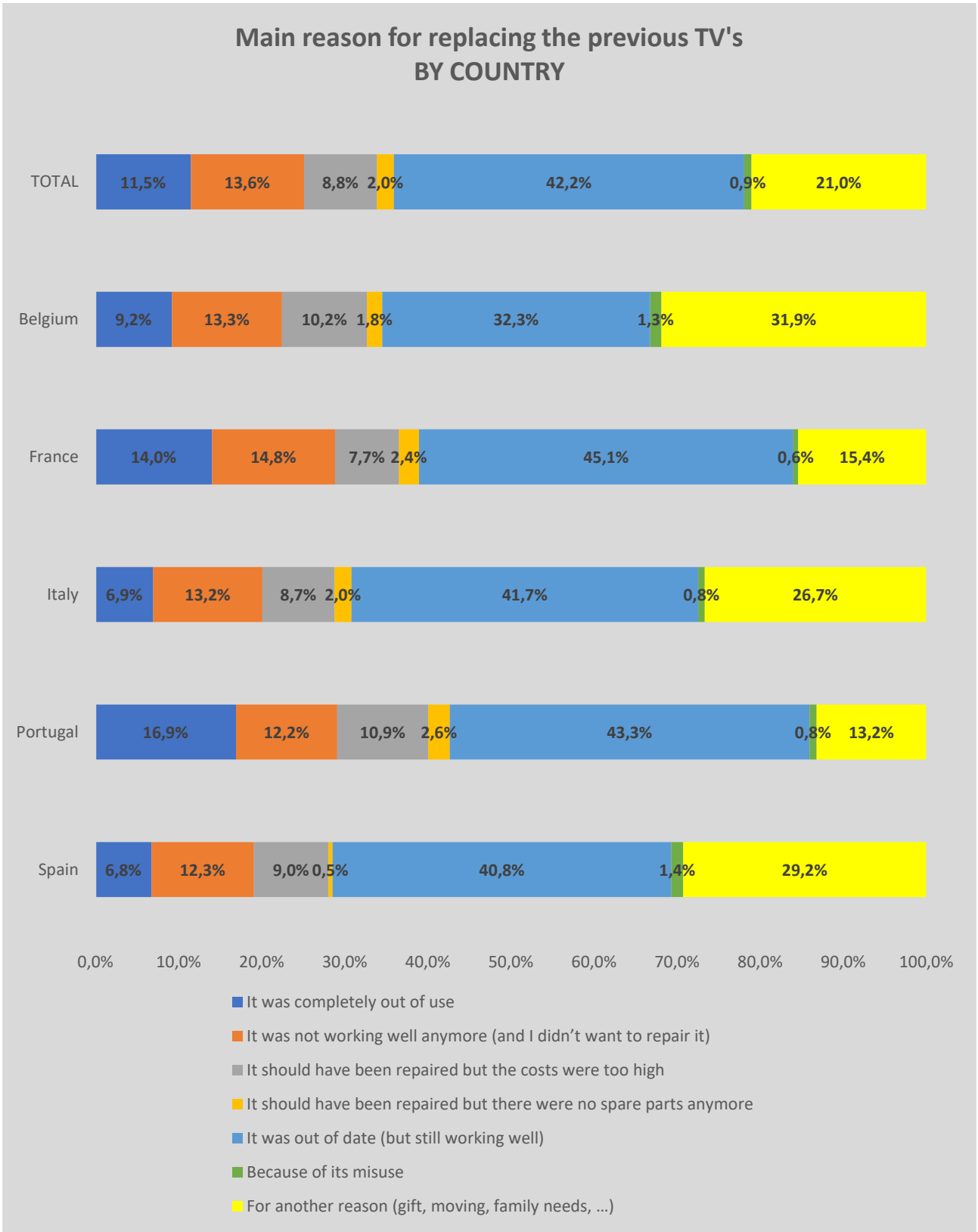
Only devices that have been replaced because of lack of (good) functioning reasons were considered for this analysis.

For lifecycle duration, brands more recently on the market cannot be fairly compared with brands being on the market for a longer period already. Therefore, the 95th percentile of each brand current device age (assumed to be a realistic indicator of the presence on the market) has been compared with the highest average age (within all previous devices brands) plus half of the specific brand standard deviation of the previous device. Brands having their 95th percentile below this value have been excluded from the analysis: For these specific brands, the overview below gives a (less accurate) indication of their lifecycle.

brand	N	Mean
HUAWEI	611	3 years and 1 months
HONOR	37	2 years and 10 months
ASUS	165	2 years and 9 months
XIAOMI	110	2 years and 6 months

3.3 TV's

Chart 10.



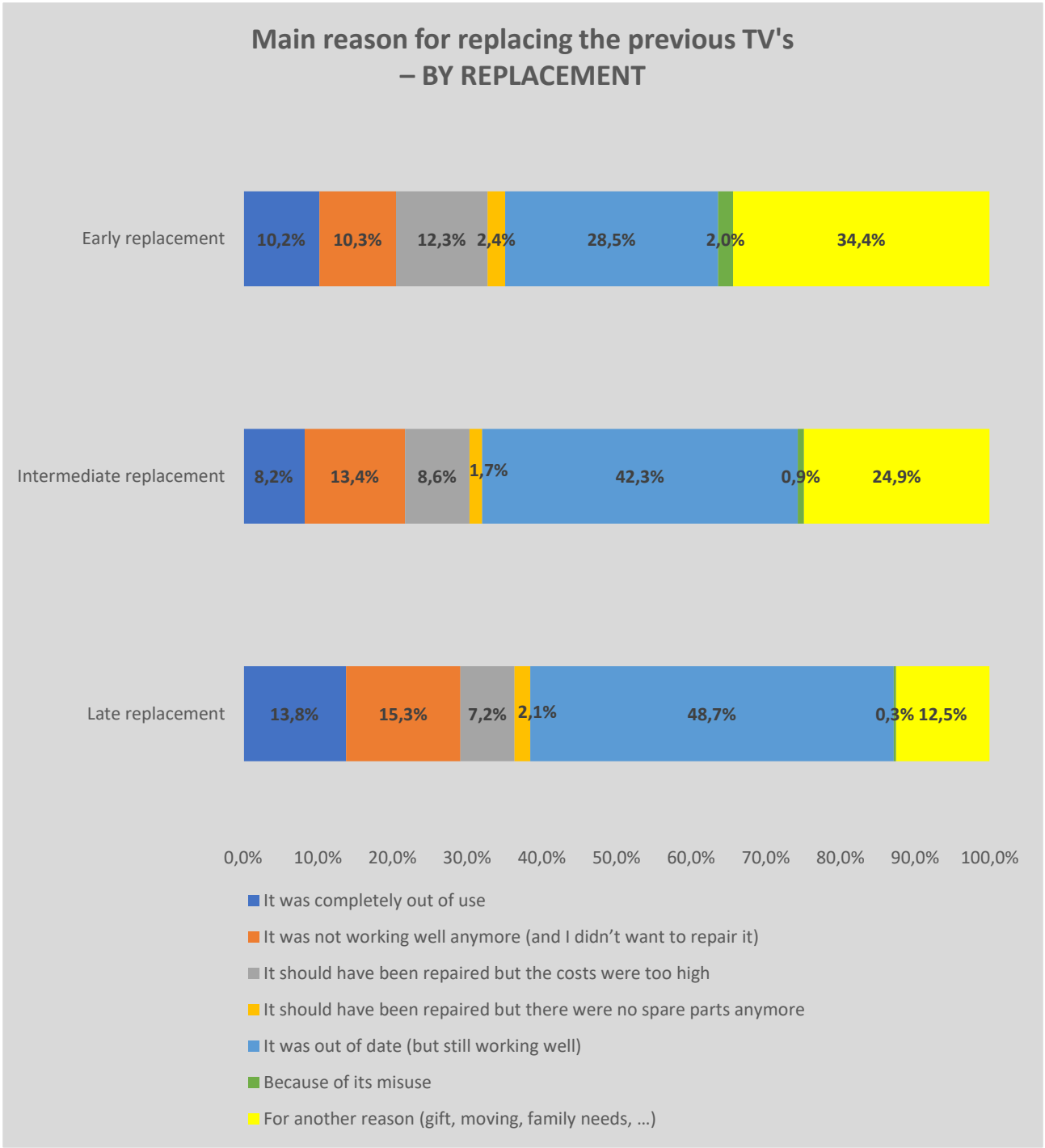
Hi-Tech Devices 2019

34% of previously owned TV's (BEL 32% FRA 37% ITA 29% POR 41% SPA 27%) were replaced because of reliability-related reasons.

Table 10. Main reason for replacing the previous TV's – BY COUNTRY

			Belgium	France	Italy	Portugal	Spain	TOTAL
	completely out of use	Count	199	1167	266	442	185	2259
		% within country	8,6%	13,3%	6,6%	16,2%	6,5%	10,9%
	not working well anymore (and didn't want to repair it)	Count	287	1231	504	319	337	2678
		% within country	12,5%	14,0%	12,5%	11,7%	11,8%	12,9%
	repair costs too high	Count	221	641	332	286	246	1726
		% within country	9,6%	7,3%	8,3%	10,5%	8,6%	8,3%
	no spare parts available anymore	Count	40	201	78	68	14	401
		% within country	1,7%	2,3%	1,9%	2,5%	0,5%	1,9%
	RELIABILITY-RELATED REASONS	***% within country***	**32,4%**	**36,9%**	**29,4%**	**40,9%**	**27,4%**	**34,2%**
	out of date (but still working well)	Count	698	3749	1599	1132	1117	8295
		% within country	30,3%	42,7%	39,8%	41,5%	39,1%	40,1%
	Because of its misuse (e.g. fall)	Count	29	49	30	22	39	169
		% within country	1,3%	0,6%	0,7%	0,8%	1,4%	0,8%
	another reason (gift, moving, family needs, …)	Count	690	1281	1021	345	801	4138
		% within country	30,0%	14,6%	25,4%	12,6%	28,0%	20,0%
Total		Count	2164	8319	3830	2614	2739	19666
		% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 10.1



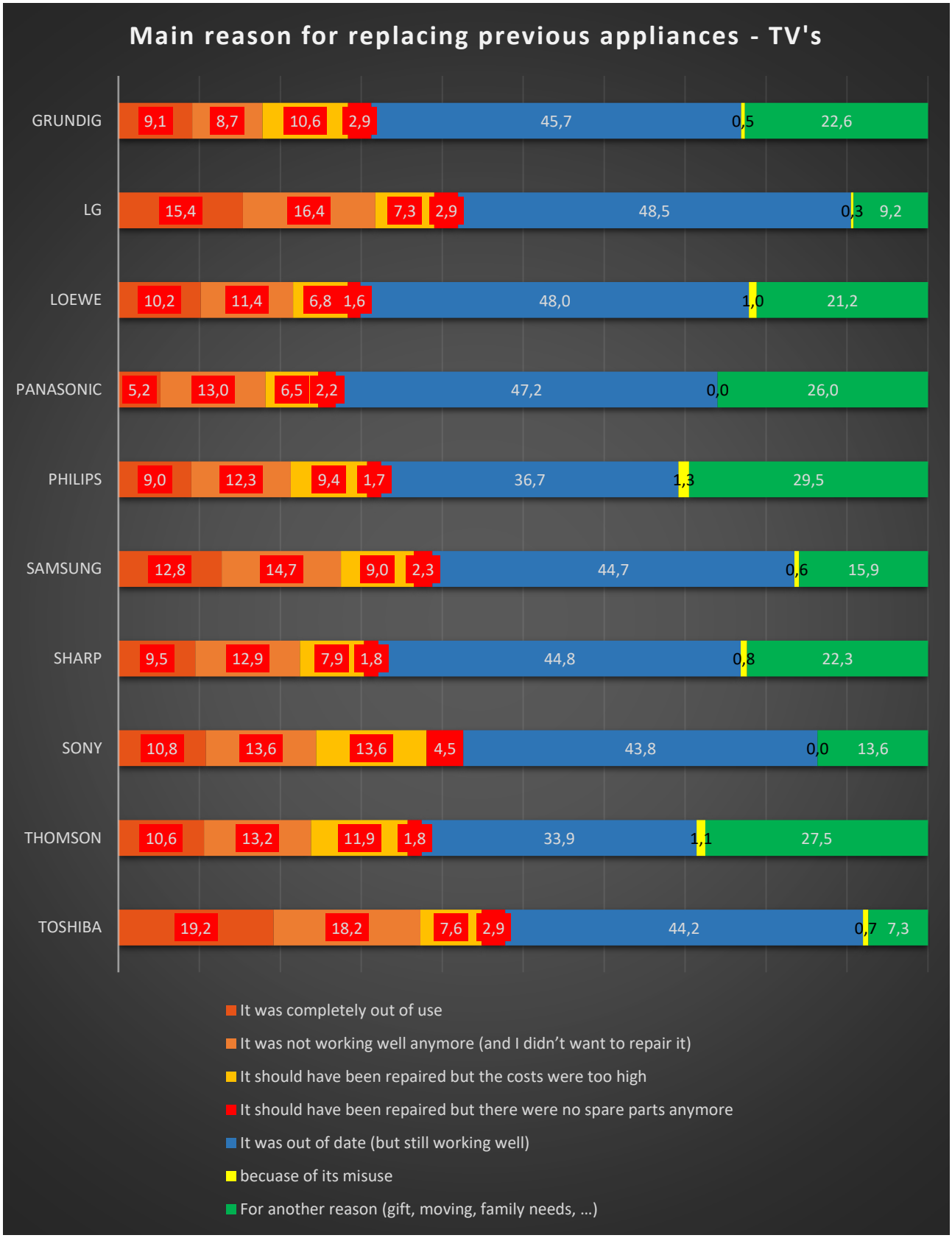
Hi-Tech Devices 2019

TV's have been divided into early, intermediate and late replacement through a Two-steps cluster analysis. (poor/early = 1, 2, 3, 4 or 5 years (34%), intermediate/fair =6, 7 or 8 years (38%), late/good = 9, 10 or more than 10 years (28%)). 38% of lately replaced TV's were replaced because of reliability-related reasons; this is significantly higher than in the other groups (*Pearson chi square = 64,2*).

Table 10.1 Main reason for replacing the previous TV's – BY REPLACEMENT

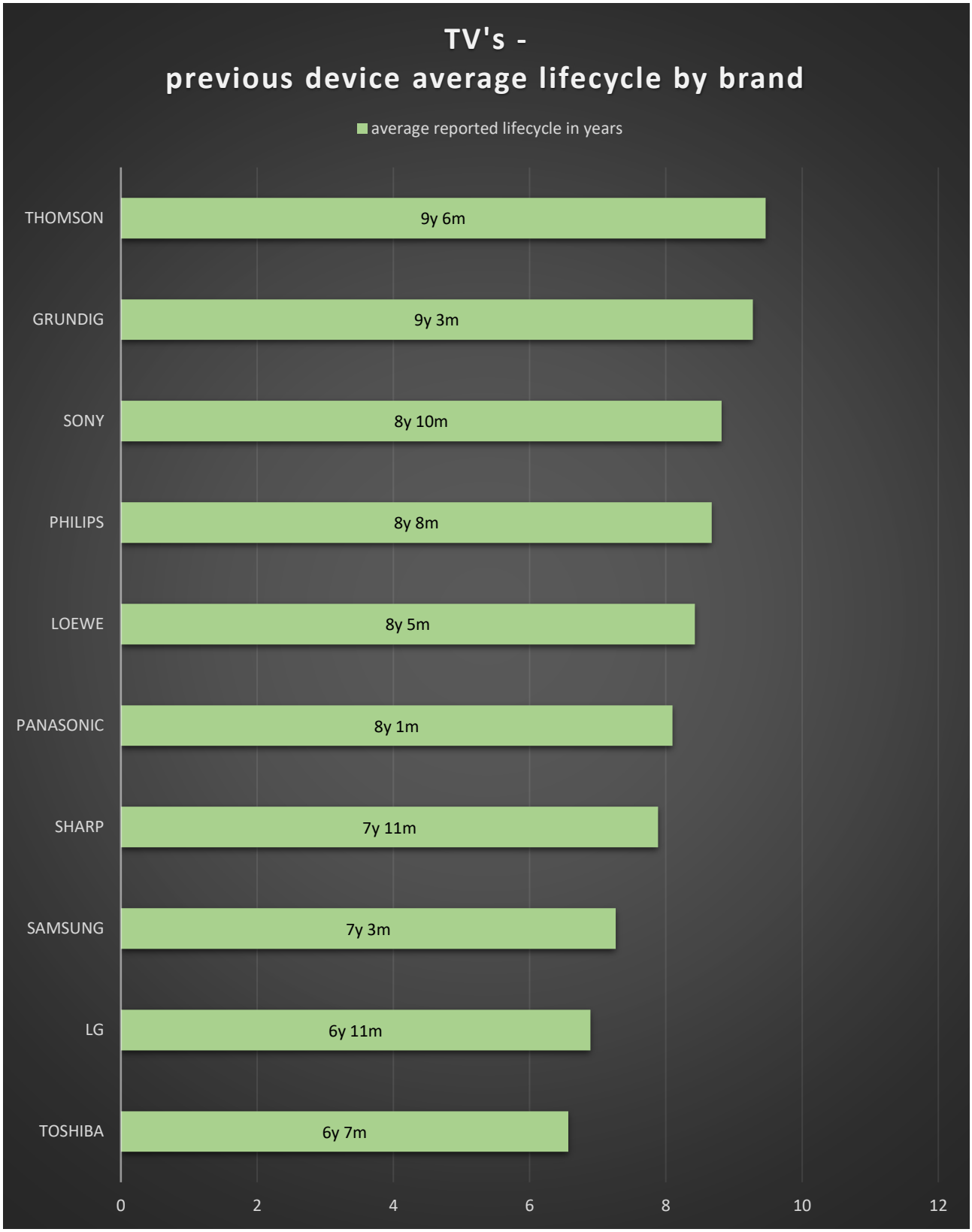
			Early	Intermediate	Late	TOTAL
	completely out of use	Count	435	471	1265	2171
		% within country	10,2%	8,2%	13,8%	11,3%
	not working well anymore (and didn't want to repair it)	Count	437	767	1410	2614
		% within country	10,3%	13,4%	15,3%	13,6%
	repair costs too high	Count	522	493	664	1679
		% within country	12,3%	8,6%	7,2%	8,8%
	no spare parts available anymore	Count	101	98	193	392
		% within country	2,4%	1,7%	2,1%	2,0%
	RELIABILITY-RELATED REASONS	***% within country***	**35,1%**	**32,0%**	**38,4%**	**35,8%**
	out of date (but still working well)	Count	28,5%	42,3%	48,7%	42,3%
		% within country	85	49	30	164
	because of its misuse (e.g. fall)	Count	2,0%	0,9%	0,3%	0,9%
		% within country	1464	1419	1150	4033
	another reason (gift, moving, family needs, …)	Count	34,4%	24,9%	12,5%	21,1%
		% within country	28,5%	42,3%	48,7%	42,3%
Total		Count	4259	5710	9187	19156
		% within country	100,0%	100,0%	100,0%	100,0%

Chart 10.2



Hi-Tech Devices 2019 - these results should be read within the context of a varying lifecycle duration of the respective brands

Chart 11.



Hi-Tech Devices 2019

Considering only reliability-related reasons for replacing, the **average lifecycle of previous TV's** has been analysed, by including all brands with at least 30 valid cases. Further statistical analysis was done with One-Way ANOVA in order to detect homogenous subsets of brands.

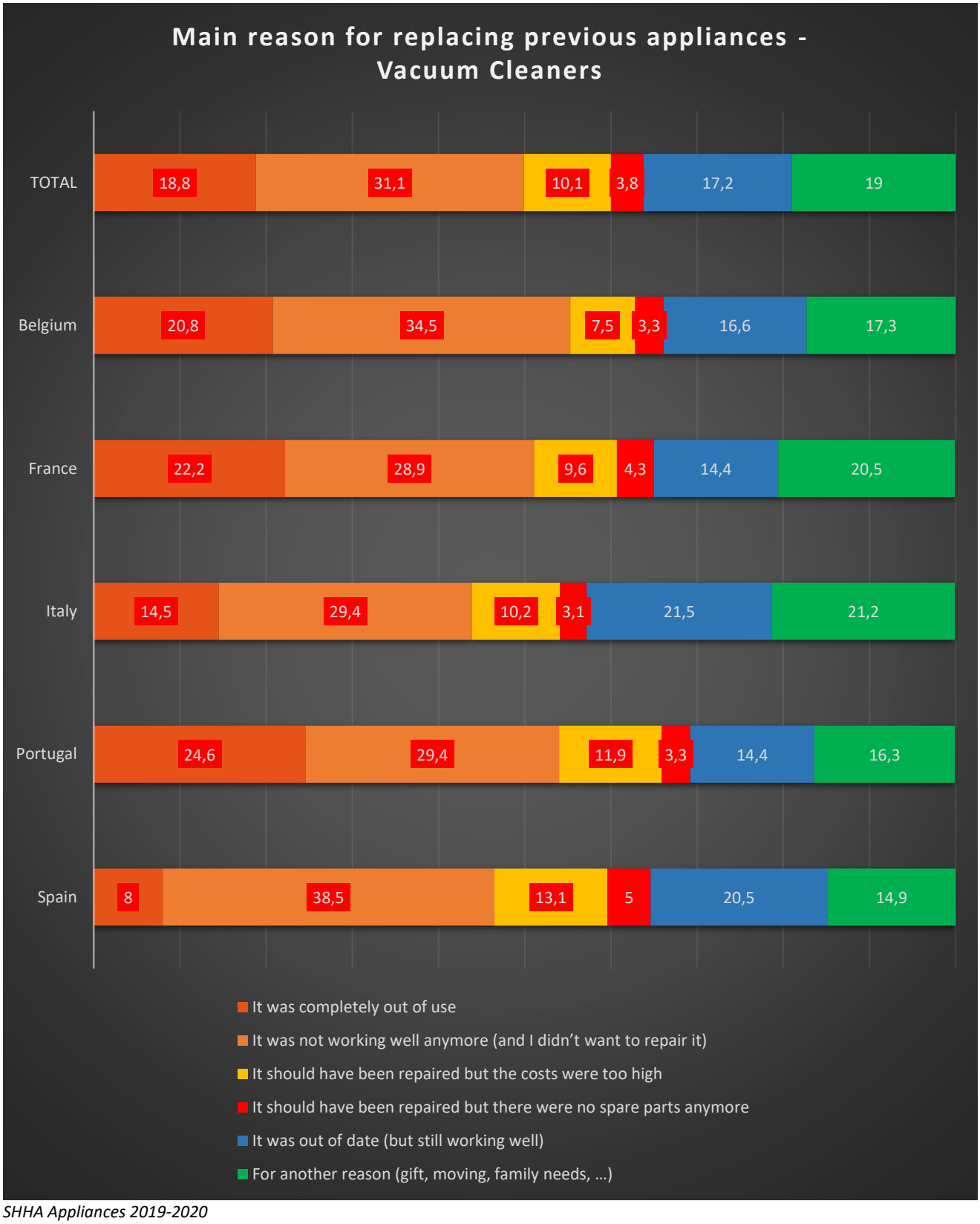
Table 11. Average lifecycle of TV's in years (reliability-related reasons) – BY BRAND

brand	N	Mean
THOMSON	395	9 years and 6 months
GRUNDIG	415	9 years and 3 months
SONY	991	8 years and 10 months
PHILIPS	1527	8 years and 8 months
LOEWE	73	8 years and 5 months
PANASONIC	442	8 years and 1 months
SHARP	62	7 years and 11 months
SAMSUNG	1385	7 years and 3 months
LG	776	6 years and 11 months
TOSHIBA	65	6 years and 7 months

Only devices that have been replaced because of lack of (good) functioning reasons were considered for this analysis.

3.4 VACUUM CLEANERS

Chart 12.



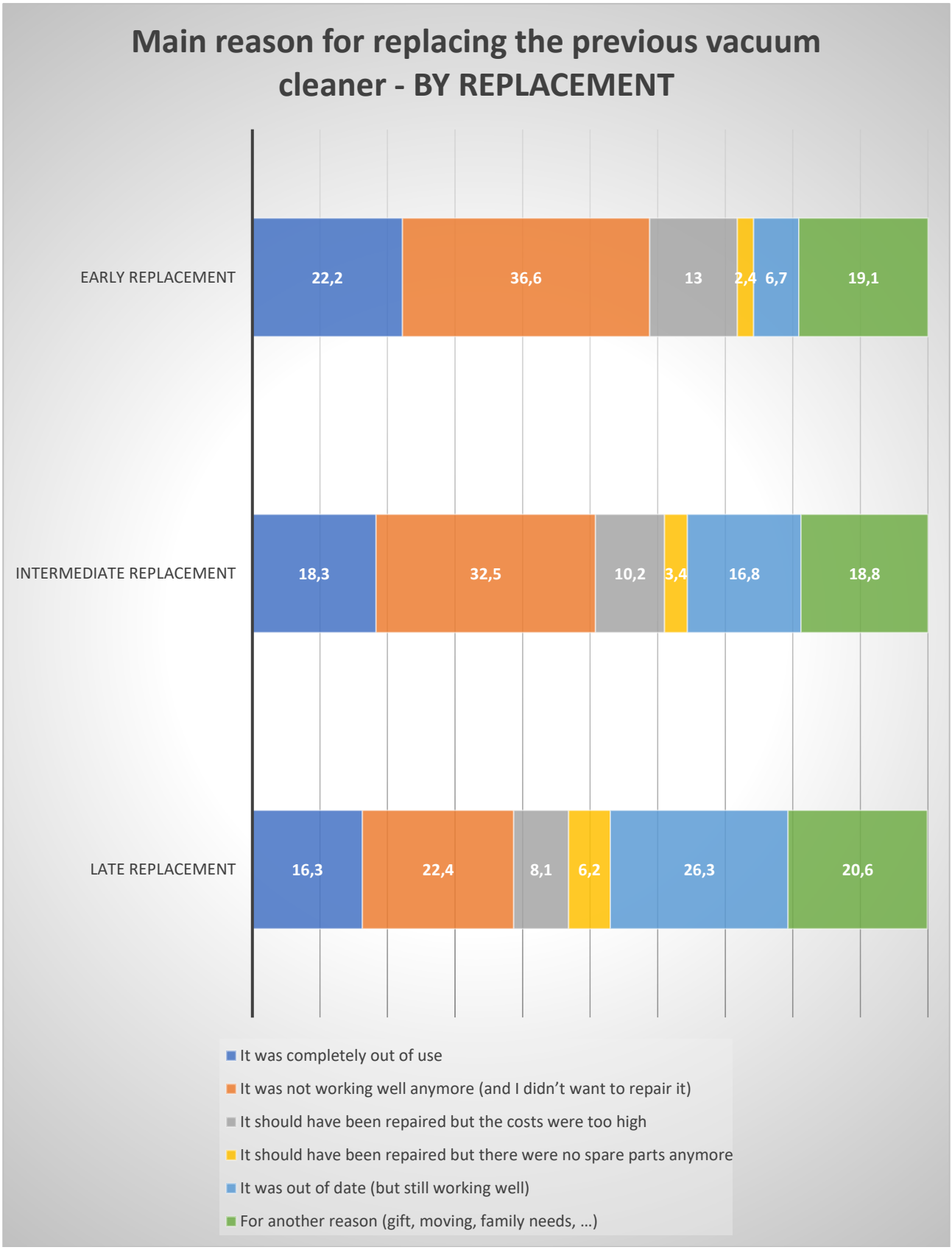
SHHA Appliances 2019-2020

64 % of vacuum cleaners (BEL 66% FRA 65% ITA 57% POR 69% SPA 65%) were replaced because of reliability-related reasons.

Table 12. Main reason for replacing the previous vacuum cleaners – BY COUNTRY

			Belgium	France	Italy	Portugal	Spain	TOTAL
	completely out of use	Count	1593	3595	1709	1388	396	8681
		% within country	20,8%	22,2%	14,5%	24,6%	8,0%	18,8%
	not working well anymore (and didn't want to repair it)	Count	2648	4677	3462	1658	1912	14357
		% within country	34,5%	28,9%	29,4%	29,4%	38,5%	31,1%
	repair costs too high	Count	577	1552	1205	672	652	4658
		% within country	7,5%	9,6%	10,2%	11,9%	13,1%	10,1%
	no spare parts available anymore	Count	252	699	368	186	250	1755
		% within country	3,3%	4,3%	3,1%	3,3%	5,0%	3,8%
	RELIABILITY-RELATED REASONS	***% within country***	**66,1%**	**65,1%**	**57,3%**	**69,3%**	**64,6%**	**63,7%**
	Out-dated or consuming too much (but still working well)	Count	1276	2332	2532	811	1018	7969
		% within country	16,6%	14,4%	21,5%	14,4%	20,5%	17,2%
	another reason (e.g. gift)	Count	1324	3306	2492	918	741	8781
		% within country	17,3%	20,5%	21,2%	16,3%	14,9%	19,0%
Total		Count	7670	16161	11768	5633	4969	46201
		% within country	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Chart 12.1



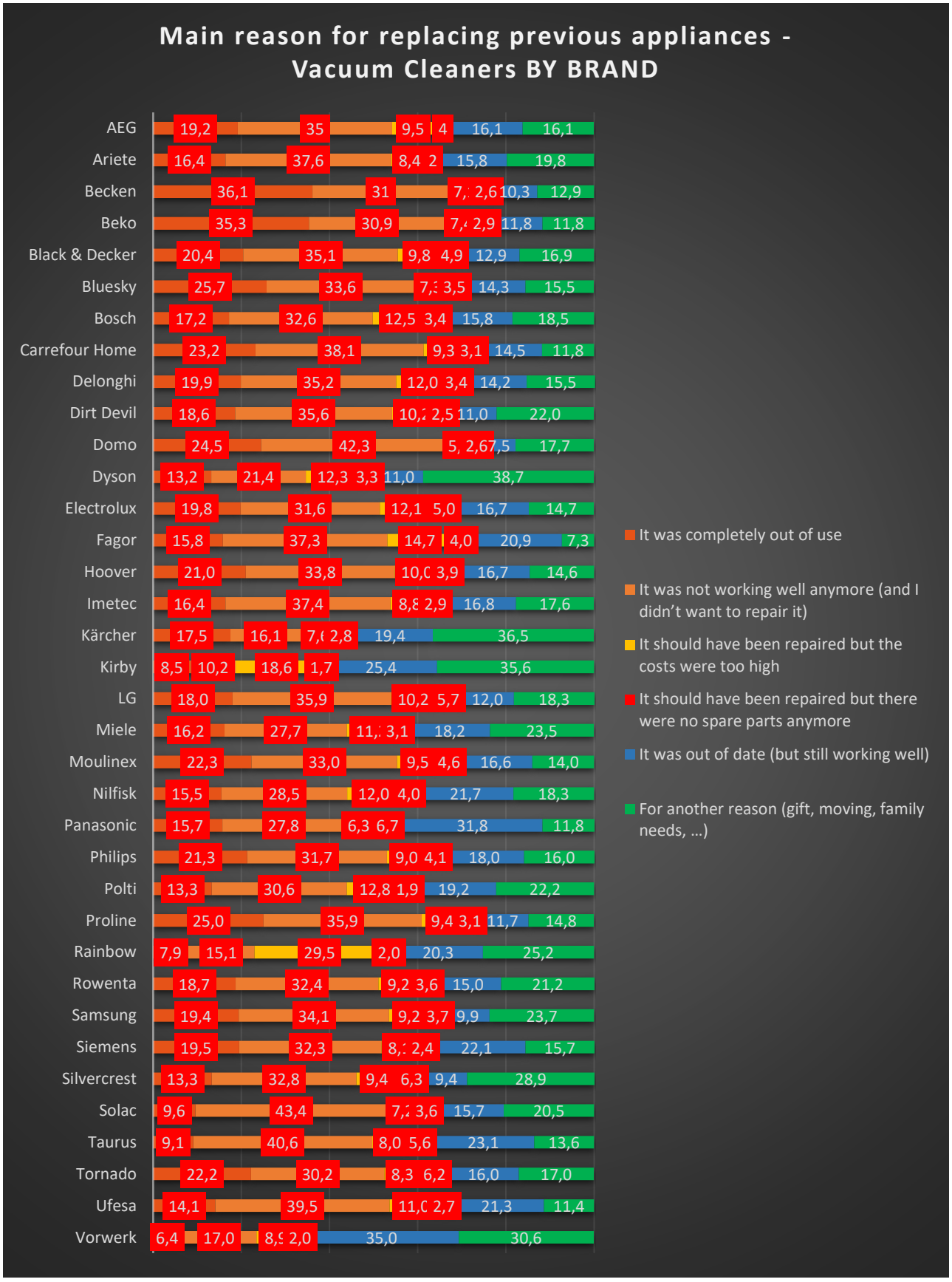
SHHA Appliances 2019-2020

Vacuum cleaners have been divided into early, intermediate and late replacement through a Two-steps cluster analysis (poor/early = 1 to 4 years (15%), intermediate/fair = 5 to 12 years (64%), late/good = more than 12 years (22%)). 74% of early replaced vacuum cleaners were replaced because of reliability-related reasons; this is significantly higher than in the other groups.

Table 12.1 Main reason for replacing the previous VACUUM CLEANERS – BY REPLACEMENT

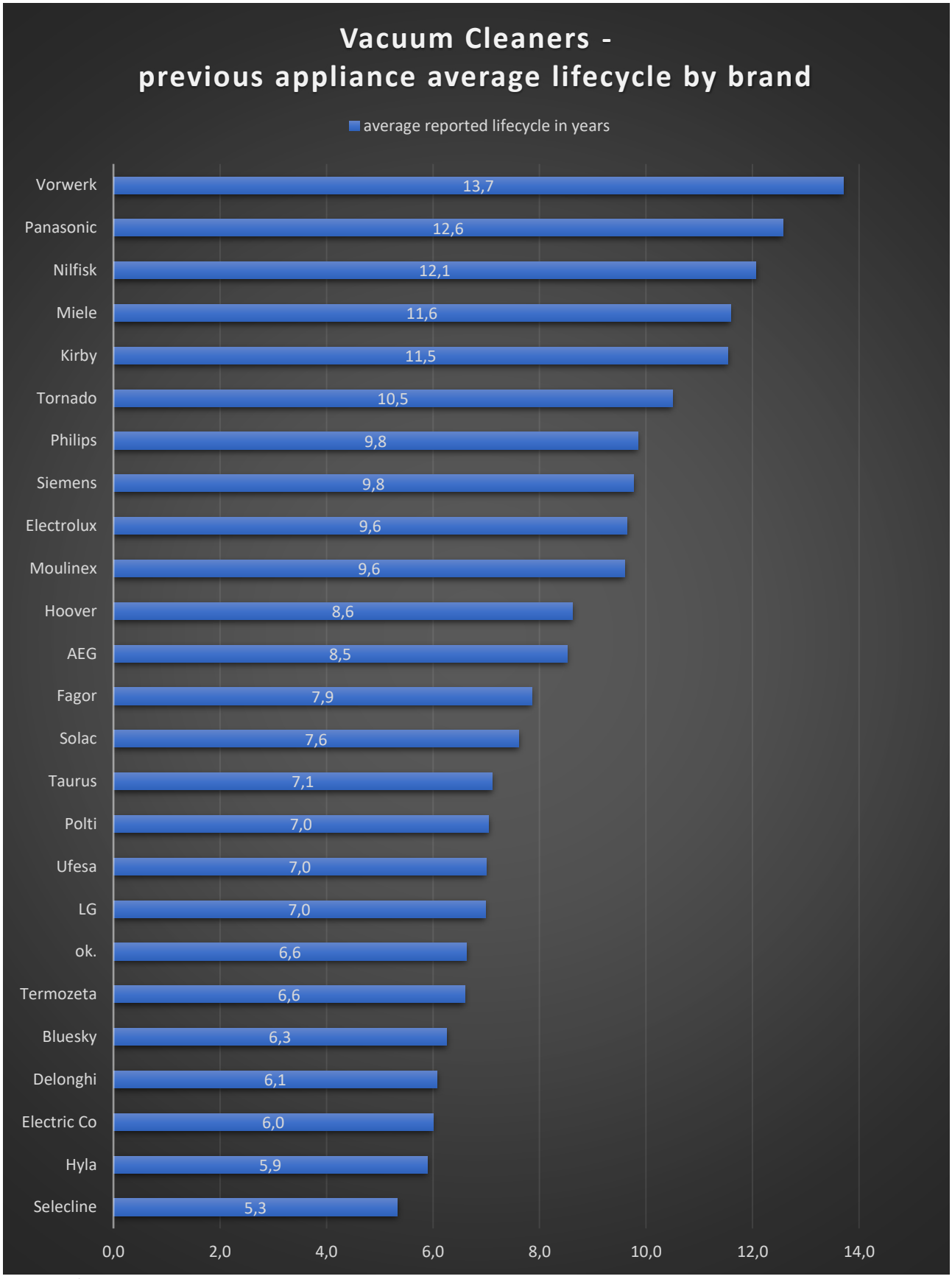
			Early	Intermediate	Late	TOTAL
	completely out of use	Count	1444	5007	1511	7962
		% within country	22,2%	18,3%	16,3%	18,5%
	not working well anymore (and didn't want to repair it)	Count	2382	8882	2082	13346
		% within country	36,6%	32,5%	22,4%	31,0%
	repair costs too high	Count	847	2782	755	4384
		% within country	13,0%	10,2%	8,1%	10,2%
	no spare parts available anymore	Count	157	927	576	1660
		% within country	2,4%	3,4%	6,2%	3,9%
	RELIABILITY-RELATED REASONS	***% within country***	**74,2%**	**64,5%**	**53,1%**	**63,5%**
	out of date (but still working well)	Count	434	4574	2439	7447
		% within country	6,7%	16,8%	26,3%	17,3%
	another reason (gift, moving, family needs, …)	Count	1243	5130	1915	8288
		% within country	19,1%	18,8%	20,6%	19,2%
Total		Count	6507	27302	9278	43087
		% within country	100,0%	100,0%	100,0%	100,0%

Chart 12.2



SHHA Appliances 2019-2020 - these results should be read within the context of a varying lifecycle duration of the respective brands

Chart 13.



SHHA Appliances 2019-2020

Considering only reliability-related reasons for replacing, the **average lifecycle of previous vacuum cleaners** has been analysed, by including all brands with at least 30 valid cases. Further statistical analysis was done with One-Way ANOVA in order to detect homogenous subsets of brands.

Table 13. Average lifecycle of vacuum cleaners in years (reliability-related reasons) – BY BRAND

brand	N	Mean
Vorwerk	844	13 y 8 m
Panasonic	142	12 y 6 m
Nilfisk	746	12 y 0 m
Miele	2285	11 y 7 m
Kirby	67	11 y 6 m
Tornado	582	10 y 5 m
Philips	2165	9 y 10 m
Siemens	400	9 y 9 m
Electrolux	2433	9 y 7 m
Moulinex	658	9 y 7 m
Hoover	3065	8 y 7 m
AEG	1469	8 y 6 m
Fagor	120	7 y 10 m
Solac	98	7 y 7 m
Taurus	166	7 y 1 m
Polti	196	7 y 0 m
Ufesa	165	6 y 11 m
LG	221	6 y 11 m
ok.	31	6 y 7 m
Termozeta	42	6 y 7 m
Bluesky	227	6 y 3 m
Delonghi	453	6 y 0 m
Electric Co	47	6 y 0 m
Hyla	46	5 y 10 m
Selecline	30	5 y 3 m

Only devices that have been replaced because of lack of (good) functioning reasons were considered for this analysis.

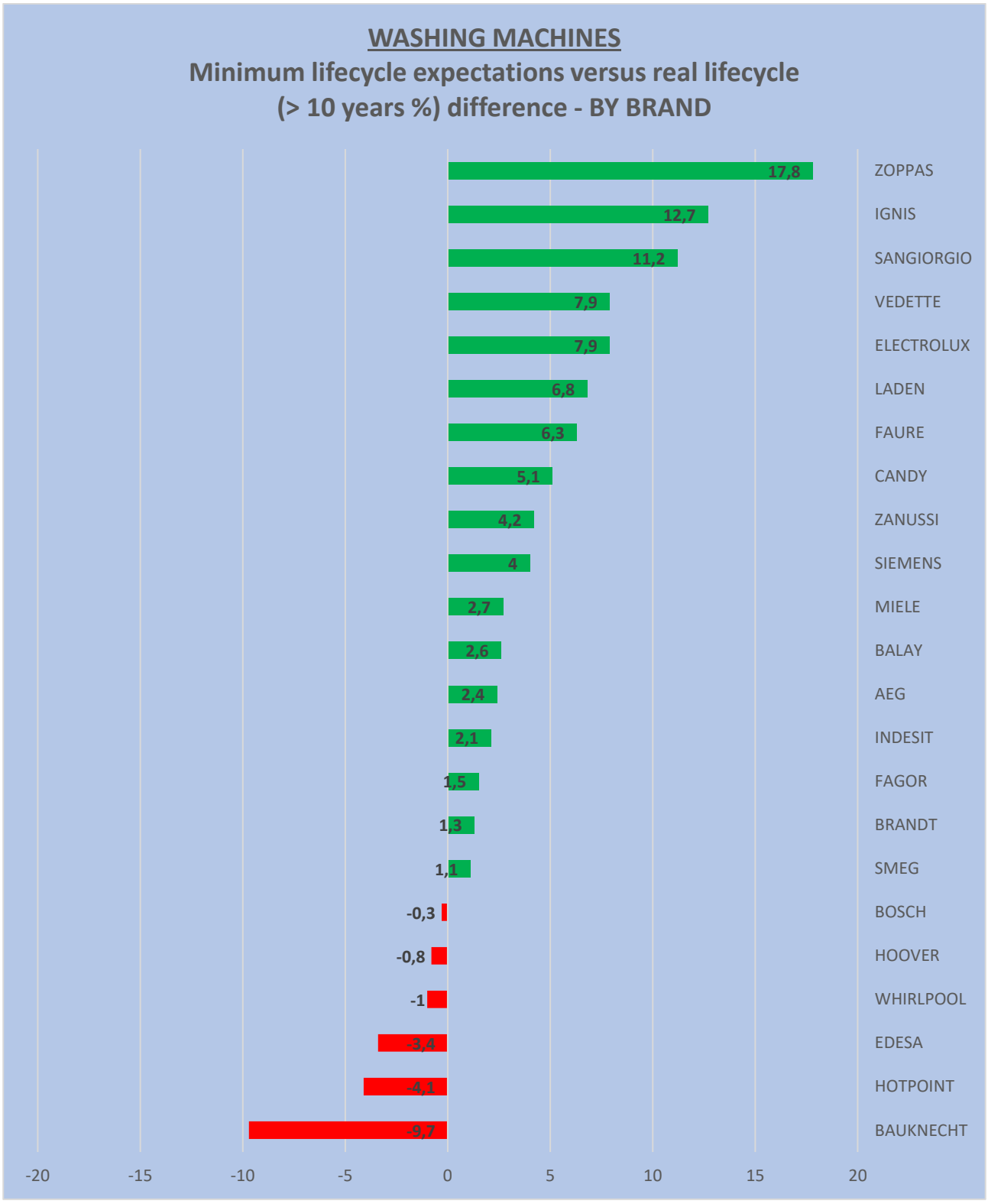
For lifecycle duration, brands more recently on the market cannot be fairly compared with brands being on the market for a longer period already. Therefore, the 95th percentile of each brand current appliance age (assumed to be a realistic indicator of the presence on the market) has been compared with the highest average age (within all previous appliances brands) plus half of the specific brand standard deviation of the previous appliance. Brands having their 95th percentile below this value have been excluded from the analysis. For these specific brands, the overview below gives a (less accurate) indication of their lifecycle.

brand	N	Mean
Ariete	184	6 y 3 m
Becken	117	5 y 8 m
Beko	102	5 y 3 m
Black & Decker	148	6 y 11 m
Bosch	1614	7 y 8 m
Carrefour Home	201	6 y 0 m
Dirt Devil	150	4 y 5 m
Domo	180	5 y 2 m
Dyson	813	7 y 5 m
Imetec	144	6 y 2 m
Kärcher	87	7 y 8 m
Proline	89	6 y 7 m
Quigg (Aldi)	37	5 y 7 m
Rowenta	2586	7 y 11 m
Samsung	267	6 y 11 m
Severin	42	6 y 8 m
Silvercrest	77	4 y 9 m
Zanussi	55	8 y 2 m

4. DIFFERENCES BETWEEN EXPECTATIONS AND REAL DURATION

4.1 WASHING MACHINES

Chart 15.



LHHA Appliances 2019

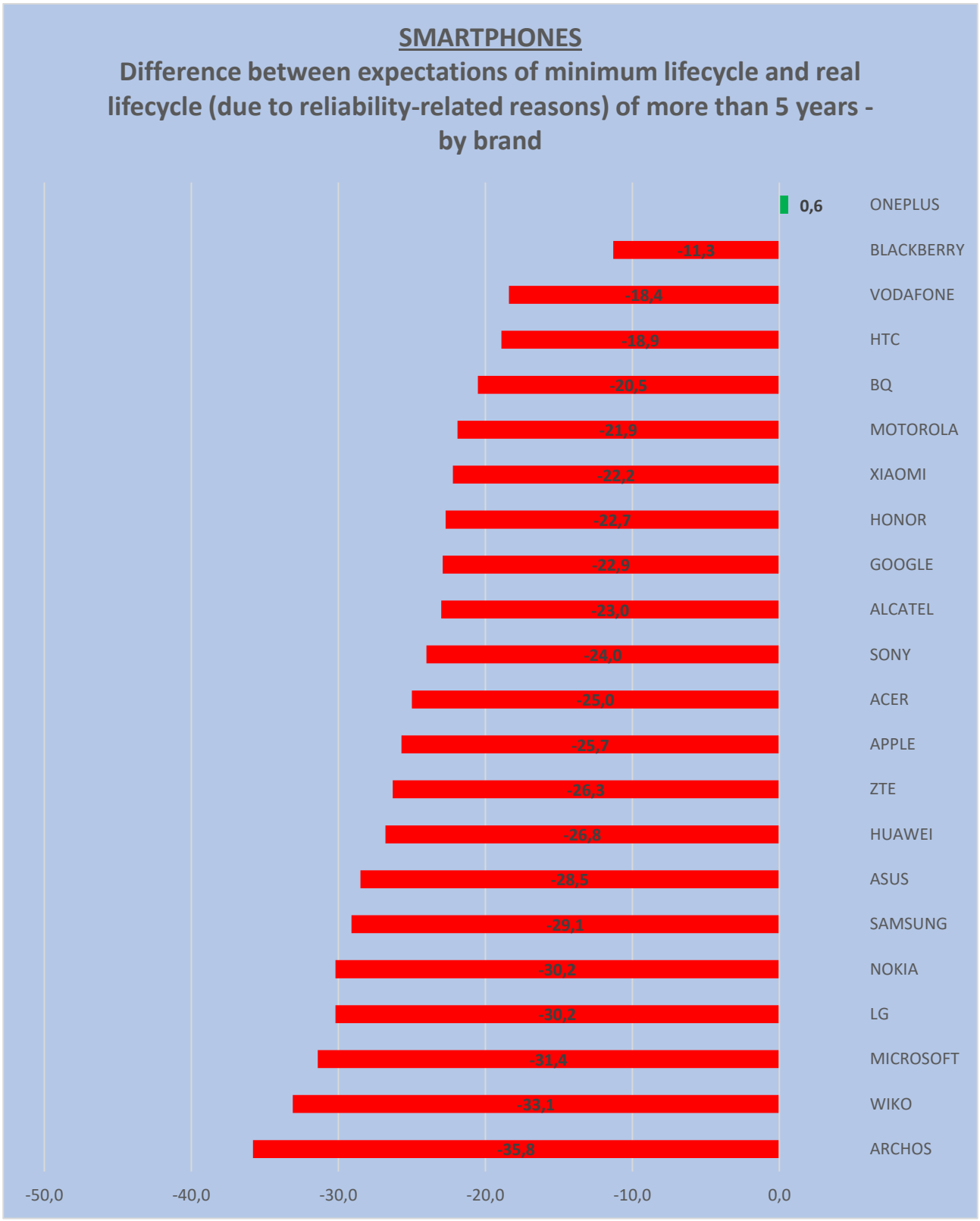
Table 15. WASHING MACHINES - Minimum lifecycle expectations versus real lifecycle (> 10 years %) difference - BY BRAND

	Expectation of more than 10 years minimum lifecycle (%)	Real lifecycle of more than 10 years* (%)	Difference (%)
AEG	48,3%	50,7%	2,4%
Balay	42,9%	45,5%	2,6%
Bauknecht	53,1%	43,4%	-9,7%
Bosch	42,3%	42,0%	-0,3%
Brandt	37,9%	39,2%	1,3%
Candy	30,9%	35,9%	5,1%
Edesa	38,6%	35,2%	-3,4%
Electrolux	32,6%	40,6%	7,9%
Fagor	39,1%	40,6%	1,5%
Faure	28,8%	35,1%	6,3%
Hoover	35,3%	34,5%	-0,8%
Hotpoint	35,4%	31,3%	-4,1%
Ignis	29,1%	41,8%	12,7%
Indesit	30,0%	32,0%	2,1%
Laden	28,9%	35,7%	6,8%
Miele	75,3%	78,0%	2,7%
Sangiorgio	40,0%	51,2%	11,2%
Siemens	48,7%	52,7%	4,0%
Smeg	41,5%	42,6%	1,1%
Vedette	30,5%	38,3%	7,9%
Whirlpool	32,8%	31,8%	-1,0%
Zanussi	42,2%	46,5%	4,2%
Zoppas	41,9%	59,7%	17,8%

***real lifecycle (excluding non-reliability related replacements)**

4.2 SMARTPHONES

Chart 16.



Hi-Tech Devices 2019

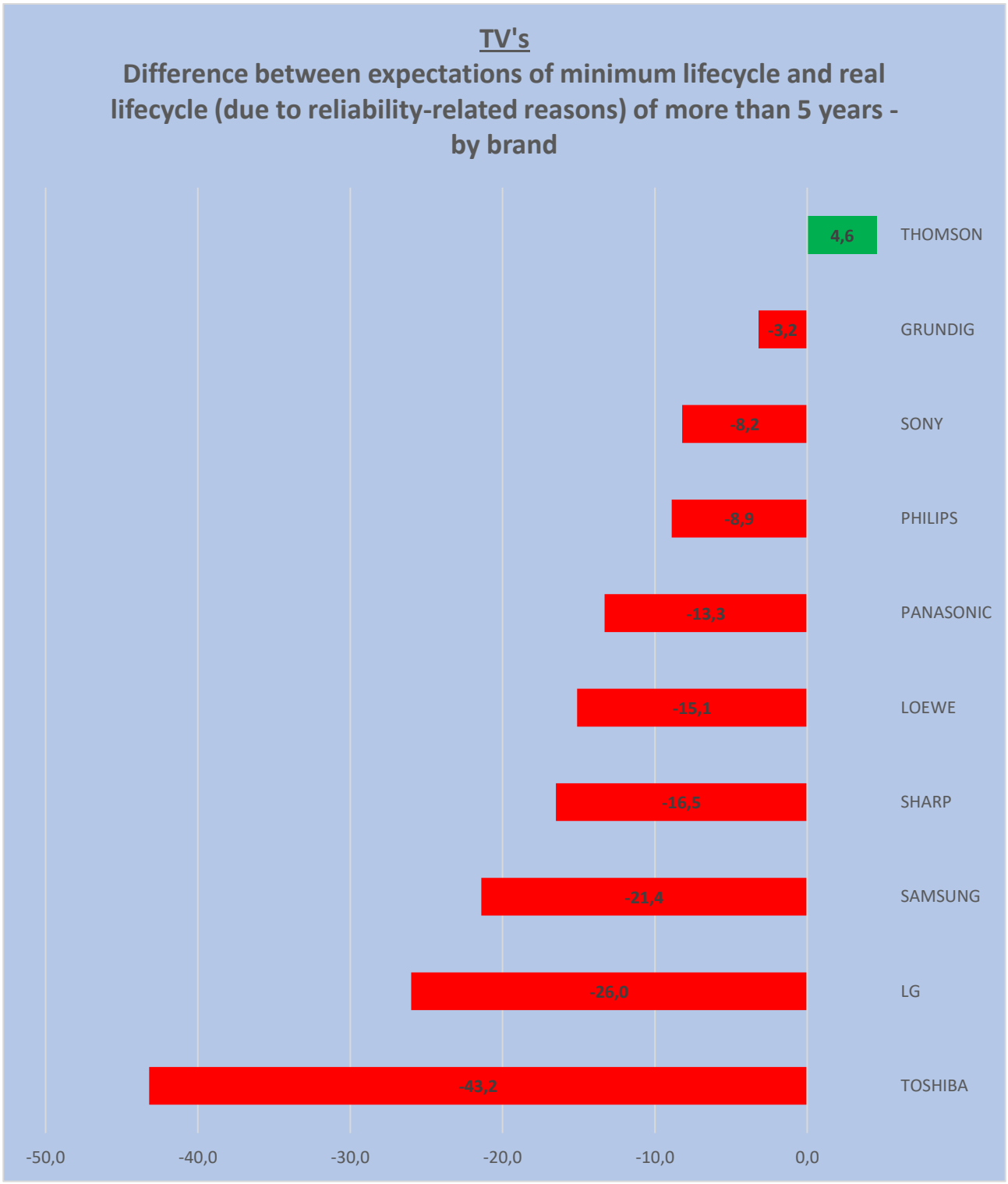
Table 16. SMARTPHONES- Minimum lifecycle expectations versus real lifecycle (> 5 years %) difference - BY BRAND

	Expectation of more than 10 years minimum lifecycle (%)	Real lifecycle of more than 10 years* (%)	Difference (%)
ACER	34,6%	9,6%	-25,0
ALCATEL	36,5%	13,5%	-23,0
APPLE	44,4%	18,7%	-25,7
ARCHOS	39,8%	4,0%	-35,8
ASUS	30,3%	1,8%	-28,5
BLACKBERRY	41,7%	30,4%	-11,3
BQ	25,5%	5,0%	-20,5
GOOGLE	27,9%	5,0%	-22,9
HONOR	22,7%	0,0%	-22,7
HTC	36,5%	17,6%	-18,9
HUAWEI	31,1%	4,3%	-26,8
LG	33,1%	2,9%	-30,2
MICROSOFT	40,7%	9,3%	-31,4
MOTOROLA	33,0%	11,1%	-21,9
NOKIA	45,7%	15,5%	-30,2
ONEPLUS	30,2%	30,8%	0,6
SAMSUNG	38,2%	9,1%	-29,1
SONY	38,7%	14,7%	-24
VODAFONE	29,8%	11,4%	-18,4
WIKO	35,7%	2,6%	-33,1
XIAOMI	23,1%	0,9%	-22,2
ZTE	28,5%	2,2%	-26,3

***real lifecycle (excluding non-reliability related replacements)**

4.3 TV's

Chart 17.



Hi-Tech Devices 2019

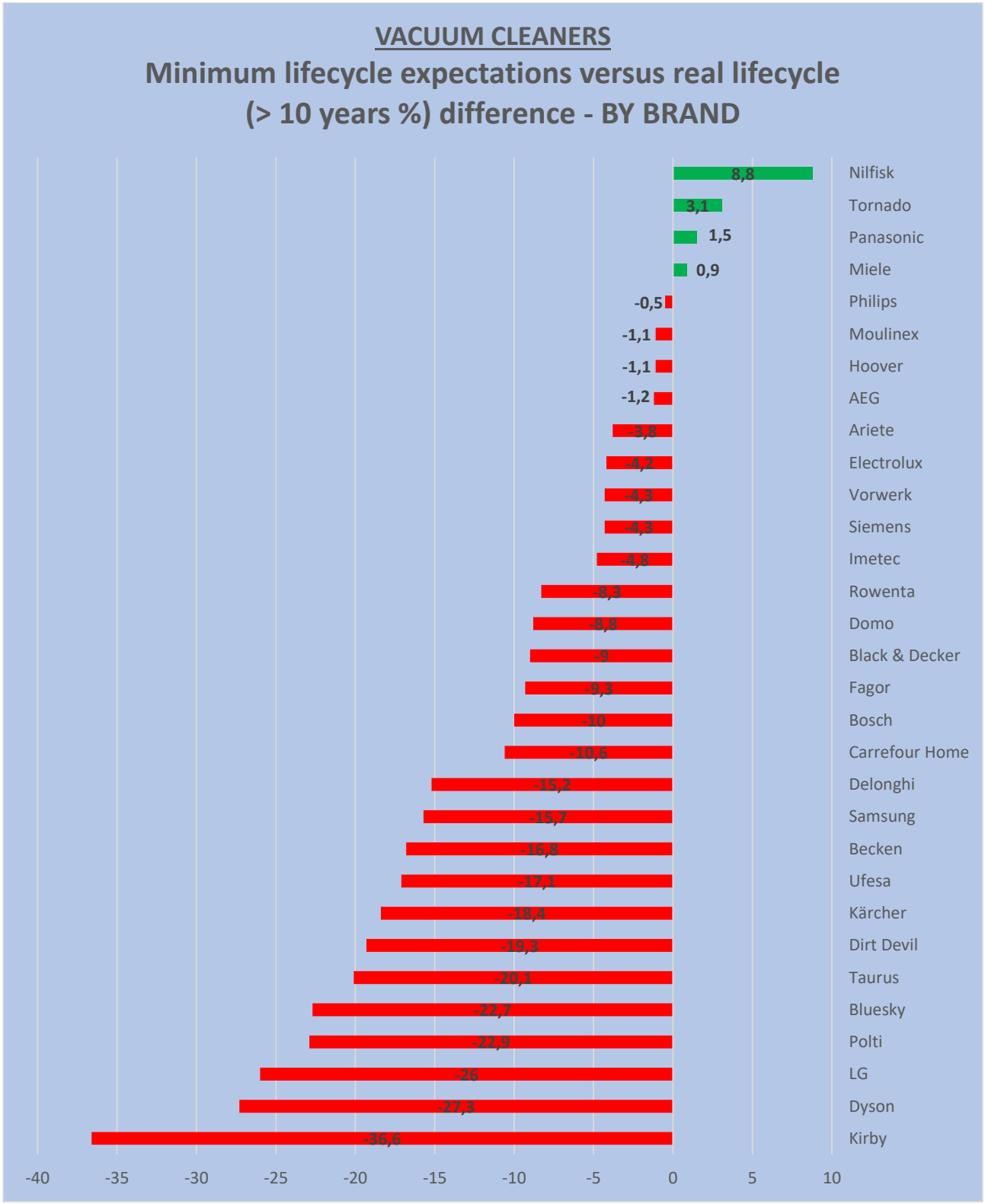
Table 17. TV'S- Minimum lifecycle expectations versus real lifecycle (> 5 years %) difference - BY BRAND

	Expectation of more than 10 years minimum lifecycle (%)	Real lifecycle of more than 10 years* (%)	Difference (%)
GRUNDIG	91,6%	88,4%	-3,2
LG	88,4%	62,4%	-26
LOEWE	95,9%	80,8%	-15,1
PANASONIC	93,2%	79,9%	-13,3
PHILIPS	92,7%	83,8%	-8,9
SAMSUNG	89,8%	68,4%	-21,4
SHARP	92,3%	75,8%	-16,5
SONY	92,5%	84,3%	-8,2
THOMSON	86,8%	91,4%	4,6
TOSHIBA	92,4%	49,2%	-43,2

***real lifecycle (excluding non-reliability related replacements)**

4.4 VACUUM CLEANERS

Chart 18.



SHHA Appliances 2019-2020

Table 18. VACUUM CLEANERS - Minimum lifecycle expectations versus real lifecycle (> 10 years %) difference - BY BRAND

	Expectation of more than 10 years minimum lifecycle (%)	Real lifecycle of more than 10 years* (%)	Difference (%)
AEG	31,3%	30,1%	-1,2%
Ariete	19,2%	15,4%	-3,8%
Becken	26,2%	9,4%	-16,8%
Black & Decker	25,3%	16,3%	-9,0%
Bluesky	36,8%	14,1%	-22,7%
Bosch	34,3%	24,3%	-10,0%
Carrefour Home	22,6%	12,0%	-10,6%
Delonghi	28,0%	12,8%	-15,2%
Dirt Devil	24,2%	4,9%	-19,3%
Domo	14,9%	6,1%	-8,8%
Dyson	47,4%	20,1%	-27,3%
Electrolux	43,3%	39,1%	-4,2%
Fagor	34,5%	25,2%	-9,3%
Hoover	31,9%	30,8%	-1,1%
Imetec	20,3%	15,5%	-4,8%
Kärcher	44,5%	26,1%	-18,4%
Kirby	80,5%	43,9%	-36,6%
LG	42,2%	16,2%	-26,0%
Miele	52,8%	53,7%	0,9%
Moulinex	39,4%	38,3%	-1,1%
Nilfisk	50,7%	59,5%	8,8%
Panasonic	59,8%	61,3%	1,5%
Philips	41,2%	40,7%	-0,5%
Polti	42,7%	19,8%	-22,9%
Rowenta	34,3%	26,0%	-8,3%
Samsung	31,1%	15,4%	-15,7%
Siemens	46,2%	41,9%	-4,3%
Taurus	42,5%	22,4%	-20,1%
Tornado	42,4%	45,5%	3,1%
Ufesa	34,4%	17,3%	-17,1%
Vorwerk	65,3%	61,0%	-4,3%

***real lifecycle (excluding non-reliability related replacements)**

SHHA Appliances 2019-2020 – brands with more than 100 respondents in both current and previous appliances